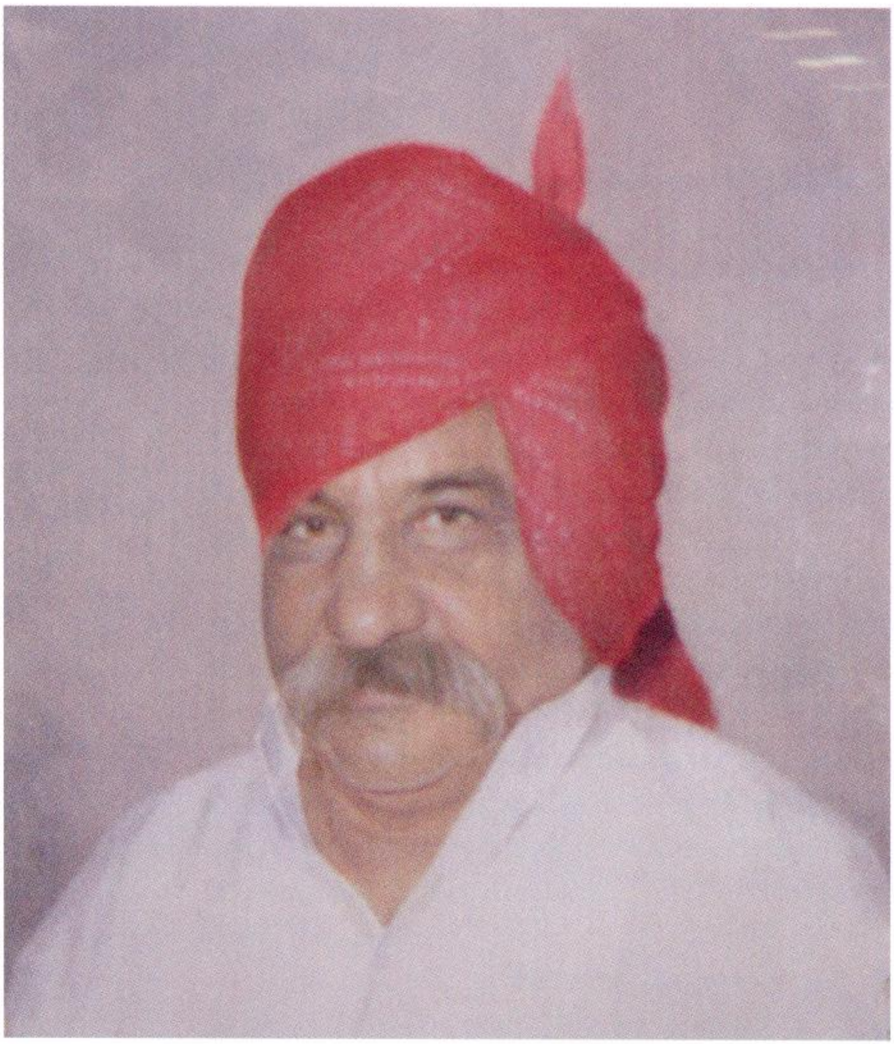
A Civil Engineer's Handbook on
Building Construction

Compiled by

Kumar Properties™
Construction & Biotechnology

DEDICATED TO



Late Shri Kesrimalji Jain

LAST WORD

We, at **Kumar Properties**, memorise those days when we started the housing construction with the aim of **'Building Trust and Reliability'** in every person related to our business. 38 years have passed since then.

Many raw materials, technology, methods, and machinaries changed. Since then, our Architects, Consultants, Engineers, Surveyers and all team members have kept their attitude towards delivering the best quality product.

Many tribulations, crisis, changing market conditions, changing customer demands were exerting a great pressure, but our confirmed faith in **'Building Trust & Reliability'** took us on the proper path.

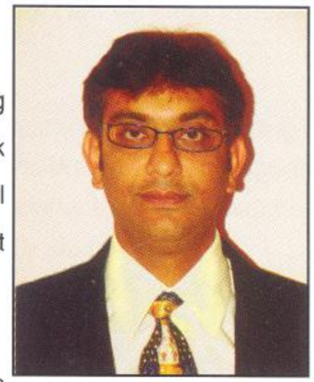
This handbook, as said in the foreword, is one of our efforts to be with the changing time towards attaining '<u>customer delight</u>; which, we feel that, is nothing but the other side of the same coin i.e. **'Building Trust & Reliability'**; not only in the business but also in the society.

This is a time to meet the challenges of the future by developing a healthy team. This is an instance to be happy about the commitments fulfilled & take on the new commitments achieving excellence in every job we undertake. We believe that, all civil engineers will become capable to achieve the excellence by practicing this handbook.

Vimalkumar Jain
Chairman

EDITORIAL

A long time dream has come in reality through publishing this handbook.



We had a great desire since a long time, to present our experience of building construction on a common platform . The purpose behind creating the handbook was to reconfirm our working methods and methodology for sharing it with civil engineers and the people related with construction industry who will deliver the best product and achieve the aim of customer's satisfaction.

The aim behind, is to develop the reader's mindset to face the changing reality of the world, to recognize and meet the new pace of the world without disturbing our endeavor of ' Building Trust and Reliability'.

In view of the wide scope of ' Building Construction Industry', it was an intricate task of editing this handbook. The overwhelming response of civil engineers to participate in preparing this book, made our mission more fascinating and more challenging. A Hugh paper work, scripts, layouts, drawings, pictures, graphics, broachers, technical informations, standards were sorted, handled, read, re-read, wrote and re-wrote and finally refined version of script was derived.

We have tried to convey the most scientific, economic procedures and methods of construction activities in this handbook. We expectantly look forward to get suggestions from the valuable readers. We are sure that the book will be a ready reckoner for every person working for building construction .

We are grateful to one and all that directly or indirectly contributed for preparing this handbook.

RAJAS JAIN
DIRECTOR / CHIEF EDITOR.

PREFACE

As a close associate of Kumar properties since beginning, I am very much proud to announce the publication of this construction handbook.

In the past 35 to 40 years, the building construction Industry went on upgrading its technology, methods to meet the needs of the customers. We, at Kumar properties tried to update with time along with building permanent relations with the customers, contractors, consultants, engineers, surveyors and everybody involved.

The pace of changing demands and lifestyles has taken a big leap in the past 15 to 20 years. To meet this pace of the time, it is very much essential to develop the mindset of the person working on the job. I am sure that this book will serve the purpose to meet this crucial need.

In the changing life-styles, the basic building materials may change but basic engineering concept of line, level and plumb do not loose their importance. This view is emphasized in the section II of this book. The importance of process study irrespective of the material used is made easy to understand in this section. The earlier working styles of piece work contracts force to loose the ability to look at quality in totality. The process study will help to look at the concept of quality in totality. The most essential but neglected part of a procedure is ' Scientific Planning'. The authors of this book have taken proper cognigence of this error and have given sufficient thought for the planning of a project.

The typical construction items have been dealt in section III, right from foundation till the handing over the unit. The specification and the materials of these items may change from project to project, but given procedure shall be taken in correct spirit and can be molded in as per requirement of the project. In the future, we may not use bricks for walling for walls, but concept of walling will not loose its importance. In this manner, section III will be useful as a guideline.

A single residential unit, however well constructed it may be, will become useless, if supportive amenities and services are not developed properly. Therefore, a special focus has been given for development and maintenance of the infra-structural amenities in section IV. The sequence of the chapters will help an engineer to develop a view of 'Part to whole' and broader view from 'Whole to Part'.

The authors of this book have tried to elaborate the construction of certain amenities which will become essential in future. These amenities have been given only as a path-setter and it is expected that every reader of this book shall develop his own thought process to meet the future challenges.

I am confident that every reader after practicing this handbook will become self-motivated. The devotion and involvement of a person working on a job will come from bottom of the heart and as an inherent habit.
Personally as a civil engineer, I congratulate the editing team for their sincere efforts to prepare this handbook.

Mr. Ashok Palesha

M.E. (Structure)

Technical Director, Kumar Properties

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FOREWORD

We the **'Kumar Group of companies'** at **'Kumar Properties'** while, **entering in the 39 Th year of the construction business, are very much pleased to present this handbook.**

In today's **'Continuously Improving'** world, towards **excellence** in every industry, we decided to **contribute our efforts** in the construction industry.

In the strive for **'Continual Improvement'**, it becomes necessary to **Continuously change** the methods, procedures, processes, specifications, technology, the **Mindset of the employees** and **even the strategies of the management.**

Having the goal set for the **'Continual Improvement'** in our mind, **we decided to introspect all the working methods. Work procedures were defined and documented. A formal organizational structure was designed and documented.**

The next obvious step was to prepare a handbook for working Civil Engineers. The handbook will help the civil engineers to work as per the standardised civil engineering practices. The handbook will also help to avoid repetitive reworks. In the fast changing world, the handbook will help the civil engineers, to mould their mindset in accepting the change. In this sense, this handbook is a part of our continuous effort to **concentrate** and **chanalize** our team efforts to achieve **'Customer Delight'**

The handbook is not only particularly for the civil Engineers, but also for everybody related to the industry. This book is also a step to fulfill our COMMITMENTS TOWARDS **'BUILDING TRUST & RELIABILITY'.**

We are very much thankful to everybody, who has exerted a lot of efforts in preparing this handbook.

We will be obliged to receive your suggestions about the book, so as to improvise in the next edition. We hope that, the handbook will be useful to all readers.

KUMAR PROPERTIES

A hundred times everyday

I remind myself that

my inner and outer life

depended on the labours of other men

living and dead

and that I must exert myself

in order to give in the same measure

as I have received

and am still receiving.

- Albert Einstein

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NEED OF THIS HANDBOOK

Civil Engineers are involved in the daily site activities to a great extent. It is a common experience that, civil engineers are required to co-ordinate and attend to many simultaneous activities and events. These activities are spread over a large area and are at different difficult heights. The diversified workstations, work cultures and skills, are required to be attended and supervised through out the day.

The co-ordination of designers, consultants, suppliers, contractors, workers, supervisors and many other variables; is quite exhaustive. Civil engineers work in the directly exposed, changing atmospheric conditions in various seasons, in the available resources and in the time bound frame for completion of the project.

In spite of dedicated hard working, the ultimate product contains many Non-conformities on several occasions. Many times, it is also noticed that the management expects certain outputs and the employee gives a totally different response.

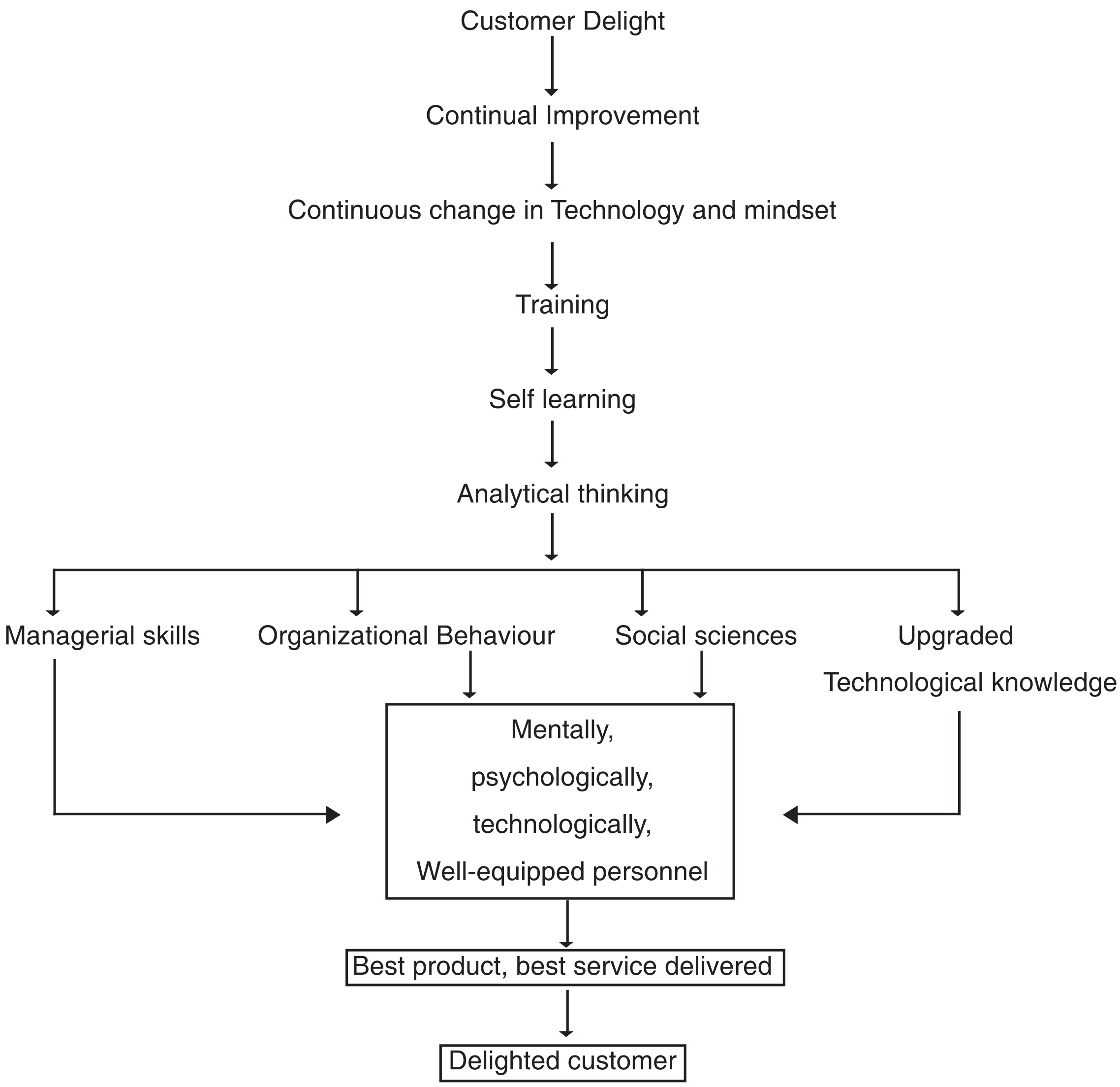
The phenomenon of mismatching of the **Expectations** to **Response** is also observed in everyday life. This means that the employee-employer relations is not the only factor affecting the behavior of a person. Then what are the factors, which affect the behavior and response of a person?

Some of the factors which affect the behavior of a person are
1) Technical ability.
2) Managerial skills.
3) Method of communication.
4) Awareness.
5) Habit of homework.
6) Personality
7) The combination of qualities listed above.

These are the qualities acting simultaneously in a person, but the proportion of each factor is different in each person. It is not true that a particular ability is totally missing in a person. It is possible that a particular ability is not surfaced till a problem arise, but it is present in that person. In difficult situations a person is forced to discover his ability and then learns to use it in proportion. But to discover ability due to forced conditions, is not advisable. Therefore it is necessary to find out a method to develop the abilities. To develop such method, it is necessary to look at a person as a whole, collective personality. This point-of-view will help to locate the correct reason behind the unexpected behavior of a person and then take the remedial measure accordingly.

The process to mould the behavior of a person towards the organization's goals can be easily understood by studying the following flowchart. Let us start with the organization's goal and try to understand the importance of the role of a person in achieving it. The flowchart also proves the necessity of training and self-learning in achieving the organization's goal.

A simple Flow-chart **explains the total process as shown:**



Thus, it is clearly evident from the flow chart that it is necessary to remain update to achieve the common goal. The continuous change demands continual training. Any change, if adopted abruptly, creates friction in an organization. A planned training helps to reduce the friction in the process of continual change. In the Building Construction Industry and also in the Total Construction Industry, it is a widespread feeling that, there is no need for separate training. The direct on-the-job training is sufficient.

In this process of on-the-job- training, the product gets hampered in the quality norms and even the time over-runs. But these facts are overlooked for various reasons.

There are some organizations which have understood the importance of a separate training program, but these are exceptions only.

The fact remains that, what about the civil engineers who are working and have no means for training, and have no time and energy after the job hours, for the training?

The available training programs outside the job organizations are scattered. Many of the programs are conducted without detecting the 'Training Need' of a particular candidate. The available books are designed for a particular skill and have no linking with the other skills.

Therefore it is a need of the time to have a platform, which will look collectively at various training needs. A platform fulfilling the following necessities becomes essential:

1) It will cover the various aspects related to 'working-together' towards a common goal.
2) It will help the participant to find out his own, training need.
3) It will offer a choice for the participant for selecting a specific topic to suit the training need.
4) It will be available any time to suit the participant's available time.
5) It will facilitate the 'Self-learning', in the absence of a trainer.

The purpose of the desired platform will be served by this handbook. Therefore best efforts are put in designing this Handbook.

The first section of this book is devoted for the subjects related to acquiring **'Managerial skills'** and for learning **'Organizational Behaviour'**. This section also deals with the various qualities related to the personality, and helps to acquire the necessary skills.

From the section II onwards, more emphasis is given to explain and understand the importance of:

1) The **interdependence** of various **trades** in the construction industry & especially in the building construction industry.
2) The activities **demanding multi-trade skills** in a single activity, and hence becoming critical, during the work.
3) The method for **defining a process** for a peculiar item as per the **uniqueness of a project.**
4) To understand the **difference** between **activity management** and **project management.**
5) To **develop a mindset** in which the **scope of project management** is always **remembered** while managing a **single** activity.

The scope of the Handbook starts from the step of self-learning in the flowchart, guiding us towards customer delight.

Considering the importance of continual change, it will be a great help, if the readers will give their suggestions to meet the purpose of this Handbook.

CONSTRUCTION INDUSTRY: A RETROSPECT

The construction industry can be called as the mother of all the other industries. People stay at **Home,** travel on **Roads,** drink water from **Wells** & **Dams**, work in a **Factory** or a **Office**, get entertained in a **Theater** & return to their **Home** for rest & sleep.

In this way, a person is **consuming a product** made available by the **construction industry** during 90% period of his lifetime.

For setting up any new industry in any sector, **construction industry** has to **create** the **basic infrastructure**. Therefore to mould the future of such a big industry, it will be better to understand the present.

To understand the present situation, many-a-times a comparison is made between two companies in the same construction field, e.g. a comparison between two 'contracting firms' or a comparison between two 'promoters & builders', etc. but this type of comparison has its own limitations. The conclusion of such comparison gives us only **pseudo-satisfaction**.

If at all, a comparison is to be made; make it with an industry, having more excellence than construction industry.

In this point of view, once a group discussion was arranged amongst project managers of construction industry.

The subject for group discussion was **'Similarities & Differences between construction industry & other engineering industries'.**

Almost all the aspects of comparison surfaced as the discussions went on. The atmosphere was very healthy & interesting. The discussion ended with the conclusion that we **must have a document** of today's discussions.

The contents of discussion show that construction industry **has a lot of a talent, enthusiasm, and micro level thinking ability, dedication, and technically sound & hard working people**. The only major drawback seems to be the lack of '**Systematic organized working**'. Here, the **other industries surpass** the construction industry by miles.

The other problem surfaced, that of, **change** in **design** & drawings **during** & **half way after** the production (construction) starts. This problem is not taken seriously by consultants, architects, developers, engineers, customers, under the banner of **'change in demand of the client & as per the site conditions'**. But actually, major of the times, the problem arises due to **lack of foresight & improper communication during the design stage.** This problem further deteriorates the aim of 'organized working'. This **ultimately** results in **a product** having **many non-conformities.**

Another serious observation is that, many of the civil engineers are lacking the 'ANALYTICAL MINDSET'. This ability can be developed by practicing this handbook on site.

The degree of automation & mechanization is also one serious aspect to be given thought to. But still, during the discussions it was decided that let us fully disintegrate our production process, study it part by part, derive the conclusions & then integrate (re-organize) it to have clarity of thoughts. This will help us to evolve a new method to work in an '**organized way'**.

The conclusions of the group discussions are as follows:

A COMPARATIVE STUDY

Sr.No	Norms for comparison	Other Engineering Industries	Construction Industry
1	Manufacturing Process:	Very well defined & documented before starting the actual production.	Not very well defined & documented beforehand.
2	Methodology:	Very well decided before starting the production.	Very well decided only for very big projects as Dams, bridges, etc. Not well decided in Housing projects.
3	Periodic review of process & methodology:	Review is taken frequently as a habit & accordingly processes are refined, documented & followed.	Most of the times, review is taken only when problems arise during production.
4	Material handling:	Is treated as serious activity & scientific methods are used for material handling in an economic way.	Material handling is not given much importance except in big projects & hence cost go up in improper handling of materials.
5	Time & motion study:	Every process is studied for these two aspects regularly & whenever the technology changes, fresh study is done.	Many a times this study is not done due to lack of awareness.
6	Time schedules:	The time scheduling is a daily practice. The coordination of various resources is therefore done more effectively.	Time scheduling is neglected most of the times. **Time & Cost over- running** is a daily practice. Resources are either under-utilized or totally exhausted.
7	Technological changes:	Rapid technological changes take place with reduced **change -over** time.	Very slow technological changes take place. New technology(if adopted)is accepted with reluctance.
8	Degree of automation & precision:	Highly atomized, mechanized & hence precision in the product can be achieved to a very high standards.	Less atomized & mechanized. Degree of precision & quality changes with the workers' skill & moods.
9	Training facilities:	Training is accepted as a part of production procedure & hence regular training programmes are conducted.	No separate training facilities are available. Direct, on the job training takes place along with the production procedure.
10	System approach:	Positive approach towards laying down system & following it. **(System is for me)**.	Negative approach towards laying down system & very much reluctance towards following it. (If at all compelled to be systematic, then the approach is **'I' am for the system**).
11	Type of production process:	Since the same product is manufactured on **mass scale**, a repetitive **cyclic process** is followed. The **cyclic process time is less**. Therefore all the variables **are** brought under control & accuracy is achieved.	Every construction project (product) is **unique** & **needs** new production **procedure to be defined**. The process of an individual item may remain same. The **cyclic process time** is **more**. The process is linear for a long time. Therefore the **number of variables increase**, making them difficult to **bring under control** & the accuracy decreases.

Sr.No	Norms for comparison	Other Engineering Industries	Construction Industry
12	Place of production & assembly:	Usually under one roof & away from the ultimate consumer of the product.	Production (construction) places change from time to time. Production & assembly is done in the premises of the ultimate consumer (cast-in-situ).
13	Nature of organization:	Well defined from top to bottom. This results in better outputs & quality products. Selection & posting of personnel is more scientific. This results in better **job satisfaction** & **Job Assurance.**	Many times not defined. This results in unorganized working styles & reflects in the bad quality of the product. This leads to **uncertainty** in job satisfaction as well as job assurance.
14	Change in design during production:	Avoided fully during production except, very much extra-ordinary situation arises.	Many changes take place **during** the production (construction).
15	Mind set of the personnel for different changing situations:	The most of the personnel **are prepared** for this type of changes & have the capacity to **'analyze'** the **new situation** in a very **short time** & to re-organize efficiently.	Most of the personnel **are not** prepared for such situation & lack the ability to 'analyze' & re-organize the new situation.
16	Geo-physical scope:	Most of the production is within a fixed **'Geo-physical (factory)'** limit. This results in timely & effective communication & lesser fatigue.	Most of the production (construction) is spread over a big 'Geo-physical' factory limit. This results in delayed communication & increase in project cost, more fatigue, etc.
17	Special, professional problems:	Workers are literate & organized but also sometimes **united** for their own interest rather than 'Organization's Interest'.	Majority workers are illiterate, untrained & unorganized, & hence are not united as yet.
18	Peculiar Hurdles:	Once the factory is erected & started; the hurdles due to 'land title' & 'acquisition process' are very rare.	Even after starting the production (construction) the land title & acquisition problem is a typical hurdle in construction industry.
19	Quality controls & inspections:	Usually quality of the product is defined & inspected **before, during & after** each process. **Quality is quantified in standards. Very less dependence on visual checks**.	Very rarely, the quality of the product is defined. Inspection is done at random. **Quality is rarely** quantified in standards. **More dependence on visual checks.**
20	End product:	Possess all the pre-decided properties, giving satisfaction to the end users.	Lacking many of the pre-decided properties, having unexpected faults, resulting in inconvenience to the end users.

THE HISTORY OF CONSTRUCTION INDUSTRY :

To overcome the present problems of the construction industry, let us have a look in the past of the industry.

Possibly, it is the heritage of construction industry to work in an un-organized way. Historical monuments' involving great construction activities is looked upon, only as a product of creation & imagination of **Great Personalities**.

The historical myths of **Lord Bhagiratha** bringing **Ganga** to the Earth, **Lord Parshurama reclaiming the seas**, **Lord Rama** building a **'Setu'** to reach **Lanka** are taken as **miracles**. However; these activities **must** have been a result of **'organized construction activity'**.

These examples & the examples of **Taj Mahal**, **Pyramids & the Great Wall of China**; show us **apathy** towards **preparing & preserving documentation of construction projects**. This tendency is perhaps also shown by today's project managers.

The history of construction industry is full of various construction materials (Lakshagrih to marble house), spectacular craftsmanship, durable, stable structures, oldest water supply & drainage schemes & what not? Simplest technology was developed as per the local needs & available resources. One can learn a lot from it.

THE FUTURE OF CONSTRUCTION INDUSTRY:

The future of the construction industry can become bright, if we accept the facts of the present & the past, courageously.

The construction industry will face the challenges of the future with confidence through 'strive for excellence'.

WHAT ARE THE CHALLENGES OF THE FUTURE?

Big towering buildings on the moon in the $1/6^{th}$ gravity force than the earth, floating hotel buildings in the space, big solar electricity generating stations mounted on spaceships, folding type 2 BHK flat, are some of the future challenges.

FINAL CONCLUSIONS OF THE GROUP DISCUSSIONS

1. Some people in the construction Industry may not agree with the comparison done as above, but this is a general scenario of the construction industry, as on today.
2. There are definitely some organizations that are doing **exceptionally well** in construction industry. But these are exceptions only. All of us shall make efforts to **work exceptionally well.**
3. The quality consciousness and the efforts towards customer satisfaction are definitely picking up in a positive direction. These efforts shall be made more effective with a time frame.

4. Maximum item wise production processes shall be defined and documented.
5. **Checklists** shall be prepared in brief for each item **before, during and after the process** to enable the site engineer to deliver effective supervision of various items.
6. **Develop** a habit amongst the civil engineers to prepare a specific procedure as per the ‘uniqueness’ of a specific project/item.
7. With the above target in mind, a handbook shall be prepared for civil engineers, especially working in the field of building construction/ ownership flats construction.
8. **A periodic review** of this **handbook** shall be taken and revisions shall be made accordingly.

THE PSYCHOLOGY OF AN ENGINEER

In the light of the **'Continual Improvement'** in every aspect of life, it is essential for an engineer to set his mind for adopting **'Continuous Change'.**

This creates a need to understand the psychology of an engineer at work. This need surfaces when the **'Actual response'** given by an engineer does not match with the **'Expected response'.**

What are these **expectations**?

In the construction industry, the job expects two basic skills from the civil engineer, first the **'managerial skills'**& second (but simultaneously) the **'Applied Civil Engineering skills'.**

Civil engineers learn the **'Theory'** of the technology, in the formal college education. But they are not taught much about **Application & Implementation** of the theory on the job, in an **organized manner.**

When the Civil Engineers actually start working on construction site, they are expected to **Organize & Manage** the work, which they **are not taught for,** during formal Education.

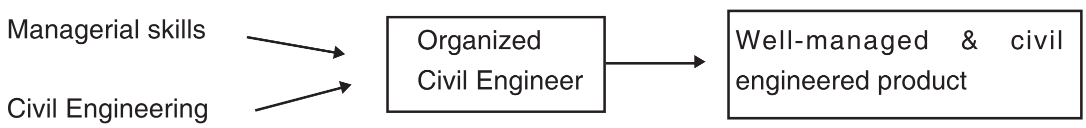
Therefore it becomes their top priority to achieve control over **Manageability** but in the process, they go on **loosing** their **control** over **Civil Engineering practices.**

Most of the civil engineers feel that **'Civil engineering'** & **'Manageability'** are two forces acting in **opposite** direction**.**

The initial Model about working on a product, in a Civil Engineer's subconscious mind, is as follows:

(MODEL No. 1)

Whereas the job expects an engineer, the process and the product in the following model from an engineer



(MODEL No. 2)

The figures are self-explanatory.

In the first model, it is seen that, a civil engineer has **No place** in the total process, whereas in the second model, a civil engineer has a **prominent role to play** to achieve the results.

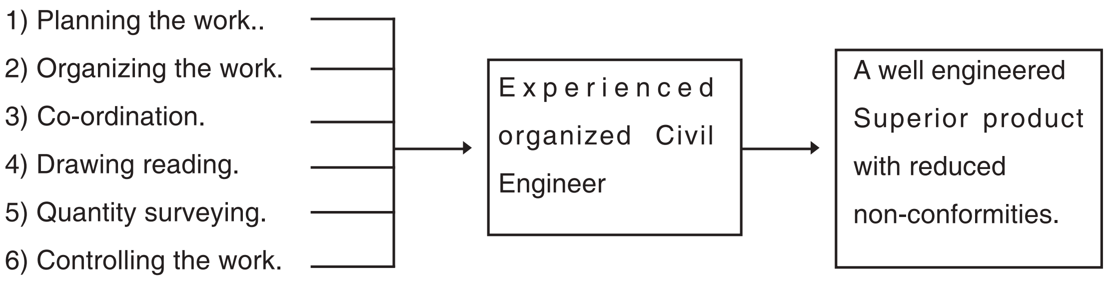
We, as editors of the book, **are more concerned** for a civil engineer who particularly **remains stuck to the first model**, as perceived by him. **The very purpose of this book is to lighten such an Engineer's mind**

towards the second model. A civil engineer, who **understands** and **implements** the **second model** & rejects the first , **becomes a successful 'Engineer- manager'.**

The model explained above, is a very **simplified** one. As the complexity of a project goes on increasing, the model also becomes complex. It seems apparently, that the expectations also go on increasing as per the complexity of the project and the need of the time.

A COMPLEX MODEL

Expected abilities



An engineer perceives **that, the management is** expecting too much **from him.**

Is it a fact?

The model, if observed carefully, shows that the expectations are not increasing**,** but the **scope** of managerial and engineering skills has increased.

Therefore an engineer requires **Analytical mind** to understand the revised situation. If this basic ability of **analysis is lacking,** then the civil engineer is **thrown out of** the total model and returns to the model one, in which he had **not kept any place** for himself in the beginning. Therefore he mentally returns to the level of college education.

At this juncture of time, if his **'Ego'** is balanced, the engineer accepts the fact, and starts anew from the scratch by a **Self-learning process.** If his **'Ego'** is not balanced, then the engineer never understands the reality and **keeps on swinging** between **'success'** and **'failure'.**This is a general observation of the psychology of an engineer.

To avoid such embarrassing situation, an engineer shall develop the **'Analytical'** abilities. This will help an engineer to learn to **Manage** the work in an **organized manner,** simultaneously to learn the importance of working in a **'Team'.** The importance of choosing a proper skill or a proper quality to suit the need of the situation can be learnt by observing the behaviour of the collegues, analytically.

This process of **self-learning** leads to introspection and a mind, striving for **'continual improvement.'** Once, this type of mindset is developed; it will help the engineer to derive **new methods, new procedures** to suit the **changing specifications** and **changing life style.**

SUCH AN ENGINEER, INTELLECTUALLY AND PSYCHOLOGICALLY WELL EQUIPPED, FACES THE PROBLEMS IN ANY SITUATION TO DELIVER THE BEST PRODUCT. THIS POSITIVE ATTITUDE ALSO HELPS IN HANDLING THE PROBLEMS IN THE PERSONAL LIFE.

SELF STUDY

All of us are aware of a fact that the knowledge of the mankind about the universe is increasing with rapid speed. Knowledge is exploding.

The **rate** of addition to knowledge is also **increasing**. This is putting a great pressure on the **modern technology & technocrats**. There is not a single moment, when we feel that we have ‘ updated the knowledge’, because in the mean time, more knowledge is added in every field of life.

Let us be cautious in distinguishing between knowledge & information. Knowledge is the **sequential arrangement** of the **scientifically proven** facts. Information is anything related to the subject and it **need not be** a **scientifically proven** fact. Therefore, sometimes, accumulated information is misinterpreted as knowledge and we go on accumulating useless information. This may bring us in a critical situation during some crisis.

Institutionalized education pattern is unable to update our knowledge, for obvious reasons. Any institute has to **draw a line in the Time-span**; while designing its curriculum. Obviously, the knowledge accumulated after that control line is not available in the institutes. By the time the new **curriculum** is designed; we become the **‘past student’**. This **creates** the **necessity** of **self-learning**.

Therefore let us not wait for somebody to come & find out our weakness & then train us. Let us also remember that such type of teaching will not be necessarily gentle, caring. Many times, this type of training on the job could be harsh & disgusting, because the trainer’s mood may not always be good during the work.

Therefore to acquire the knowledge in a systematic way we shall develop our **own method.** A method, if followed step by step, will help us to acquire the knowledge, qualities and related skills. The method is as follows :

1. A simple SWOT analysis (strength, weaknesses, opportunities & threats) of our personality will help us to locate our strengths & weaknesses.
2. Self assessment, about real strengths & real weaknesses.
3. Locate own weaknesses and arrange them as per the priorities of elimination.
4. Acceptance of a particular weakness.
5. Define own training needs, to overcome a particular weakness.
6. Do the self learning with the help of various mediums, persons, institutes, etc.
7. Do the self monitoring of everyday program as per decided time table.
8. Follow the same procedure to overcome other weak areas after coming out of a particular weakness.
9. Utilize all the ‘Strength & Opportunities’ to overcome as many ‘Weakness & Threats’ as possible.

To decide the strengths and weaknesses and to help in the self-assessment, answer the following questions and do the self ranking.

1. . Openness for self-analysis:

Do I accept my weakness & try to overcome it?

Do I apply my all best qualities during my work?

Do I get angry when somebody points out my mistake?

2. Self-Initiative:

How many times do I start some activity or discuss about starting it with my seniors, out of my own initiative?

Do I require constant pushback from others ?

3. **Sound knowledge of the profession:**

Can I solve the problems related to my profession independently, without the help of seniors?

Am I aware of the latest developments in my profession ?

4. **Continual Improvement:**

Do I try to overcome my weakness as soon as I notice it ?

Do I feel that I am perfect and others are not ?

Am I open to accept new technology & procedure ?

5. **Sense of responsibility:**

Do I feel that the things happening around me are not of my Concern ?

Do I accept the errors, mistakes in my work or keep on Arguing ?

6. **Self-disciplined:**

Am I disciplined because of my own habit ?

OR am I disciplined because of some compulsion or condition ?

Can I set example to others by my disciplined behavior ?

7. **Team Spirit:**

Do I ever give the credit of good work to my colleagues ?

Do I appreciate other's qualities ?

Do I try to elevate the weakest link of the work chain with the strongest link ?

8. **Involvement:**

How many times do I feel that, this is my own work ?

How many times do I even forget to have a cup of tea during my work ?

9. **Time Management:**

Can I plan my time to suit the work conditions ?

Do I miss my planned work due to change of priority during some time ?

Can I visit the worksite at the correct checking time of a particular activity ?

10. **Cost conscious:**

Am I handling all the resources to the optimized level ?

Do I contribute in reducing wastage & repetitive repair works ?

11. **Creativity:**

    How many times I think of some change in the working procedure or change in materials ?

12. **Tenacity:**

    How vigorously do I take the follow-up of a particular activity till the completion of it ?

    Do I just leave some of the activities half way after making a good start ?

    How meticulous am I ?

13. **Overall Presentation:**

    How effectively do I present my thoughts, through various means ?

    How much neatness is there in my work ?

14. **Integrity:**

    How many times do I deviate from my values, principles ?

    Can I use the sum total of all qualities in a balanced manner ?

15. **Target achievement capacity:**

    How many times do I set targets ?

    How many times, daily, weekly, monthly, do I achieve my Targets.

16. **Personality:**

    Do I think about my behavior, dressing, attitude, positive approach ?

    Do I make some efforts to feel others good in my company ?

These questions are given as a guideline. With the help of the answers to these questions, the self-assessment and next steps shall be followed to define the training needs.

COMMUNICATION SKIILL

Mankind survived over the other species because of its special skill of '**communication'.**

Sometimes it is said that, the mankind survived because of **'Intelligence'.** But it is a **half-truth. Intelligence without communication extinguishes** with the time. **Intelligence with communication, creates** the **heritage of knowledge**. The knowledge, the information, the experience of one generation, is passed on to the next generation, only because of communication.

The mankind took **thousands of years** to **gather** the **knowledge** and the same can be **handed over** to the next generation in **some few years of schooling**. This is the **magic** done by **communication**. But even in today's era of information technology, we face the problem of mis-communication. Many messages from phone calls are misinterpreted due to improper communication. Many things are **made** & required to be **remade** because of the misleading communication.

Therefore let us try to understand about communication, proper communication & many aspects of the same. Communication can be defined as **a process of passing information & understanding the same between oneself or more persons.** Communication binds people together.**Communication** results in effective **teamwork**.

The process of communication involves:-

1. **Ideation** of communicator or formulation of the message.

2. **Encoding** means translating the ideas in proper language.

3. **Transmission** means conveying the message through proper channel.

4. **Receiving** means tuning the Receiver to receive the message.

5. **Decoding** means translating the words into ideas.

6. **Action** means the necessary behavioral change in the receiver in consequence to the perceived idea.

7. **Feedback means** the receiver sending the information about the message he has received.

If the process is studied carefully, we come to the conclusions that-

1. When a communicator starts communication **without** his proper **Ideation**, the communication remains empty. If the communicator goes on communicating **without 'formulating'** his Ideas, **nobody listens to him.**
2. It is equally important for the communicator as well as the receiver to do the **Encoding** & **Decoding** exactly in the same essence of the language, otherwise the communication is **mis-interpreted**.
3. If the communicator chooses a wrong channel (medium) for transmission; the message is taken in a wrong way.(A person giving verbal instructions regularly, starts giving the instructions in writing all of a sudden. In this case, the **instructions** could be very simple & **clear** but the **abrupt change of medium** (verbal to written) will pass a **'wrong'** message. This could create **mis-understanding** between; an otherwise **good team**. Therefore selection of proper channel (medium) is equally important.
4. If all the other parameters are controlled but the ' Receiver' is not 'tuned' to receive the message; the

whole purpose of communication is lost. Therefore the communicator shall confirm while transmission that, the receiver is tuned properly to receive the message.

5. The communicator (atleast during the first communication with a new Receiver) shall observe carefully about the Decoding done by the receiver, is matching in meaning to the encoded message. If the encoding & Decoding are not matching each other; there is a threat that the receiver may take a wrong Action. In this case also the purpose of communication will be lost.
6. The Receiver is supposed to give feedback about the message received before taking any action thereon. Many receivers get confused between feedback and action. **The decision could be not to take any action but they take the action of not giving the feedback.**
7. When the **Ideation** of communicator is exactly **perceived** by the **receiver** in his ideation; we can say nthat, it is the **.'Proper and complete communication'**.

If, all of us will understand the process seriously & communicate in the scientific way, we can form a Good - Team, can give better results, can avoid wastages (of time, material, money) & the most importantly, can be **LISTENED** by all.

TYPES OF COMMUNICATION

Upward communication:

In any organization, the communication made **from the bottom to the top authority** is called as upward communication. This is a very important communication for the health of any organization. But the **conventional autocratic habits** are still seen, right from the foremen, supervisor to the top manager about a 'faith' that **'Do not listen to the subordinates'**. They **refuse** to become **'the Receiver'** of any message from the subordinates. This is the worst & horrible faith leading to **big loss of men, material and machinery**.

Downward communication:

This is a communication made from **top to bottom authority** in any organization. In this type, the receiver is supposed to give **feedback before taking any action**, but unfortunately is not practiced. This leads to **mis-interpretation** of the message and results in **wrong action.**

The 'one way communication' in the order form is another bad practice. The **communicator** is **not** at all **bothered** about the language he is using, the **medium for transmission** being used, the **'Perception level'** of the **'receiver'** etc. Obviously the **action** taken by the **Receiver** as per his **'Perception'** becomes a **' gamble'** between **'wrong or right action'**.

Peer communication:

This is an informal communication developed by the persons working together. This is neither upward nor downward but is horizontal. This communication is a good sign for a project to be in good rhythm.

Communication can also be classified, as per the medium used. The verbal and written communications are two types, as classified as per the medium.

In the **verbal communication,** the body language and the tone of the communicator plays a vital role.

In the **written communication,** the meticulous selection of words, phrases, language play an important role.Engineering Drawings are also mediums of written communication.

In any type of communication, **the success is governed by the clarity in the Ideation.**

COMMUNICATION AT CONSTRUCTION PROJECTS

We know that, in India, a construction project involves a variety of people. From Illiterate workers to top managers having **different mothertoungs** are working hard in the heat, rains & colds**. (Kannada, Telgu, Tamil, Punjabi, Udia, Bhojpuri, Hindi, Marathi, Hinglish & English are some of the languages).** This creates a lot of problem in the communication.

A formal communication system is not defined at all. The technical language is molded as per the **'perception'** capacity of the **Receiver**. The **informal communication** is developed by the people on the field as per their **level of 'perception'**. Inspite of this **CHAOS**, the works are carried on & completed in **Record times.**

But behind the successful screen, there are, the works demolished & redone, accidental deaths, wastage of manpower & material, the unseen lost energy in trying to understand the drawings (a written medium for communication) etc. All these behind the screen losses could be avoided, if proper 'communication' can take place.

A fresh worker or a fresh supervisor, Engineer, Manager has to start his training from the **slang**, the **'Real Terminology'** of the various items**.(Gutti, tacha, Khacha, Gabadi, Pharak (face) etc.)** As soon as they learn the basics of this slang, they develop their own **'informal communication' system(Peer Communication)**. This is a **healthy sign** for a project in **'Good Rhythm'.**

All these shortcomings can be overcome by designing a proper communication system & by training the involved personnel. This will result in **a good team formation**, precision in the work & in better quality product.

COMMUNICATION WITH CUSTOMERS

The conventional meaning of **'customer'** is the **ultimate consumer** of the **'end product'.** The other meaning of 'customer' as understood in the TQM system(Total Quality Management System) is every worker of successive activity in the production chain. But the importance of communication remains same if we aim at the **' Delight'** of the customer.

A few tips for sales manager for the **fruitful communication** with the customer are-

1) Listen to the customer carefully. The appearance, body language, eye contact of the sales manager shall transmit**, assurance** and **confidence** to the customer.
2) Many times **customer** is **not sure** about his exact need, demand. Therefore the aim of the sales person shall be **to shortlist** the exact **needs** and **demands** of the **customer**. This will help the communicator (salesman) to finalize the **ideation** on his part. The **clarity** of **ideation** (the clear-cut formation of the message) results in successful communication.
3) Once the ideation is complete, select the proper language (words, phrases, technical-words) which suits to the language, ethnic background and psychology of the customer. This is nothing but the **encoding** of the ideation.
4) Transmission: Select proper medium for transmission of your message e.g. display some brochures, photographs, other customers' feedback, along with the verbal message. Remember that **only words** have **no meaning** or **many meanings**. Therefore words with suitable body language, gestures, add to the context of the message.
5) If the customer is uneasy or is in a hurry, he will not be properly **tuned** to receive the message. In this case, a **good idea transmitted** in **good language,** through a **very good medium** will not be **received properly** by the **customer**. Therefore **confirm** that the **receiver** is **tuned** and transmit the message, only thereafter.
6) If everything is done properly, but if the perception level of the customer is different than that of the sales man; the message will be **decoded** for a different **meaning**. This means that the communicator shall also confirm that the idea transmitted by him is exactly perceived by the customer in the **same meaning.**
7) Now comes the turn for the perceiver to take the **action**. A decision taken as not to act is also an action. In **such case**, many people **think** that **no feed back** is required. But the decision taken as **'not to act'** shall also be **conveyed** to the concerned to **avoid confusions**.
8) If the perciever (the customer) does not give the feedback, the communicator (the salesman) shall take the follow up till he gets the feedback.
9) The total cycle of communication completes only after receiving the feedback.

ORGANIZATIONAL BEHAVIOUR

SETUP OF ORGANIZATION

INTRODUCTION :

The civil engineers, while working on the scattered sites, offices, just **forget that**, they are **a part of an 'Organization'.** It happens, because our organization is not seen, as is seen in a **covered factory**. We do not work under one roof because our **worksite itself** is **exposed to the sky** and we are supposed **to build a roof** for others.

When, we **forget** that, we are a **part** of **an organization**, it leads to:

a) We forget the organization's goal.

b) We work **more on personal intuitions** and forget organised work.

c) We forget the **importance of communication**.

d) We get stuck to **'activity Management'** and loose the overall view of **'Project Management'**.

e) We become **unable to develop social ties** in the organization.

f) We develop either a **strong 'Ego'** or an **'Inferiority complex'**.

All these things lead to **'Mismatching'** of **'Actual Respon**se' to the **'expected Response'** on many occasions.

Therefore, to overcome these faults, let us try to understand about an **'Organization'** and **'Organizational behaviour'**.

ORGANIZATION

An organization can be defined as: A **consciously co-ordinated social unit**, composed of **two or more people**, that functions on relatively continuous basis to achieve **a common goal or a set of goals**.

The definition is simple to understand. When **two or more people** are required to work together to achieve **a common goal**, the relation between them must be **consciously co-ordinated**; otherwise anything of the following will take place:-

a) The common goal will not be achieved.

b) The relations of the people will be strained.

c) Undue stresses will be developed in a person.

d) The whole purpose of the organization will be lost.

Any **two persons** are **never Identical**. It does not mean that one is superior and the other is inferior. It means that, the **proportions of qualities** and **ability to convert** them into **skills**; is different in every person. These **factors** make it difficult, for any two (or more) persons to work together.

This creates the **necessity** to **consciously co-ordinate** the **relations** of the people working together.

One may be working at any level in an organization; but he is required to form a **'Team'** to **achieve the goal**. Team is nothing but a small organization, inside a big organization, but more tuned towards **small targets**. These small **targets**; meaning a **set of goals** for different teams, **achieve** the **common goal** of the organization at the end. Therefore it is very important for everybody to understand the concept of 'Organization' and 'Organizational behaviour'.

DESIGN OF AN ORGANIZATIONAL STRUCTURE:

Work specialization ↓	:	List out the works to be carried out. Arrange the list of works as per the 'special' feature of every work.
Departmentalization ↓	:	Define the various departments as per the speciality of the work to be carried out by that department.
Chain of command ↓	:	Distribute the specific work of a Department among the different 'commands' i.e. sections within a department to form a chain as per the flow of the work..
Span of control ↓	:	Define the 'scope' or 'span' for each post Showing clear- cut lines of control under that post.
Centralization and Decentralization ↓	:	Authority means right to take decisions. Define the 'Authority centres' as per the lines of control. Delegate the Authority in more centres or centralize the Authority as per the need of the work and as per the time frame.
Formalization	:	Formalizing means 'Standardizing a job'. 'Highly standardized jobs' have programmed job behaviour, less discretion over what is to be done and less freedom. In the low formalization the job is not much standardized, has more discretion and more freedom. Formalization is a very important task. Choose the correct degree of standardization as per the nature, importance and responsibility of a job.

The flow chart to design an organizational structure helps to design the frame, but the following points shall be kept in mind simultaneously that:-

1. The organizational **structure** shall be **simple.**
2. The standardization of work process, to achieve co-ordination and control, shall not lead to a new hurdle of **'Red-tapism'**. The bureaucracy's **primary aim shall be achieved** i.e. to **perform standardized activities** in a highly **efficient manner.**
3. The **overall functioning** of the organization shall be **elastic** and not rigid.
4. The interdepartmental communication shall be defined and a formal communication system shall be designed.
5. The **environment of each work-station**, department shall be maintained **healthy.**

In simple words, the structure of an organization shall be flexible to **achieve** the **common goal**. The structure of the organization shall **not become a Dead load** on the organization itself. The structure itself shall become a **guideline** towards the 'Expected behavioural change' in the people working in that organization.

ORGANIZATIONAL BEHAVIOUR

Every person behaves differently, at different places accordingly to his personality. A person behaves; in family, in family functions, in the society, in the public gatherings and his place of work, differently. His personality, emotions, relations, expectations, responsibility and many other variables govern the behaviour. The **focus** of our **study** is in the behaviour of a person in his **job organization** and in the **consistency** of his behaviour in the organization.

The behaviour of a person in an organization is the **sumtotal** of his **Individual behaviour** and his **Group behaviour.**

The individual behaviour is governed by:

a) Age
b) Gender
c) Marital status
d) Tenure on a particular job.
e) Intellectual, physical and learning abilities.
f) The values
g) Attitudes
h) Job satisfaction
i) Personality
j) Emotions
k) Perception level
l) Decision making style
m) Motivation
n) The permutations and combinations of the above variables

This list shows, how difficult it is, **to predict** an Individual's **behaviour**; keep-aside the thought of changing the behaviour towards common goal.

The group Behaviour is governed by:

a) The nature of group.
b) The nature of work team.
c) The communication skill and methods.
d) The type of leadership in the group.

e) The trust amongst the group members.

f) The authority (power) structure of a group and the malafied use of power towards politics in a group.

g) The ability to handle conflicts and the knowledge of negotiations.

h) The permutations and combinations of the above factors.

Thus, the **group behaviour** also becomes **unpredictable** to a great extent.

Just imagine the situation: ‘Organizational Behaviour’ is the **sumtotal** of **two unpredictable variables**.

And now, just imagine this situation:

The aim : to **mould** the ‘Organizational Behaviour’ towards a **‘Common goal’**.

This means to convert the difficult unpredictability to predictability. It shows that this is a aim beyond the control of a single person.

Therefore it is a responsibility of every person in an organization to develop trust among the other members about the ‘predictability’ of his behaviour.

This can be achieved by:

a) Improving informal communication.

b) Developing social ties.

c) Participating in yearly gatherings.

d) Sharing the views in group discussions and seminars.

e) Apologizing in time, if something goes wrong.

f) Choosing correct values and philosophy.

Coming to the building construction industry, we study the organizational structure usually adopted :

DUTIES & RESPONSIBILITIES OF STAFF ON PROJECT:

ZONAL MANAGER

1. Independent charge of execution, monitoring & successful completion of projects under the guidance & control of the Board of Directors with assistance from project manager & other site staff.
2. To guide & control the site staff for getting better quality work, time & material management & cost cautiousness, with optimal utilization of resources.
3. To finalize the specifications of different material to be used, finalize the agencies & their rates for execution. Selection of staf for the projects in consultation with the management.
4. To prepare bar chart in association with the project managers & get approval to the bar charts, estimated construction cost, bill of quantities & have subsequent follow up for the same.
5. To check all monthly R.A. bills & certificates of work done by the contractors & approve it for payment
6. To develop various vendors, petty contractors, suppliers well in advance for different projects.
7. To take surprise checks at sites for materials & workmanship.
8. To co-ordinate the sites and the management, architects, consultants, specialized agencies & contractors for smooth functioning of the sites.
9. To interact with the sites & get a continuous feedback for drawings, disicions, manpower & materials & **try to minimize the day-to-day site problems**.
10. To cross check the tendered items & the same being executed at site along with the Billing.
11. To maintain a record of probable dates of completion of different building & projects. To carry on the necessary follow up with the liasioning agencies / consultants & architects to obtain NOCs in time.
12. To control, monitor & train to the junior staff and update their technical knowledge for proper execution & supervision at site.
13. To finalize different rates for extra work done / required by the clients. To check the bills received from the sites for extra items. To formulate the procedures to be followed for customers extra work.
14. To prepare technical notes, circulars & checklists for different items based on the feedbacks and observation at site.
15. To look after the field security arrangements.
16. To look after the site staff arrangements at site on holidays.
17. To control mandays during construction .

PROJECT MANAGER : -

I) Independent charge of the Project under the guidance of Zonal Manager & control of the management For a new Project –

   (i) To cross check the actual boundaries with City Survey/demarcation/Architects lay out.

   (ii) To locate encroachment, roads, trespassers' paths, trees, electric & other poles, existing structures, drainage/water supply line passing through, nalla, culverts etc.

(iii) To make a contour plan of the plot.

(iv) To locate main drainage lines & water supply line for feasibility of the connections of the project in future.

(v) To clean the plot.

II) To submit above details through Zonal Manager to the concern authorities such as – a) The Director b) Architect c) Surveyor d) Plumbing consultants etc. for finalizing the drawings.

III) To check from the preliminary drawings a) the out/out dimensions b) set backs c) orientation of proposed buildings d) center line drawings e) finalization of plinth levels of various proposed structures.

IV) Before starting the actual work get approval of the Managing Director through the Zonal manager.

V) Parallelly with the above procedure; confirm & start with the work of (I) Fencing/boundary wall (ii) Approach road to the project (iii) Site office & store (iv) Material Stacking yard (v) Water storage & / electrical connection (vi) Security arrangements (vii) Street lights (viii) labour camp.

VI) To prepare a Bar Chart as per priorities & commitment in brochures & get it approved, from the management through the Zonal manager.

VII) After getting the approval to (i) Setting out of building / buildings (ii) Respective plinth levels (iii) The bar chart from the Director, Project Manager may proceed further to start the actual construction of the building / buildings.

VIII) Project Manager shall confirm (i) final centerline drgs. (ii) RCC drawings (iii) trial pits, for finalization of type of foundation.

IX) Project Manager shall get introduced to the contractor/ contractors selected by the management for every item and shall judge his capacity & capability in regards quality & timely completion of work

X) To give regular feedback about the manpower, material, tools and plants, machinery etc. to the management.

XI) He shall control all the activities at site in association with the junior staff and control & guide them for quality, time & material management.

XII) In consultation with the Zonal Manager he shall distribute the work reasonably to the junior staff.

XIII) He shall avail training to the junior staff for proper execution & supervision at site.

EXECUTION RESPONSIBILITIES OF PROJECT MANAGER:

1. To check the railing & outer face, centerline nails over it, etc.
2. To check, out to out dimensions, set backs, distance between two buildings etc alongwith right angles/ diagonals etc.
3. To check strata of foundations and get it approved.
4. To finalize plinth & 1st slab level from the Director.
5. To check shuttering, reinforcement & electrical conducting of each RCC slab and getting it approved from RCC consultant & electrical consultant (if desired).
6. To check all critical RCC works as & when required along with junior staff.

7. Along with the junior staff, take out quantity of materials required for preparation of schedule and planning requisitions.c
8. To control all the quality of concreting & framed structure in totality.
9. To check masonry layouts and get it approved from the Director
10. For a sample flat, finalize all the specifications for various items, its selection & approval from the Director.
11. To check frequently, masonry, internal plaster, concealed electrical drop work, concealed plumbing, trap fixing & water proofing of toilets, attached terraces and all other activities
12. I) Point out the errors and mistakes to the concerned staff and contractors.
    II) Suggest corrective actions and improvements. III) Severe mistakes & lapses are to be brought into the notice of Zonal Manager.
13. Before starting the external plaster & external painting, Project Manager shall inform to the architect, and the Director for suggestions about the elevation, finishes & finalization of colour shades etc.
14. Study of drawing – a) Working drawings i) RCC drawings ii) Electrical layouts iii) Plumbing layouts iv) Lifts v) Fire fighting – refuge area & staircase (v) main staircase (vi) Parking (vii) Staircase & terrace railing, window grills etc misc. details
    b) Landscaping drawing along with Club House, Community Hall; Swimming Pools c) Roads & Pathways d) Electrical Sub Stations & Electical Distributaries e) Under Ground Water Tanks & Water supply distributaries f) Septic tanks & drainage distributaries g) D.G. Sets & distributaries (h) Entrance gates etc. It is the responsibility of the Project Manager along with individual site engineers to study the drawings, before & during construction. If he finds any difficulty, difference, deviation, discrepancies he shall immediately contact the Zonal Manager & the concerned architect, RCC designer, electrical/ plumbing/Lift fire fighting /Landscaping consultant/ agency. Final decision for major problems/policy matters will be taken by the management.
15. In consultation with the Plumbing consultant & PMC Licensoning plumber, he shall calculate the capacities of UGWTS & OHWT, and inform the same to the Zonal Manager & RCC Consultant
16. In consultation with the Plumbing consultant, confirm the feasibility of critical plumbing changes demanded by clients.
17. With assistance of the site staff, reconciliation of completed work shall be done & shall be submitted to Zonal manager.
18. With assistance of site staff prepare R.A. bills & certificates of work done by contractors
19. He shall keep the record of petty cash expenses and have control on it. Keep record of payment of departmental Labour engaged in every month
20. He shall prepare progress report at every week& submit it to sales department.
21. As & when required, he shall visit the H.O., Architects office, RCC consultant's office, for reporting, giving feedback, collecting data and solving problems if any.
22. He shallcontinuously give feedback in detail to the Zonal Manager & interact there upon.
23. He shallbe acquainted with computerized reporting system, and shall have control on it.

24. He shall have control on receipt & consumption of material. He shall guide the storekeeper to maintain all documents, stock in measurable & presentable position at any time.
25. He shall have proper interaction with security engaged at his site & see their performance & security maintained at site.
26. For construction of works he shall refer all the circulars & check lists.
27. On every last Saturday of the month along with storekeeper, he shall check the physical stock of materials . He shall accompany the Zonal Manager with the storekeeper for verification / checking of store.
28. Looking after maintenance of occupied buildings at the project along with the construction is the responsibility of the Project Manager.
29. He shallaccompany all visiting Directors, consultants, officials, during their visit to site.
30. He shall accompany or depute a responsible representative with the Quality Control engineer during his visit & inspection. Note down the defect/rectification/suggestions if any, and shall take the best possible action to minimize the defects/rectifications.
31. Being the senior most person at site, he shall be well mannered, professionally competent, soft spoken with the client and caring for everyone working at his site. He shall report the site on/before 9.00 A.M. and remain present till all the activities of that day are completed, whenever required.
32. He shall abide by all the rules & regulations of the organization.

SITE ENGINEER

1) To assist the Project Manager/Zonal Manager and handling a task work for construction & supervision of building / buildings/ development works/landscaping etc as allotted to him.
2) To prepare a Bar chart for the work after studing the drawing, norms & specifications & directives of management before starting the execution and place requisitions accordingly.
3) To set different Layouts, levels and get them approved from Project Manager before starting any work.
4) To confirm priority, specifications etc. before execution.
5) To give feed back to the seniors as and when required.
6) To monitor & control day-to-day activities as per the bar chart with quality & cost cautiousness.
7) To interact with contractors & other agencies for labour strength, progress of work, quality & required speed.
8) To synchronize different agencies & their work to have smooth functioning of site.
9) To interact with all other site staff.
10) As and when required, he shall visit the Head office, Consultants/architects office for reporting, giving feedback, collecting data or solving any problems.
11) To issue materials for day-to-day work, keep records of its consumption & minimize the wastage of materials.
12) To check line, level, right angles of the structure along with controlling all the activities & their finishes & correctness.

13) In the absence of the Project Manager be shall be able to take over the charge temporarily and act on his duties.

14) To recorde the work done quantities contractor wise, preparation of contractors' monthly R.A. bills & forwarding it to the Project Manager.

15) He should see that proper care is being taken for (i) Curing (ii) house keeping (iii) Security of the materials for his work field.

16) Data of work done & material consumption should be made available to the Project Manager/ Zonal Manager for reconciliation as and when required.

17) If desired by the management, he should look after the maintenance for occupied buildings /Club House/ Swimming pool/Corporate Office/ Shops etc.

18) He should handle the clients who have booked shop/flat in his building. He should note down requirements for addition/ alterations /omissions. He should confirm the physibility of the requirements, If required, consult the Project Manager /Zonal Manager before accepting any critical change. Prepare an estimate; get it approved from the Project Manager & then the client. Before giving possession, summaries all the charges, check all the debits & credits and prepare a final bill. Inform the quality control Engineer for checking the same physically at site. After his inspection/ approval, forward the same to H.O.

19) After receipt of possession card, complete the works in all respect including cleaning in minimum time. Confirm & get satisfied about the works before handing over the keys to the client. Explain the clients about the checklist, ask him to fill the same & sign it. Note down the key numbers being handed over. Show him his electrical meter, Letterbox, & location of parking.

20) Site Engineer is totally responsible for the construction & completion of the work, which has been allotted to him, along with Project Manager.

21) He may be required to look after the stores & Sales department at site as per the directives of the management.

22) Be present at site on/before 8.45 A.M. & remain present till his duties required at site for emergency or late night work or on holidays.

JUNIOR ENGINEER

1. To assist site Engineer / Project Manager/Zonal Manager.
2. Day to day construction & supervision of Civil works /work allotted by the site engineer / project managers.
3. To get acquainted with the norms & practices, work pattern and directives of the seniors.
4. Awareness of computer handling & report feeding.
5. Adhere with the discipline, rules and regulations formed by the management.
6. To confirm norms, specification, validity of drawings& priority before execution, from the seniors.
7. To give feed back and report to seniors about activity / activities going on, labour strength, material consumption and achievement of day-to-day target.

8. To keep all required documents and drawings neat, clean & updated.
9. Interacting with other site staff such as storekeeper and sales executives at site.
10. To visit the H.O. consultants / architect's office for reporting, data collection etc., as and when required.
11. To note the changes required by the client in the absence of his seniors.
12. To check line, level, plumb, right angles etc. along with checking proportions of different mortars and concrete mix as per specifications along with minimizing the wastage of different materials.
13. To issue materials to the contractors for day-to-day work and to check material consumption at the end of the day and ensure that no material is left behind unsecured, at the end of the day.
14. To keep a daily record of materials & labourers, activity wise in the following format
    - i) Material issue and consumption
    - ii) Labour employed
    - iii) Approx. qty of work done
15. To keep keen supervision on
    i) Curing ii) House keeping iii) Stacking of materials in and around his work site iv) Access to his work site.
16. To look after the maintenance of the occupied buildings as & when required. .
17. To look after stores and sales department as & when required.
18. Be present at site on/before 8.45 am. and remain present till he is asked to be present by his seniors. In case of emergency or late night working or on holidays, he should attend his duties.
19. He should abide by the rules & regulations of the company.

QUALITY CONTROL ENGINEER

1. To work independently & impartially under the board of Directors.
2. To get acquainted with the Civil engineering, practices, construction & supervision of Civil works as per various circulars & checklists. To be cost cautious while maintaining quality of works.
3. To confirm the specifications, validity of drawings & instructions for individual sites.
4. To check every corner & aspects, at site, for various activities for line, level, plumb, right angles proper jointing, specifications, proportion of different mortars & mix etc.
5. To confirm about i) curing, ii) House keeping iii) stores & stocks etc, during his visits to the site.
6. To check i) the bill of quantities ii) Surprise or monthly stock checking along with site staff, iii) To check the estimates & bills for extra works of clients. iv) To check the contractors bills.
7. To check, the flat /flats to be handed over to client..
8. To give continuous feedback to the Zonal Manager & Project Manager for the observations made at site.
9. To note down his observations & report to the Board of Directors. To see that minor discrepancies, defects, incomplete work, missed through oversight, are pointed out to the concerned site engineer/ Project Manager on the same day and see that necessary action is being taken at site.

10. To keep in touch with the Project Managers for any new activity to be started at the sites, such as plinth layout checking, masonry layout checking, plumbing layout checking, RCC slabs, especially for critical reinforcement & elevational features etc.
11. To confirm from the site staff about the following checks: beam bottom levels, slab centering levels, beam depths, slab depths, staircase flights, lift & other voids etc.
12. To prepare a weekly programme & inform the same to the seniors.
13. To abide by all the rules & regulations of the organization.

STORE-KEEPER

1. To assist the Project Manager at site, to maintain the store.
2. To look after the day to day receipt & consumption of the various materials & maintain it's record as per the standard formats.
3. To get acquainted with norms & practice of maintaining the stores.
4. To have awareness of computer handling, report feeding & furnishing required data for the same.
5. Be thoroughly competent & knowledgeable for measuring, inspecting, accepting, storing & stacking various materials required for construction activities.
6. To be aware & remain update about the bill of quantities as per the progress of the project.
7. To receive the material as per P.O. In case of discrepancy, contact the supplier & purchase dept.
8. To check for unloading, stacking & issuing of every material.
9. To issue materials only after receipt of issue sleep duly signed by the Building In charge who has to mention building number, activity, contractors name & qty etc.
10. To maintain the record of empty bags, containers etc OR returned back material
11. Store Keeper should make arrangements at site for proper stocking in advance in consultation with Project Manager.
12. Store Keeper should confirm the quantity, specifications & delivery schedule along with the Project Manager.
13. Store Keeper should confirm the quantity, quality, and shelf life, proper unloading & storing of various materials.
14. First in first out principle is to be followed to avoid double handling.
15. He should count the exact quantity issued & make sure that the balance material is received back at the end of the day.
16. Storekeeper along with Project Manager should reconcile the material every month to confirm exact quantity of work done & material consumed alongwith wastage.
17. Storekeeper should be able to locate the exact hurdle / imbalance in actual quantity & consumed quantity. He should improvise the procedure to avoid imbalance in the future.
18. Store Keeper should discuss all the problems arising, & corrective actions therein for material handling & store management at site with the Project Manager & engineering staff at site & may inform to H.O. if

desired.

19. As and when required he is supposed to visit the H.O. for reporting / Local market for sundry purchase.
20. Be present at site at 8.45 A.M. and remain present till he is aske to be present by his seniors.
21. To abide by the rules & regulations of the company.

STORE ASSISTANT

1. To assist the storekeeper / Project Manager.
2. To look after day to day receipt & consumption of various materials & maintaining records.
3. Unloading, stacking & issuing of every material in a systematic manner.
4. Issue of material should be done only after receiving issue slip duly signed by the concern engineer.
5. To maintain records of empty bags etc.
6. He should count the exact quantity issued & make sure that the balance material is received back at the end of day.
7. Store assistant along with storekeeper / Project Manager should confirm exact qty. of material received, consumed & balance at site at every month end.
8. In any case, keys of the stores should not be handed over to any contractors/labourers for collecting materials.
9. As and when required he is should visit the H.O. for reporting.
10. To get acquainted with computer handling, furnishing required data for reporting & report feeding.
11. Be responsible to keep the stores neat & clean, stacks in countable manner at any time along with check on security of materials stacked at open spaces.
12. He should be present at site 8.45 A.M. and remain present till he is asked to be present at site by his seniors.
13. He shall abide by the rules & regulations of the company

SALES EXECUTIVE

1. To work at site / office & reportable to the Sales department at H.O. & Project Manager, at site.
2. To attend telephonic enquiries, walk-in enquiries. All possible data & details are to be furnished for such enquiries.
3. To show sample flat /flats along with landscape garden ,clubhouse, swimming pool etc. by highlighting the planning aspect, amenities, location & advantages of the project.
4. To attend buyers, listen to them, sort out their problems & doubts, find out budget & requirements.
5. To fill the enquiry forms alongwith the names, telephones & numbers of telephonic enquiries.
6. To report to head office about the walk in enquires & telephonic enquiries.
7. To sort out prospective buyers, interact with them and follow up. To take maximum efforts for converting prospective buyers into actual buyers.
8. To keep sufficient stock of costing papers & broachers.

9. To maintain booking chart & registers up to date.
10. To interact & follow up with sales department at H.O. & other departments.
11. To interact with Project Manager & other site staff for the possession dates, progress & changes proposed by customers.
12. To attend meetings, seminars, exhibitions as and when required.
13. To maintain the sample flat along with its furniture / fixtures / fittings & floor lobby absolutely clean and presentable.
14. To maintain the club house / swimming pool / landscape garden & approaches clean & presentable.
15. To be aware of computerized reporting system & handling the same.
16. To remain updated about the progress of work & probable dates of possession.
17. To cross check, flat-wise progress report fortnightly .
18. To accompany the client while handing over the flat & see that the client is satisfied.
19. To assure the client about after sales service & hand over a maintenance manual.
20. To keep the office neat & clean with proper display boards.
21. To look after the general maintenance of hoardings, name boards, & direction boards.
22. To collect maintenance charges & issue receipts.
23. To record complaints & receive telephonic messages.

MAINTENANCE MANAGER

1. To work under the directives of Board of Directors.
2. To look after the welfare & maintenance of the completed projects where the projects are yet to be handed to the societies.
3. To look after – { I} housekeeping {ii } security {iii} Electrical, plumbing & other miscellaneous maintenance work. {iv} collection of maintenance charges. Etc.
4. To co ordinate with engineering department for remaining civil work, if any.
5. To look after the house keeping & maintenance of health club equipments, swimming pools, landscape gardens, electrical substations, D.G. sets, UGWT & Pumping systems, electrical & water distributaries & drainage lines.
6. To co- ordinate with various government offices for proper maintenance & trouble shooting.
7. To maintain the harmony by keeping good relations with customers.
8. To decide the scope of work in consultation with the higher authorities for maintenance problems.
9. To arrange for the materials & workers for maintainance works.
10. To guide the customer about the maintenance manual.
11. (i)To distribute periodical maintenance bills (ii)To collect maintenance charges . (iii) To deposit the same at H.O. (iv) to follow up with defaulters (v) to hand over receipts.
12. To maintain following records.

    a) Attendance register of various staff engaged such as securities, sweepers, supervisors, health club

& swimming pool attendants, gardeners, electrician / painters / plumbers /carpenters etc. for maintainance

b) To maintain all inward / outward documents with all other pertaining documents.

14. To certify the bills of services / labour supply agencies for payments,
15. To cross-check entry books at security gates, club house, swimming pool & community halls.
16. To have all the necessary follow ups with advocates & directors for the formation of societies & to maintain all the records required for the formation of society.
17. To arrange & complete all the formalities of first General Body Meeting of the customers in a project.

MANAGING STRESS

Definition of stress: **Stress is a dynamic condition in which an individual is confronted with an opportunity, constraint or demand related to what he or she desires and for which the outcome is perceived to be both, uncertain and important.**

The definition itself creates a 'Stress'.

But, let us not worry. Every stress need not be bad. Let us try to understand the meaning of the definition by arranging it as follows:

- Stress is a **dynamic** condition, in which
- an **individual** is **confronted** with
- an **opportunity, constraint or demand** related to
- what he **desires** and for which
- the **outcome** is perceived to be both
- **uncertain** and **important**

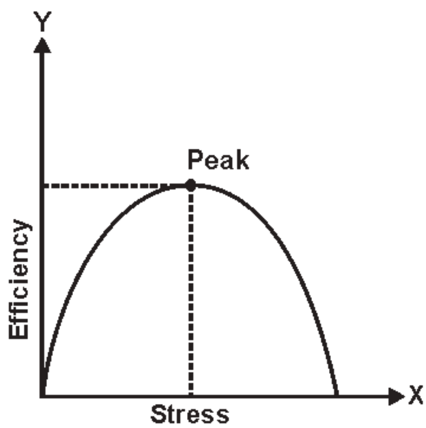
So, when the **outcome** is **uncertain** and still **important**, the stress starts building from inside of an individual. But then, what is this outcome about? The **outcome** is the result of **interaction** between the **Demand**, a person faces and **his actual Desire.**

If the **Demand** and **Desire match** with each other, the stress remains **positive** and **helpful**, but if they **do not match**, the stress starts acting **negatively.**

The negative stress is reflected through the behavioral change in a person in many ways. That person may develop high blood pressure, headache or such complaints of physiology.

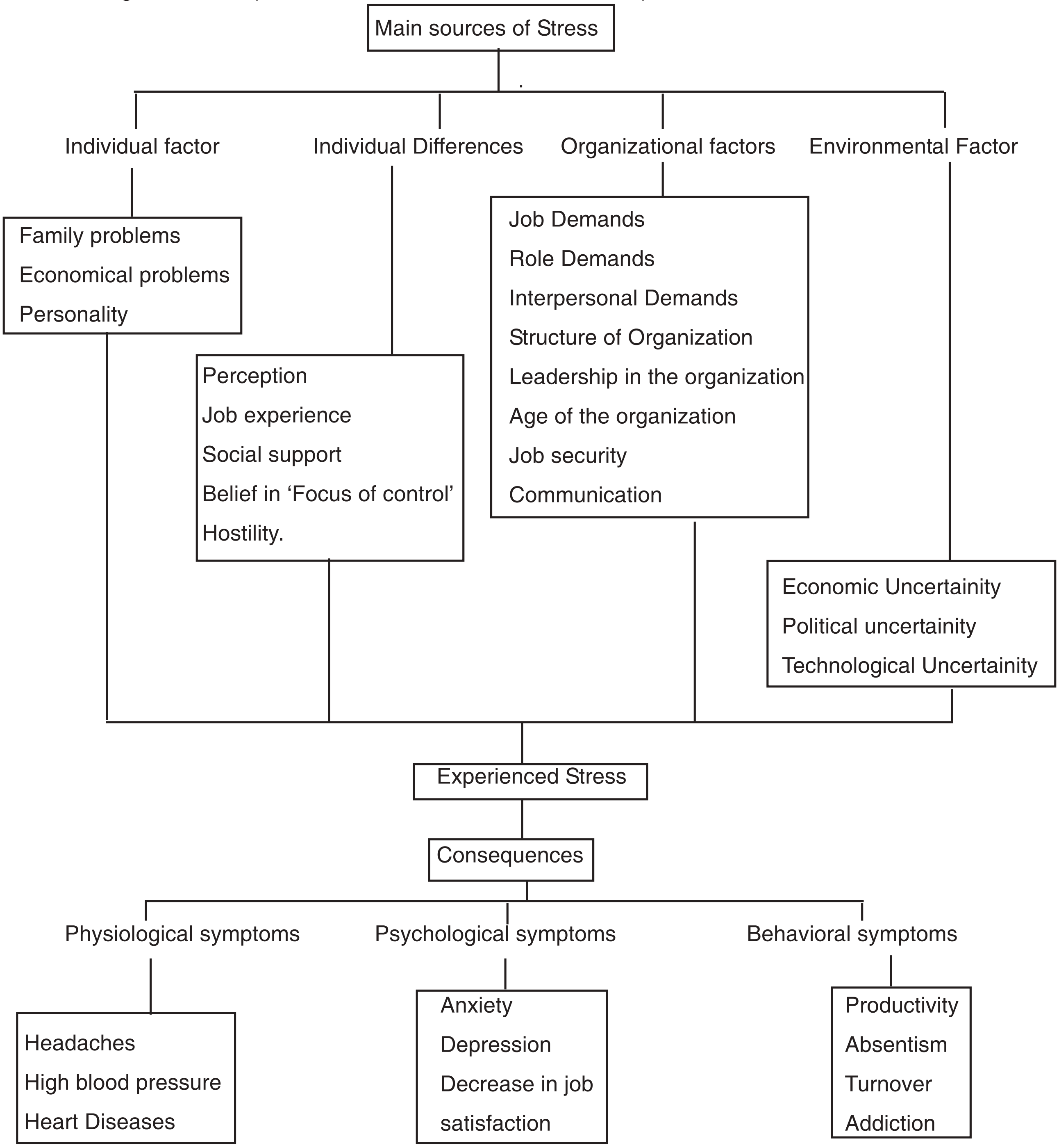
The positive stress is reflected through the timely target achievements and enthusiasm is reflected in the behavior of an individual.

The following graph will explain it clearly that,
the stress helps to increase the efficiency to a certain degree.



This clearly shows that the stress up to the peak x, is helpful to give better performance. The stress beyond the 'Peak x' needs to be Managed. This is the point from which every further accumulated stress will decrease the performance. This peak point x is different in every persons' performance graph. Why does it differ with every person? How to decide and demarket this 'Peak point' of performance and manage the further increase in the stress? How to understand the stress? How to distinguish between positive and negative stress? What are the factors, which cause stress? Let us try to understand it.

The following chart will explain more about stress, and various aspects of it.



The flowchart shows the origion of stress, factors creating the stress and behavioral change that takes place in an individual due to stress.

What is seen in the practice is the **'Behavioral change' only** and the remaining **important part, which** actually **creates** the **stress, remains unseen**.

Therefore it is a **common tendency** to **treat** these **superficial behavioral changes** only and the **root cause creating** the **stress** remains **ununderstood** and **untreated.** e.g. people go on taking medical treatments for headaches, blood pressure, depression etc. and the root cause of the stress is never detected.

If we read the **flowchart** from the bottom to the top in **reverse** and locate the exact cause, which is creating the stress, it will help us to **treat** the **exact cause** of stress and **not the symptom**. In this manner, we will be able to '**Manage**' the **stress** by **prevention** and a small **curative treatment** for the **symptoms** will be **sufficient**.

CUSTOMER SATISFACTION

A CUSTOMER :

The ultimate **consumer** of a ‘**end product**’ is generally known as a **customer.**
A **buyer** becomes a **customer**, when he is **convinced** about the **services** offered by a **product,** are **matching** exactly to his **needs** & **demands.**

In nutshell, the **matching of demand** to the **exact service offered** by a product really starts the business. A buyer becomes ‘a customer’ & then the ‘Ultimate Consumer’ of a product. When a product gives the **exact service**, which a customer demands, a customer becomes a **“SATISFIED CUSTOMER”.**

Therefore a careful**, wise** business house **concentrates** more on the **‘serviceability of the product’**; rather than on any **superficial means of customer satisfication**. Such a careful business house **starts observing** its production **process/method** so as to **improvise** in the **‘Quality of the Product’**, the final goal in the mind being **‘Delighted Customer’**

The customer who is the ultimate consumer of the product and who is outside the production process is called as an **‘External Customer.**

In this flow of observing the **‘production process’**; another meaning of the world **‘customer’** is developed. This is an **‘internal customer’**. In any production process, many operations or many activities are involved. All interdependent successive activities ultimately produce the final product. The first worker finishes one activity. A semi-finished product is handed over to the next worker for the successive activity. Now if the **first worker looks** at the **second worker as a ‘customer’** (& not as a worker) then the first activity is executed **‘in the most correct way’** in the effort to delight the customer. The customer (the second worker) is delighted to receive the right product. (though the product is semi finished). In this manner, if every successive activity is looked upon as a ‘customer’ of the previous activity, then the ultimate end product will be most superior & will definitely give **‘satisfaction’** to the real end customer. This method of production involving **‘Do the thing right while doing it for the first time’** & then **‘ Do it right every time’** is known as **Total Quality Management** (TQM).

Thus, the satisfaction of all internal customers will lead to the **delight of an ‘External customer’**.

Obviously an organization aiming at **customer delight & practicing TQM**, initially practices continual Improvement and hence is **least bothered** about the **‘cut throat’ competition** in the market.

A product manufactured by adopting this philosophy, definitely ‘satisfies’ the customer. By virtue of it , the method adopted (TQM) keeps the total **business process always alive.**

Every business-house becomes happy when it meets a **'satisfied'** customer. A satisfied customer motivates the manufacturer towards further improvement in the product. In this way, every business-house, starts looking beyond the **'monetory profits'**

The **'joy'** of a satisfied delighted customer becomes the **'profit'** of a business-house. The customers become loyal to a brand or a business-house. **One satisfied** customer **develops a chain of customers** for a business-house. The business goes on for years' because of the **delighted repeated customers.**

All this could start & happen repetitively only if **a customer is delighted.**

The efforts taken, right from the first activity towards **'customer satisfaction'**, result in a **'delighted customer'.**

SERVICES AFTER SALE

A process of business **does not end** after the **sale of a particular product.** A sale can be called a **successful sale** only if many possibilities of **new sale evolve** at the **completion of the first sale.**

If such sale opportunities are evolved, it indirectly assures that, the delightment of customer is achieved. It also ensures the healthy growth of the business in the future. The services rendered after sale, help to a great extent to achieve this goal of unending chain of sale.

In building construction industry, the time required for handling over a product (flat) to a customer, is comparatively **more from the actual date of agreement than the other industries**.. Therefore a customer expects many services during this period also.

Another peculiarity of the construction industry is that the **consumer enters** the premises of the product itself (flat/shop). Whereas in case of other products, the situation is that, the product is taken to the consumer's premises. This **criticality arises** because of the **nature of the product** (flat/shop/offices).

This **critically** creates the **necessity** to design the services very carefully which are to be rendered after sale.

Some of the critical services desired during the agreement & actual possession, period are :-

1. The **alteration/omission/additions** desired by the customer **in the layout** of the flat/ shop.
2. The desire to be **updated** with **the progress of the work** from time to time.
3. Information regarding locations of post office, banks, educational institutions, hospitals, grossary & vegetables markets etc. in the vicinity of the newly purchased flat/shop.
4. A **warm treatment** during the site visit.

The customer further desires the following services after taking the possession of the unit, till the **defects liability period.**

a) **Prompt & proper maintenance** services in flat/shop.

b) **Well-maintained common facilities** like lifts, passenger lifts, entrance foyers, parking, roads & security.

c) Information regarding, formation of legal body (society/Apartment) of the township.

The procedure for rendering these services:-

1. Changes desired by a customer :-

i) The alterations/omissions/additions desired by the customer in the layout of the flat/shop. Changes shall be accepted stage wise. Please ask the client to thoroughly inspect & study the sample flat & if he has any doubts, please discuss with him. Sample flat & its planning, standard material, itself is self-explanatory, self-sufficient and the optimum use of space is planned.

ii) Changes affecting the elevations shall be avoided.

iii) After completion of roof slab of a particular flat, changes in electrical points at ceilings & in between the depth of RCC beams cannot be accepted. Electrical points at the ceiling of toilet, terrace are not to be changed, in any case.

iv) The changes given before starting the masonry work can be accepted. Confirm that the load of the masonry is transferred to the floor beams and not on the slabs, in such changes.

v) If the masonry is to be demolished & rework is to be done, charges for demolishing & shifting of debris along with the rework are to be borne by the client.

vi) If changes in masonry layout are to be done after internal plaster & further activities, please take necessary permission from your higher authority. Charges will have to be borne by the client.

vii) If waterproofing/concealed plumbing/tiling/door shutter are fixed, do not accept the changes in masonry.

viii) If customer asks for extra loft, well in advance before starting internal plaster, you may accept it. Do not accept the work of additional loft if internal plaster is completed.

ix) We may accept the changes of extra electrical points before stating the internal plaster. Do not accept changes if internal plaster & dado work is completed.

x) If a client requires a stainless steel sink for the kitchen platform, he must inform the same, well in advance and handover the same at his risk & cost to the site whenever asked for. Do not accept the changes of S.S.sink after platform is completed.

xi) If a client requires extra L shape or C shape platform lenght draw a sketch with orientation. Show the position of sink, verticals etc and confirm the side verticals & its material with shape. Confirm & get the signature of the client on the sketch.

xii) For changes of extra dado work above the standard area of dado; remove the sanala applied for required area completely. Hack the portion properly remove all dust & loose particles by washing the surface. Take maximum care for fixing tiles of dado on such surface to avoid the peel off after few years.

xiii) For standard ceramic flooring, there are two options of joints. Please get it confirmed from the clients & explain him the advantages & disadvantages of flush joint flooring & spacer flooring. If customer desires to have his own flooring tiles or other materials such as kota, marble, granite, granamite tiles, customer has to supply the material at his cost & risk as & when required on site asked from the site.

Normal percentage of wastage of tile material, considered for costing is:

Ceramic or glazed tile	12%
Granamite	10%
Uncut Kota	30%
Marbo-granite tile	15%

Corner shelves, thresholds, soap cases & paper holders are to be supplied by the client at his risk. Fixing charges are to be borne by the client.

xiv) In any case, front main door or ply jam design cannot be changed. Client has to inform well in advance if he is supplying his own door shutters/ fixtures.

xv) Client has to inform in advance about three-track/ mosquito net provision/powder coated windows if required. Client has to bear the extra charges.

xvi) If company is not providing M.S. grills, provide approved drawings to the customer. Fixing of projecting out grills are not permitted in any case. Designs other than companies' approved designs for window grills & safety doors are not permitted. See that client's fabricator do not spoil the plaster & paint of the window openings.

xvii) If informed well in advance, the clients may supply C.P. fittings/sanitary fittings of their choice at their risk & cost. All extra arrangement for loft tank, acquaguard point, jet spray, health foset etc. to be completed in all respect and take a satisfactory note for the same.

xviii) No changes in texture & shade can be done. In this case, we can ask the client to paint his flat of his own with appropriate credit to be given.

See that customer must make his mind & confirm the changes required to be done and not repetitively changes his mind. We may provide him a preliminary estimate. Feasability of the changes, limitations etc. should be explained to the client. If the client is adamant & insisting for changes, please ask him to wait for few days. In the mean time get it confirmed from the Head office; until then please keep all the work on HOLD.

2. Information desired about progress of work :

The customer can be informed in advance & during the construction about the stages of work completed. This helps the customer to decide about his future plans of possession, furniture & financial arrangements.

3. A simple leaflet containing the information about the vicinity of the project & locations of essential services near the newly constructed project will help the customers to a great extent.

4. Till the customer gets accostumed with the new atmosphere, he expects a parental, caring, warm approach from the staff at site. A warm welcome, a good smile during his site visit, will serve the purpose.

In this manner, very simple service, given with a warmth, binds the customer to the business house.

The services rendered after sale, play an important role in a repitetive sales orders & hence shall be treated as long term investments & not as an expenditure.

ISO AND TQM SYSTEMS

ISO: **International Standards organization.**

TQM: **Total Quality Management.**

After the Industrial revolution in Europe, the world started shrinking. The world started becoming a ‘Global village’.

The new technology, more and more knowledge of the natural science, new resources, made it easy to ‘Produce’ many things on ‘Mass scale’ in every Industry.

New problems arose with the ‘Mass production’. The problem of bringing uniformity in every production became the most critical. The term ‘uniformity’ became a keyword throughout the world in all the disciplines of the society.

The pressure due to the want of uniform measuring system, uniform quality, uniform quantity, forced the world trade, production and manufacturing process, towards ‘Standardization’ of as many things as possible.

To standardize a thing, one needs to ‘Quantify’ it properly. Other physical parameters of a product are ‘Quantifiable’, but how to ‘quantify the Quality’? was the main teasing question for the experts?

ISO tried to make a breakthrough by **‘Standardizing’** maximum production **processes**. It helped, to a lot extent, to bring ‘awareness’ in all industries, that, it’s the need of the time to **‘standardize’** maximum **‘processes’.** But, still, the question of ‘Quantifying’ the ‘Quality’ was not solved. The earlier approach of ‘controlling’ the ‘Quality’ lost its essence due to the ‘Experience’ gained by that time, about ‘controls’. **By maximizing controls**, it was observed and proved, that, the **rejection increased.**

The limitations in defining ‘Quality’ surfaced more and more, as ‘Quality’ is *Relative*. What a person disqualifies and the other qualifies is very much unpredictable.

This proved the importance of ‘Human’ factor, involved in every production process and still neglected in the ‘Standardization process’. **This ‘Human’ factor is beyond the limit of ‘Predictability’ and hence ‘Standardization’.**

This was well observed by Mr. Deming. He made a breakthrough by defining Quality from the point of view of a ‘Customer’. If a customer, a consumer is satisfied because of the exact service rendered by a product, then the product can be called as a ‘Quality Product’.Mr.Deming layed the foundations of T Q M

The Human face, Human factor, which was missing earlier in the process of achieving 'Quality'; came into the process in the form of a 'Customers', Human face'.

Now, since, the 'Quality' was defined; it made easy, 'by reverse engineering method' to look at each and every process. The concept of 'customer satisfaction' applied to each 'process' in the form of 'Internal customer satisfaction' made it further easy to build 'Quality' as an 'Inherent' property of a product. The problem of 'Controlling' the 'Quality', putting the managers under heavy 'stress'; was solved.

A detailed study & application of TQM system will also help the construction industry to a great extent.

SECTION

II

1) PROCESS STUDY
2) INTRODUCTION TO PLANNING
3) PRELIMINARY PLANNING
4) DETAILED PLANNING
5) ESTIMATING AND COSTING
6) CONTRACTING AND BILLING
7) SELECTION NORMS FOR SUPPLIERS AND CONTRACTORS
8) MATERIALS AND STORES MANAGEMENT
9) SURVEYING
10) SAFETY PRECAUTIONS
11) SECURITY SERVICE

PROCESS STUDY

Production of any product is done by processing the raw materials with the help of skilled and unskilled manpower, various tools and machineries. If the process is not defined beforehand, the cost of production goes on increasing. Any undefined process results in huge wastage of men, materials and machinery hours. Therefore, it is necessary to define the production process beforehand. It is therefore essential to study the process so as to define it properly.

The main objective of process study is to evolve the most economical, human friendly and environment friendly process of production. This study also helps to decide the time duration for each process, which helps indirectly in many ways to refine the process.

A periodic study of process helps to change the technology to minimize the consumption of costly materials and hence remain competent in the market.

A following flow-chart will help to understand the process of 'Process Study'.

PROCESS STUDY CHART

Study the Objective of the production process Under consideration ↓	: Ask the question; why?, for every item . e.g. why brickwork? Such type of questions will help to decide the exact purpose, objective of carrying on a specific item.
Study the method of Production ↓	: Ask the question ; How? for every method . How to pour concrete? : by pumping or manually. Such type of questions will help to decide the exact ' Methodology' to suit the specific site conditions.
Study the drawings, materials, manpower, machinery required for the production ↓	: Ask the question; What? What to use? What is required as per the drawings? The answers to such questions are hidden in the specifications, in defining the required level of human skills and in the precision levels of the machinery and tools.
Time and motion study ↓	: This study will help to plan the store area, the movement of raw materials through manpower or machinery, the movement of skilled and unskilled workers and machinery. This will help to

↓	avoid fouling of cross movements and double handling. This helps to estimate the correct time duration for the production and to decide the period for procurement and mobilization.
Fix the responsibility ↓	: Ask the question; Who? Who will do item 'A' and Who will do item 'B'? Who will supervise? Who will Control? Who will co-ordinate? The answer to this questions will help to fix the exact responsibility of a specific job amongst the people involved in that process.
Study the other variables and classify them as a) Controllable variables b) Uncontrollable variables ↓	: List out the other variables e.g. Holidays (planned-controllable) Absentism (uncontrollable – unplanned) Festivals (planned- controllable) Non-availability of power supply (uncontrollable) etc. This study will help to arrive at exact time estimates, and also to achieve control on many variables.
Conclude the process with Flow-charts, Network diagrams etc. ↓	: These charts and networks will help to locate the ‘Critical Activities’ even during a process. This will help to locate the “Focus of control’ On a specific activity.
Decide the final refined process .	: Considering all the above aspects and after exercising the total cycle two to three times (if required) ; the final process shall be defined and documented.

The materials, technology and specifications may **change** from time to time ; but the process study will help an engineer to **reorganize** his **mindset** to **adopt the changes** faster.

INTRODUCTION TO PLANNING

Planning is the most important part of management processes. Successful completion of any project or running of any organization depends on the proper planning. The objective of planning is to help to understand the complexity of situation in a project in a better way. This helps to take logical decisions to complete a project in a predecided time duration and at estimated cost.

The analytical methods of planning include, system analysis, operation research and system engineering. However, in a very simple language, the planning of any project includes answers to the following questions.

1. Where to do?
2. What to do?
3. When to do?
4. How to do?
5. Who will do?

Any project consists of different activities, which will have interdependence. A system is an arrangement of different activities in proper sequence as per their interdependence. Proper sequencing and proper scheduling of the different activities **before commencement** of the work and **controlling** the operations in a systematic manner is "THE HEART OF PLANNING."

PROJECT AND ITS OBJECTIVES

A project is composed of different jobs, tasks, functions and activities, which are related to each other. Every project has the following objectives:

1. The project should be completed at a minimum capital investment i.e. the project should be economical.
2. The project should be completed within a defined time-frame.
3. It should be completed with the optimal use of available resources.

Every job in a project has some objectives. Successful completion of all these related jobs will lead to completion of the project and the objective of the project is fulfilled. Any project has to commence at a specific time and will be finished within the stipulated time. For successful completion of any project, basic things required are,

1) Material resources including raw material and machinery,
2) Manpower resources.

Once the objectives of a project are defined, it is necessary to decide the method by which the objectives will be achieved.

In project planning, technology & management both are very important. The technology considers the recent innovations in using the material and processes while the management deals with the manpower resources. It is, therefore, necessary that the rapid accumulation of scientific techniques & innovations, should match the corresponding improvement in the sphere of human group relations. Management is necessary to increase the productivity using technological innovations & optimal use of the manpower resources available.

To meet the need of the objectives, planning is very essential.

Planning consists of the following steps:

1. Defining clearly the objectives of the project.
2. Dividing the project into different independent tasks
3. Determining the total requirement of different types of materials.
4. Determining the machinery required.
5. Determining the manpower required.
6. Preparing cost estimate of the project.
7. Determining the duration of different tasks.
8. Determining the action plan.

The above steps are absolutely necessary for successful completion of the project. This planning is important; as it will decide the direction of the implementation, which help in preparing framework of works. It will also be useful in setting some performance standard.

MODERN TECHNIQUES OF PLANNING:

1. Critical Path Method (CPM)
2. BAR CHARTS
3. Time and motion study.

These techniques help the engineers in planning, scheduling & controlling the projects. These techniques are discussed later on. But it is usually observed that, in spite of such really helpful techniques, many a times planning of any work is not done for this or that reason.

Let us observe these reasons and try to remove the prejudices attached to the reasons. This will help us to emphasis the importance of planning on over minds.

REASONS GIVEN FOR NOT PLANNING A WORK......

(A) : WE DO NOT GET TIME AT SITE FOR PLANNING, THEREFORE WE DO NOT PLAN.

The reason itself is fallacious, because we can prove ourselves through a sample exercise that, we can do the planning for one year in just 9-10 hours. Let us say the total detailed planning can be done in 3 working days. To spare 3 working days' equivalent man-hours is not impossible even at site conditions. What we lack is strong **Will** for planning. It is equally true that **non availability of time is the outcome of non-planning**.

So let us be clear that since we do not plan, we do not have time. We are always working on war fronts. Our programmes are not planned & therefore we are always working on **Crash porgrammes**, without the knowledge of it. Since we ourselves, are not aware of crash program, how can we deal with contractors, suppliers, customers involved in that project. Therefore the friction starts with the contractors & others, which in turn delays the work further. Therefore instead of wasting the time afterwards, let us devote the time for planning.

(B) : THE CONTRACTORS DO NOT WORK AS PER OUR PLANNING, BUT, WORK ONLY AS PER THEIR CONVENIENCE; THEREFORE WE DO NOT PLAN.

Since we do not give sufficient lead-time for the mobilization, do not assure continuity of work to the labour employed; the contractor's fail to work as per our plan. The contractors have also become wise enough to find out the loopholes in our planning. Sometimes the contractors may take the disadvantage of the loopholes in our planning, but then the answer to it cannot be non-planning but a perfect planning only.

(C): THE MANAGEMENT KEEPS ON CHANGING PRIORITIES & HENCE OUR PLANNING BECOMES NON-WORKABLE, THEN WHAT IS THE USE OF PLANNING?

If our planning is perfect & we are aware of the various floating times then even a changed priority can be accommodated during floating times. Even a revised planning prepared immediately after changed priority, can also help the management to consider the decision w.r.t. time, cost etc. So to prepare a revised planning which is essential for an engineer to help management to take rational decisions. Therefore, changed priority cannot be an excuse for non-planning.

(D): THE PURCHASE DEPARTMENT DOES NOT SUPPLY THE MATERIAL IN DUE TIME & OUR PLANNING FAILS; THEREFORE WE DO NOT PLAN.

This again is related to our perfect planning & offering sufficient lead-time for Purchase department to supply the material in the stipulated time. Many a times the material is not specified properly, which causes the delay; which is avoidable.

(E): THE TURNOVER OF SUBORDINATE STAFF IS A MAJOR PROBLEM IN EXECUTING THE WORK. THE CHANGING STAFF, NEW STAFF IS A HURDLE IN EXECUTING THE WORK AS PER PLAN; THEREFORE WE DO NOT PLAN.

If our planning is perfect initially & accordingly resources balancing is done then the excuse of changing staff cannot be justified. In certain exceptional conditions, if we convince the management properly, then this problem can be avoided.

(F): THE VARIOUS AGENCIES ARE NOT PROVIDED IN TIME & ALSO THE AGENCIES PROVIDED ARE NOT COMPETENT TO DO THE WORK AT THE REQUIRED SKILL THEREFORE THE PLANNING FAILS, SO WHAT IS USE OF PLANNING?

This problem arises because we do not finalize our demand for a new agency, in due time, i.e. sufficiently earlier than the activity begins. So far as the competency of the agency is concerned: it is essential to convey to the agency about the required skill, manpower etc in advance. A Simple discussion with the agency within the initial lead time will help us to judge his competency & further problems can be avoided.

(G): MANY OTHER RESOURCES LIKE LIGHT, TELEPHONE WATER, OFFICE, FURNITURE, OFFICE BOYS, STATIONERY, PETTY CASH ETC. ARE NOT PROVIDED SUFFICIENTLY HENCE WE CAN NOT PLAN.

This again is related with perfect planning in which the resource allocation, balancing, has to be defined **before hand**. Since we are not perfect in planning, we are short of resources.

(H): NATURAL CALAMITIES, ACCIDENTS, GOVERNMENT DECISIONS ALSO DELAY THE WORK SO WE DO NOT PLAN.

A safer side planning with sufficient floating time & in an exceptional case, crashing of program can help to overcome such type of hurdles. But we generally are not aware of a simple saying, "Think of the best & be prepared for the worst".

(I): I AM NOT GETTING SUFFICIENT SALARY THEREFORE I WORK ONLY FOR THAT MUCH TIME WHICH I FEEL MY SALARY IS JUSTIFIED.

If I am getting lesser salary then it is the outcome of my poor show. If a **good financial package** is the only cause of my **motivation** then the question is of the type "A hen first or an egg first?"

Therefore it is necessary for us to think that my work shall speak for myself & the **outcome** of which shall be **a good financial package**.

The habit of devotional work is otherwise also good for our life in general.

(J) : INSPITE OF WE WORKING SO HARD, WE ARE NOT GIVEN THE DUE RESPECT. EVERYBODY SHALL GIVE US MORE DIGNIFIED TREATMENT. SINCE WE DO NOT GET THE RESPECT; WE DO NOT PLAN.

The reason behind this is again lying in our half hazard work. Any work done by thinking till the root of the work reflects out personality in it, which automatically fetches respect & dignity to us. Secondly, dignity is the reciprocation of our behavior. If we start respecting a smallest work & smallest worker then they also respect us in reciprocation. It is us, who loose the dignity of hard work first & therefore in turn receive the same treatment by others.

(K) : BUILDING CONSTRUCTION IS MORE LABOUR ORIENTED & MOST OF THE LABOUR ARE ILLITERATE, THEREFORE IT IS IMPOSSIBLE TO PLAN.

Our wrong concept about the task work, inability to give continual employment to labour, is the real reason behind the problem, but we mislead ourselves by giving the above excuse.

The illiteracy of the laborers can be overcome if we have good communication skill, proper terminology, clarity of thoughts & habit to give clear-cut instructions. Insufficient & ambiguous instructions shall be avoided to overcome the problem.

(L): DECISIONS OF ARCHITECTS' & CONSULTANTS' DELAY DISCOURAGE US FROM PLANNING; THEREFORE WE DO NOT PLAN..

Sufficient lead-time for everybody & still sufficient floating time in planning, can be the best solution to this problem.

These are the some of the reasons, which cause the delay, & hence we conveniently start thinking that it is better, not to plan anything but let the events take their own course & let us be a passive observer.

PLANNING MAY FAIL, BUT NON-PLANNING DEFINITELY FAILS.

PRELIMINARY PLANNING

INTRODUCTION :

Every construction project needs a land for building the structures thereon. This is the foremost requirement for any construction project like roads, buildings, treatment plants, theatres etc. Therefore it is very essential for an engineer to know about title of a land, procedure of land acquisition, the various land revenue records and documents etc.

In the housing construction industry, it becomes a predominant function to know about the land records, because The Developer/ builder/promoter enters a land for a comparatively short period of time. The land is ultimately transferred from the original owner to the legally founded body (society) of the purchaser members.

Though the Developer enters the land for very short period, it becomes his prime responsibility, to ensure the proposed buyers of individual units, about the clarity and marketability of the title of the concerned land.

Therefore the preliminary planning in the housing construction industry begins with purchase of a land.

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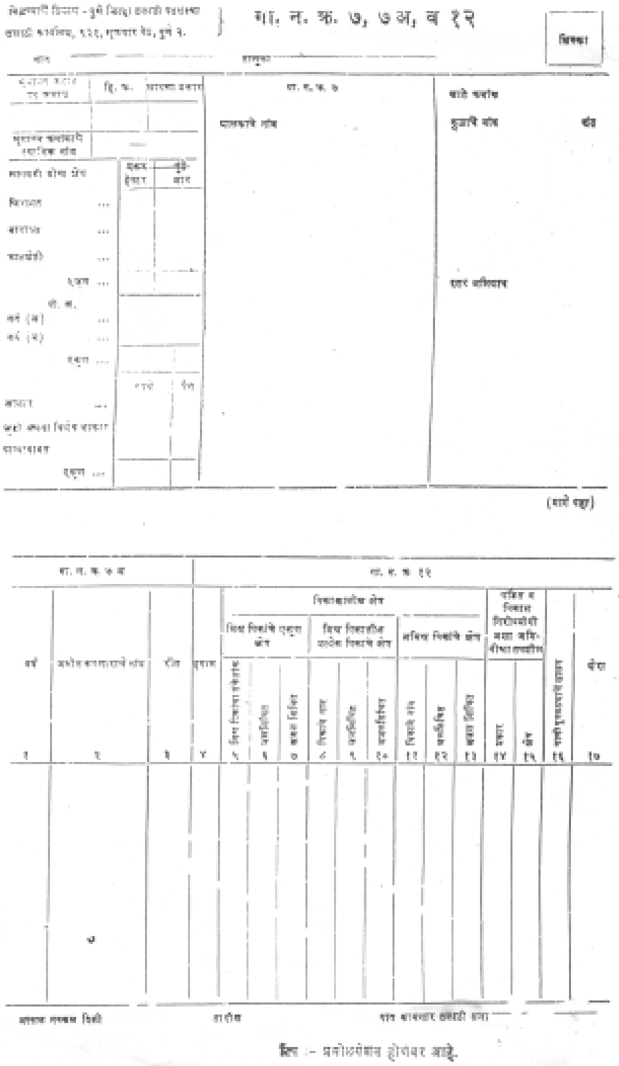
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1. LAND ACQUISITION :

Following documents are very important for purchase of a land for construction of any project

I. Purchase of land can be made by entering some of the following documents.

a) Sale deed

b) Long lease

c) Power of attorney to develop the land

II. If the land is given on power of attorney, the developer reserves the rights to construct and sell individual units (flats,shops), building /buildings, commercials etc.

III. The zone of the land shall be confirmed for its purpose of use from the local town planning authority.

IV. **The city survey** department of a revenue department issues the authorized copy of plan showing the measurements of concerned land and the boundaries of it. This plan helps to demarket the legal boundaries of the land.

V. The title of ownership of the land shall be confirmed through an Advocate by an investigation known as 'Search report.'

2. NECESSARY LEGAL DOCUMENTS FOR A LAND:

A) Property card

B) 7/12 extract

C) Changes in extract

D) Zone certificate

E) City survey plan, Reservations if any, for public purpose.

F) Lease Agreements.

G) Power of attorney

3) CONTOUR PLAN:

A survey shall be conducted to decide the relative heights, level difference and undulations on the surface of land with respect to some temporarily datum like the top of nearest access road.

This plan is very useful for deciding the various levels e.g. plinth levels, services, cutting &filling in the plot, retaining walls etc.

4) TRIAL PITS:

Trial pits shall be taken at various spots of the plot, which helps to know the strata available for designing of foundations.

5) APPOINTMENT OF ARCHITECTS & CONSULTANTS:

Experienced, competent and licensed Architects and Consultants shall be appointed for the designing of the proposed project.

Architects & consultants play an important role throughout the project.

Some of their responsibilities are:

i. Preparing preliminary layout of project & getting it approved from the client and the Local Authority.

ii. To prepare detailed drawings.

iii. To prepare working drawings.

iv. To visit the project as & when required.

v. To monitor the progress of the project.

vi. To attend necessary meetings arranged by everybody concerned with the project.

vii. After completion of the project he should get completion certificates from corporation or relevant authorities.

6) ORGANIZATION SET UP FOR CONSTRUCTION PROJECT:

From the preliminary planning a setup of staff is worked out. Accordingly time frame is decided for the appointment of the required staff. The duties and functions of various rank and file positions are defined. The details are given in the chapter ‘ Organization Behaviour’

7) DRAWINGS:

The drawings, finalized and issued by the Architects shall be verified at site for the actual boundaries of the land, existing roads etc. After this verification, final working drawings shall be prepared to commence a project. The existing electrical lines, drainage lines & Water lines shall be marked on the working drawings. These drawings help to finalise the planning of the proposed layouts of electrical, plumbing and other services.

8) LIST OF AMENITIES: -

The extra amenities other than the essential services shall be decided if they are to be provided in the project. A club house, a landscape garden or any such extra amenity shall be decided beforehand. This helps to plan the services efficiently.

9) SPECIFICATIONS:

The materials to be used , the methods and processes to be used for the project shall be listed and their quality shall be specified before commencement of work. Each and every item shall be considered while listing the materials.

10) ESTIMATES:

Preparation of estimate is very important to judge the feasibility and ascertain a tentative cost of the project before starting any project

There are two types of estimates

a) Preliminary estimate

b) Detailed estimate

The methods of preparing these estimates are discussed in a separate topic.

11) SITE & SALES OFFICE:

Site office and Sales office shall be easily approachable and shall be well-equipped with all necessary information.

Site office: - The site office shall have following information: -

I. A set of all sanctioned drawings

II. All architectural and structural drawings.

III. All necessary record books required for stores handling, reporting, customer changes and other works.

IV. Site visit reports by Architects and Consultants.

V. All safety equipments.

Sales office: - The sales office shall have following information:

I. The Brochures of the project and also of the other projects of the organization.

II. Details of areas and cost of the flats, shops and offices in the project for sale.

III. Proper means of communication.

DETAILED PLANNING

During the preliminary planning, following data is collected: -

1) Approved layout.
2) Finalized amenities.
3) Finalized specifications.
4) Structural drawings.
5) Detailed drawings.
6) Detailed quantities.

From this preliminary data, the final planning of the project shall be done in detail. Decision-making becomes easy due to the **'Detailed planning'**.

During the detailed planning, the project shall be divided into number of well manageable activities. These activities have to be performed in a definite sequence for the completion of the project. These different activities consume resources and take time for their completion.

To arrive at the logical quantification of the resources and the time, various methods are adopted. In these methods, the various activities are required to be arranged sequentially so as to estimate the correct quantities of various resources, the duration and the exact time of availing the specified quantities of the resources. Bar chart is one of the methods to help to meet the purpose of planning.

BAR CHART: -

This simple method consists of preparing a graphical presentation, which displays different activities by horizontal bars representing the schedule of different activities. Activities are represented on Y-axis and duration is represented on X-axis. Each bar represents specific activity to be performed along with the commencement and completion of the activity. Beginning and the end of each bar represents the time consumed by that activity.i.e.the duration of the activity.

ADVANTAGES OF BAR CHART:

1) It is very simple and easy method of scheduling.
2) Each activity is shown separately. Actual progress of work can be compared with proposed schedule. Hence modification can be carried out easily if required.
3) Achievements on a particular date in progress, can be easily represented.
4) Cumulative progress can be represented on a bar chart.
5) It can represent possible delays.

LIMITATIONS OF BAR CHART:

1) Interdependence of various activities cannot be shown absolute clearly and sequence of activities is not clear.

2) By itself, it does not indicate the progress of the project.

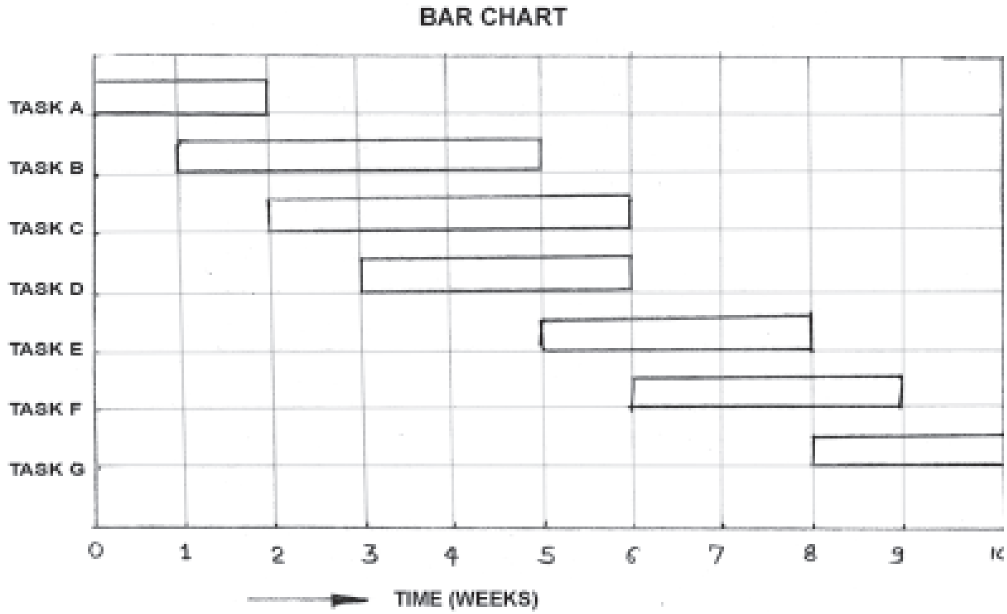
3) It cannot represent and reflect tolerance and uncertainties in time-estimation for various activities.

4) It does not give optimum duration of the project.

5) Different alternatives cannot be evaluated from bar chart.

6) It is not possible to locate a critical activity, which may delay the project to a great extent..

SPECIMEN BAR CHART:



CRITICAL PATH METHOD:

As the project and the activities become more and more complex; bar chart method of scheduling becomes less helpful. Therefore to overcome the limitations of scheduling by bar chart; a scientific networking method is developed, known as 'CRITICAL PATH METHOD' (C.P.M.)

In this method, the objectives of all the activities are defined. These objectives are compound with the targets considering the problems, which may creep-in, before or during the construction.

A project is broken into a number of distinct, well-defined tasks or activities. The beginning and end of every activity is called as an EVENT. These events when connected logically and sequentially form a network diagram. Thus this network is a flow diagram.

The method to prepare a network diagram is explained in detail.

STEPS TO BE PERFOMED IN DEVELOPING NETWORK:

1) Breakdown the project, into simple different Activities.

2) Decide the interrelationship between the activities i.e. decide the preceding & succeeding activity of each activity..

3) Decide the sequence of the activities.

4) Depending upon the sequence, draw the network.. Dummy activities may be adopted if required for

completing the network.

5) The network should be carefully studied to see that the sequence & the inter-relationship are well - maintained.

Activity is represented by an arrow ⟶

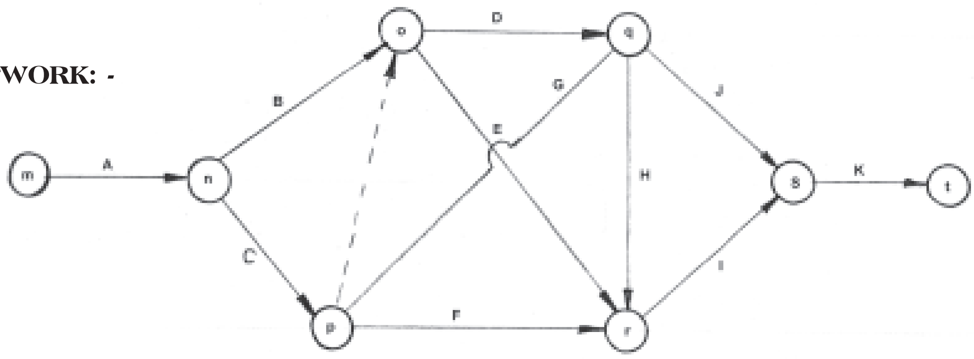
Dummy activity is represented by broken arrow – – – – – →

Event is represented by circle ○

RULES FOR FRAMING NETWORK:

1) Initial event is the starting of project. Hence different Activities will emerge from initial node. Hence there is always a single initial node in a network.
2) An event cannot be said to have occurred unless all the activities merging in that event are completed.
3) No event depends for its occurrence on the occurrence of any succeeding event. This means that there cannot be any path in the network looping back from a succeeding event to a preceding event. Such a situation known as **looping** shall not occur anywhere in the network.. If such situation occurs, the logic underlying the diagram must be re-examined & the interrelationship between the activities may be properly decided.
4) No activity can start unless the tail event has occurred. There should not be any dead end loop for any activity except the final node, which is the completion of the project. If it happens, take a dummy activity.
5) Any activity in the project should be represented by a single line arrow & each arrow should represent a singular activity & hence the number of arrows must be equal to the number of activities.
6) Dummy activities should represent the interdependency properly.
7) The activity arrowheads will point towards progress of the project i.e. from left to right. The line flows from left to right.
8) The length of arrow does not indicate the duration of any activity to any scale. Length of an arrow is chosen to suit the drafting requirements.
9) Curved arrows shall be avoided.
10) As far as possible, Activity arrows shall not cross each other, but if interdependency demands, the activity arrow should be broken to bridge over the other.
11) Head events have always-higher numbers than the tail-end events.

SPECIMEN NETWORK: -



SPECIMEN CP NETWORK

IMPORTANT FEATURES OF "CPM":

1) It is applicable to both small & large projects.
2) It provides diagrammatic form to the total project, showing independency of various activities. The complete project can be visualized at a glance.
3) **Critical** activities, **which affect the project duration**, can be easily identified & proper attention can be put, to their completion.
4) It is the technique of economic sequence of operation & hence when the minimum overall cost is the main consideration, it is the best planning tool.
5) It can ensure better utilization of men, material & machineries.
6) Slack period (float) available, can be utilized effectively.
7) Possible bottlenecks & difficulties can be visualized well in advance.

RESOURCE ALLOCATION:

For actual implementation of a project, different resources are required. The resources include men, material, machineries, money & also space. A project cannot commence in the absence of any one of the above five resources.

Bar chart or CPM techniques are used for planning & scheduling of a project. A detailed list of all the resources is prepared with the help of a bar chart or CPM technique.

The resources are then allocated on monthly basis or on suitable time intervals. In this way, all the resources are spread over in a balanced manner on suitable time duration.

This helps to complete the project with a constant pace and harmony.

TIME AND MOTION STUDY:

During the execution of each item of work, every worker, supervisor, manager moves as per the need of the job. The raw material in process, is also moved for various operations on it.

The study of this movement of raw material as well as the worker with respect to time is called as "**TIME AND MOTION STUDY**".

The objective of this study is to minimize the handling of the material during production and also to minimize the manpower. This study also helps to locate and delete the stressful movements of a worker during production process. The study helps to locate and minimize the idle time of men, machine and improve the outputs.

This study helps to pinpoint the probable congestion of traffic of raw material and workers, indirectly reducing the accidents.

Time and motion study initially started in the construction industry. Mr. Gilberth first studied the brick masonry item scientifically, to improve the efficiency of mason.

But this practice of time and motion study was totally sidetracked afterwards. The use of CPM, PERT and other networking methods were adopted by construction industry with an enthusiasm. **This is the most**

useful method for a supervisor at site level. But this study is not taught at all, at college education of civil engineering.

This method helps to plan and efficiently execute the various items at the actual work place, for a supervisor. It helps to reduce the wastage of material, manpower and time. It helps to keep the work place, safe and clean.

ADVANTAGES OF PLANNING: -

The project planning and process planning helps us in following ways: -

1) It decides the earliest and latest starting and finishing dates of all the activities. This in turn, helps to decide the dates for sanctioning, designing and finalizing the drawings.
2) It decides the exact dates for mobilizing various resources.
3) It locates the probable bottleneck in the production.
4) It shows the exact congestion of activities and hence the imbalance in resource allocations. This helps to change the flow of, some of the activities to streamline the cash flow.
5) It pinpoints the critical activities, which affect the project duration.
6) Process planning locates the exact point of necessary supervision.
7) It gives us liberty from minor day-to-day problems. It helps to minimize the fatigue due to overtime working.
8) It helps to create a good work- culture. This results in healthy work atmosphere, finally leading to good quality product.
9) It helps to carve out leisure time between the processes to overcome the monotony, imposed due to continuous work.
10) It locates the floating time between the various activities. This helps to re plan the project to achieve economy.
11) All the above advantages collectively raise confidence level of all the concerned, involved personnel. The initial picture of chaos and a feeling of 'LOST Control' is wiped off. A new picture of 'total control' is created.

MONITERING THE PLANNING DURING CONSTRUCTION

The most important reason behind the failure of a very good planning, is the lack of monitoring it.

Many times, 'very good planning' is done and kept in a file, and then the file is shut and forgotten, till some problem arises. This happens due to lack of habit of monitoring on daily basis ,during the construction . Monitoring helps in many ways, such as;

1) The reasons of an activity lagging behind-the-schedule,are surfaced. This helps to take corrective actions before the project is delayed beyond alarming situations.
2) A preventive action is evolved to avoid future congestion and delays.
3) The price fluctuations in the market can be judged and suitable advantage can be taken, without hampering

the quality and without unbalancing our resources.

4) It helps sometimes, to complete the total project, even before-time successfully.

5) In this manner, it helps to avoid complications due to delay, such as, penalties, strained customer relations and litigations.

Therefore monitoring the planning on daily basis shall be treated as a **critical activity in a project**.

ESTIMATING AND COSTING

INTRODUCTION :-

To decide about tentative cost of project in advance, various items are required to be estimated. The approximate quantities of all the items are calculated as per the specifications. These quantities of items are then bifurcated to calculate the volume and cost of the material, labours, machineries, plants and equipments.

The volume of materials, labours and machineries required ,will help to decide whether the specifications and methods are workable or not, as per the local availability. The volume of materials estimated in advance, helps to decide about the required storage facilities. The volume of labours converted into mandays helps to decide about area required for transit camp of the workers.

All these related information helps to draw the primary layout of the site.

After confirming these primary requirements, the specifications, methods and procedures are finally decided. The rates of various materials, labours and machineries are analysed as per the final specifications. The rates of individual items are then analysed considering the consumption of material, labour, machinery and their market rates. The total cost is then derived with the help of initially surveyed quantity and the rate derived for each item.

The various overhead costs are then added for the consumable items (fuel, oil etc.), supervision charges, administrative expenses, contingencies and such costs which could add as per the importance and uniqueness of the project.

To judge the feasibility of a project, preliminary estimates are helpful. These preliminary estimates help to decide about, whether to start the project and how to start the project.

If the feasibility is proved, through the preliminary estimates, the detailed estimates can be worked out.

Procedure for preparing preliminary estimates

To ascertain the tentative cost of a project at a glance, in short time; the preliminary estimates are prepared. The preliminary estimates of ownership type buildings are prepared on the following guidelines.

The total cost of project = Direct cost + Indirect cost

WHERE

Direct cost includes,

1. Cost of land.
2. Cost of Material.
3. Cost of Labour.

Indirect cost includes:-

1. Land development cost.
2. Legal expenses.
3. Administrative expenses.
4. Supervision expenses.
5. Infastructural development costs.

6. Cost of Security services.
7. Miscellaneous costs.
8. Any other costs as per the peculiarity of the project.

To fulfill the time essence of preparing preliminary estimates, certain rules are derived, based on practical past experience. These thumb rules help to decide the approximate project cost, quickly.

SOME OF THE THUMB RULES IN BUILDING CONSTRUCTION:-

To ascertain the preliminary cost of a residential building, certain assumptions are made for the rate of consumption of materials per square feet area of building. These assumptions are purely based on practical observations and records. These observations are converted into some thumb rules. These thumb rules will help to ascertain the preliminary cost of a building, easily.

SR.NO.	MATERIAL	QUANTITY PER SFT
1.	Cement	0.45 Bags
2.	Steel	2.2 to 3.5 Kg
3.	Sand	2.25 Cft.
4.	Metal	1.10 Cft
5.	Ruble	0.30 Cft.
6.	Murrum	075 Cft
7.	Bricks 9" x 4" x 3"For plinth	4 Nos.
8.	Bricks 6" x 9" x 4" For external walls in superstructure	4 Nos.
9.	Bricks 4" x 9" x 3" For internal walls in superstructure	4 Nos.
10.	Sanala	0.22 bags
11.	Ceramic tiles	0.80 Sft.
12.	Ceramic skirting	0.25 Sft
13.	Bathroom Floorings	0.10 Sft
14.	Dado	0.3 Sft
15.	Kitchen platform	0.012 Rft or minimum 8 feet per flat
16.	Chequered tiles	0.08 Sft
17.	Staircase flooring	0.10 Sft
18.	Brickbat for waterproofing	0.05 Cft
19.	Door frames	0.06 Nos.
20.	Door shutters	0.08 Sft
21.	Staircase railing	0.003 Rft
22.	Aluminium window	0.09 Sft
23.	Light point including common areas	0.022 Nos.
24.	Power points	0.02 Nos.

DETAILED ESTIMATE: -

To prepare a detailed estimate, quantities of all the items are worked out in detail, with the help of finalized specifications and detailed drawings. The total project cost is then calculated by taking into account the quantities worked out and considering the prevailing market rates. The rate analysis of the individual item is done with the help of market rates of labours, materials, stipulated task work, cost of machinery, tools & plants. The total process study of an item helps to decide the exact quantum of material, labour, task work and components of machinery in that item.

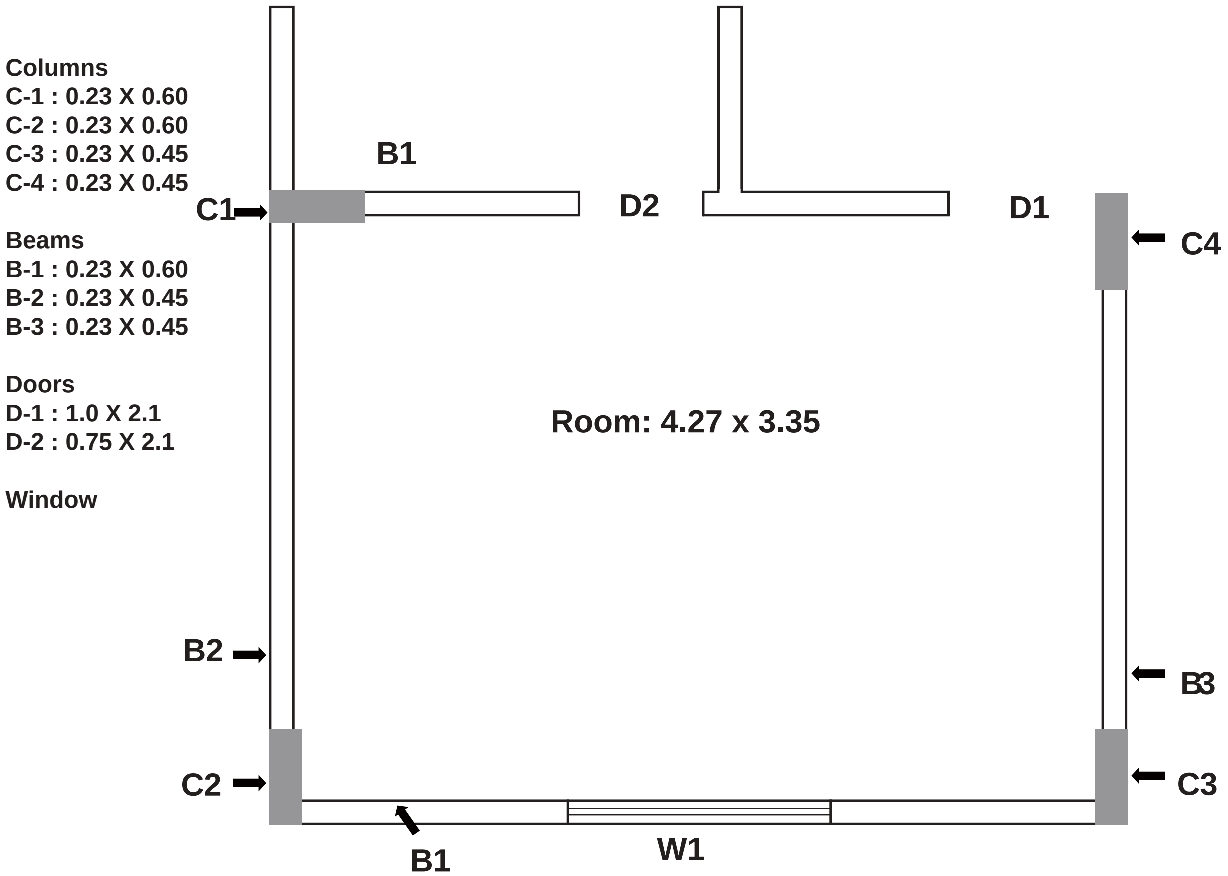
The detailed estimate gives us the total cost of a project and helps us to take the following decisions.

1) To decide the exact date of starting the work.
2) To decide the total project duration.
3) To plan the work with the help of suitable tools e.g. Bar chart.
4) To decide the required cash flow.
5) To decide about various itemwise contracts and most suitable type of contract.
6) To freeze the bill of quantities.
7) To take the advantages of fluctuations in market rate.

An exercise will be self-explanatory to understand the process of estimating and costing.

Consider a bedroom having clear dimensions of 4.27m x 3.35m in plan. The Floor to floor height is 3.05m.

The sizes of the openings: Door (D1): - 1m x 2.1m, Door (D2): - 0.75m x 2.1m, Window (W1): - 2m x 1.2m



Estimate the quantities of materials and labours for 6" thick B.B.M.

Sr. No.	Particulars	Nos.	Length (L) mtr.	Breadth (B) mtr.	Height (H) mtr.	Area in Sq.mtr.
1.	Long walls					
	L1	1	4.11	-	2.45	10.05
	L2	1	3.74	-	2.45	9.16
2.	Short walls					
	S1	1	2.82	-	2.60	7.33
	S2	1	2.45	-	2.60	6.37
				Total B.B.M. (A)		32.92
3.	**Deductions**					
	Doors					
	D1	1	-	1	2.1	2.10
	D2	1	-	0.75	2.1	1.57
	Window					
	W1	1	2	-	1.2	2.40
			Total deduction for openings (B)			6.07
			Net B.B.M. quantity (A-B)			**26.85**

Therefore the total quantity of B.B.M. for bed room = 242.5 square feet

Material Analysis for 6" thick B.B.M. in C.M. 1:6

1) 6" Bricks: -

bricks required for 100 sft B.B.M. work

Volume of B.B.M.= 100 sft x 6" = 50 cft.

Consider 30% wet mortar.

Total quantity (Volume) of bricks= 50 x 0.7= 35 cft.

Volume of one brick= 9” x 6" x 4"= 0.75 x 0.50 x 0.33 = 0.12 cft.

No. of bricks required = volume of brick work / volume of one brick

= 35/0.12

= 291.66 Say 292 No.

Add 2% wastage = 292 x 1.02 = 297.84 Say 300 Nos.

Nos. of bricks required for 100sft = 300 Nos.

Nos. of bricks for 242.5 sft = 242.5 x 300 =727.5 say 730 Nos.

2) Cement: -

Quantity of mortar = 15 cft.

For C.M. 1:6

Cement = 1/7 x 15=2.14 cft

Volume of one bag of cement = 1.25 cft.

Quantity of cement = 2.14/1.25 =1.712 say 1.75bags

Quantity of cement for 242.5 sft B.B.M.= 242.5/100 x 1.75 =4.243

Quantity of cement = 4.243 Say 4.25 bags

Quantity of sand = 15cft –2.14 cft = 12.86 cft.

Quantity of sand for 242.5 cft B.B.M.= 242.5/100 x12.86 =31.18 cft

Quantity of sand = 31.18 cft Say 32 cft.

Water = As required for workable mix.

Rate Analysis:- For 6" B.B.M. in C.M. 1:6 for 100 sft.

Sr No.	Particulars	Quantity	Unit	Rate/unit	Amount
1.	Material				
	a) Cement	1.75	Bags	160/-	280=00
	b) Sand	12.86	Cft	20/-	257=20
	c) Bricks	300	Nos.	3.5/-	1050=00
	Total cost of material (M)				1587=20
2.	Labour				
	a) B.B.M.	100	Sft	4/-	400=00
	b) Curing	-	-	-	10=00
	Total cost of labour (L)				410=00
3.	Total material + labour (M+L)				1997=20
	Add 1% for supervision charges				19=97
	Total cost of B.B.M (100 sft)				2017=17
			Say		2020=00

Therefore cost of B.B.M. for 100 Sft = Rs.2020/-

From the example above,

Cost for B.B.M. for 242.5 sft is :-

242.5/100 x2020 =4898.5 Say Rs.4900/-

CONTRACTING & BILLING

AGREEMENTS WITH CONTRACTORS

Agreement is a legal document, which acts as a legal binding between both the parties for all terms & conditions mentioned in the document.

Agreements are based on:

1) Legal Conditions
2) Responsibilities of Contractor
3) Responsibilities of Company
4) Scope of Work
5) Payment terms & mode of measurements

After finalizing the rates & conditions, agreement is to made .Both the parties should act on it as legal & mutual understanding. Work is to be commenced only after issuing/receipt of Agreement copy & Work Order.

An agreement is beneficial for both the parties as

1) It binds both the parties legally for any disputes, non-compliances of the terms, arbitration etc.
2) Rates are finalized & confirmed for various items, before commencement of work.
3) Scope of work is very clear before commencement of work
4) Mode of measurement is finalized before commencement of work.
5) It clears the understanding between both the parties .
6) Finance provision as per the payment terms can be made by both the parties.
7) Estimation for total expense overheads etc. can be planned out by both the parties.

TYPES OF CONTRACT AGREEMENT

1. ITEM RATE CONTRACT

2. BUILT UP AREA BASIS CONTRACT

3. LUMP SUM CONTRACT

1) ITEM RATE CONTRACT

For billing & measurements, the work is split into various items.

Rates are finalized for various items as per agreements and are considered for billing.

Measurements are taken as per approved mode of measurement for billing.

2) BUILT UP AREA CONTRACT

For this type of contract the rates are worked out for estimated material, labour, tools & plants, machinery cost, overhead expenses etc.

Value of contract is derived in terms of built up area agreed mutually.

Mode of payment is finalized as per the stage wise work done, or as per the percentage agreed, or as per contract.

3) LUMP SUM CONTRACT

For lump sum contract, measurements are not required for billing as normally petty works are to be carried out through this contract.

TYPES OF BILLS

Contractors are paid by preparing bills for the work done at various stages through

A) ADVANCE BILLS

B) RUNNING ACCOUNT BILL

C) FINAL BILL

A) ADVANCE BILL

1) If mentioned in contract, an advance Bill may be prepared, after receipt of material supplied by the contractor.

2) To facilitate the contractor or to give an interim relief due to some uncertainties, an advance bill may be prepared considering the expected work to be completed within a scheduled period.

3) If some discrepancies are observed or some disputes arise then to avoid further delay some part of the payment can be released as an advance payment .

B) RUNNING ACCOUNT BILLS (R.A.BILLS)

If mentioned in the contract, contractors are paid on forthrightly or monthly basis for work done during that period.

For such bills, quantities or work done during that period is to be measured & paid.

Preparing R.A. Bills at Site

Billing is one of the most important documentary activity and should be sincerely carried out by engineers, very sincerely & carefully. All measurements should be recorded on measurement sheets with required **self-explanatory** sketches & notes. Payment is to be made as per stage of work & percentage payable to that stage of work. Previous work done & advances paid up to date are to be considered while calculating final payable figure. Rates & mode of measurements should be as per the agreement .In case of doubts refer higher authorities. Check that all necessary information is written & bills are duly signed.

Record to be maintained at site

- Copies of all agreements with contractor / work orders.
- Copies of bills shall be maintained in separates files at site
- The contractors file and payment status shall be updated periodically.
- Quantities of work done as per drawing & as actual as per site execution, shall be noted.

Specimen format of R.A. Bill

R.A. BILL FORMAT

Name of Company: ______________________ R.A. Bill No: ____________

Name of Site: ______________________ Name of Contractor: ______________________

Date: ______________________ Period: ______________________

Work: ______________________ Building: ______________________

Sr. No	Item	Previous Qty	Current Qty	Total Qty	Rate	Unit	Amount

	TOTAL AMOUNT BILL	RS.	
	LESS RETENTION AMOUNT	RS.	
	BALANCE AMOUNT (1-2)	RS.	
	LESS TOTAL PAYMENT UPTO PREVIOUS R.A. BILL	RS.	
	TOTAL BALANCE PAYMENTS	RS.	
	LESS OTHER DEDUCTIONS		
	i) DEBITS IF ANY	RS.	
	ii) ADVANCES IF ANY	RS.	
	iii) T.D.S	RS.	
	NET PAYABLE AMOUNT	RS.	

PREPARED BY : CHECKED BY : PROJECT MANAGER

3) FINAL BILL

After satisfactory completion of the work by contractor; the final bill may be prepared. As per the agreement the liquidated damages period shall be considered while releasing the retention amount. The recommended consumptions of materials shall be crosschecked at the time of final bill. The various amount debitable against penalties, material supplied by company, water & electricity charges, if any, shall be taken into account.

SELECTION PROCESS AND NORMS
FOR SUPPLIERS AND CONTRACTORS

Every project involves many activities, demanding different skills to achieve the **required result** of the activity**.**

Therefore it is essential to define the **'Required Results'** of an activity. These 'defined required results' will guide us **to lay the norms** for selecting a supplier and a contractor for a specific activity.

It is also essential, alongwith the skills, to verify the integrity, loyalty of a supplier, contractor towards the organization's philosophy and the goals. The past experience of the organization about a supplier, contractor shall also be considered but; this need not be treated as the only qualification, as; the real need of a project is governed by its **uniqueness** and not by experience only.

Following diagram will help to decide the norms.

Define and shortlist the Required Results ↓	: Skills, available manpower and machinery, speed, consciousness about time and quality, integrity, loyalty, Past experience, financial stability etc.
Screen the available list (Or new list) to the services offered by a supplier or contractor and short list it ↓	: The screening is done by compaining the 'offered services' to the required results. If more than 75% requirements are assumed on the above norms; then the supplier, contractor is included in the short list.
Negotiations with the supplier and contractor. ↓	: Negotiation does not necessarily mean 'Financial Negotiation' , it includes to assess the real willingness of supplier, contractor to deliver the services, if entrusted a job. This assessment is also done for present commitments, jobs in hand of the supplier, contractor and the credit facility offered by the supplier, contractor to suit the organization's Cash flows, the time required for mobilization etc.
Final selection ↓	: The shortlist is finally screened after negotiations and the final selection is done. The supplier or contractor's written agreement (P.O., work order) is prepared. The main essence of the agreement is highlighted in writing as well as by verbal instructions. Sufficient mobilization time for the supplier and sufficient floating time for the organization shall be maintained. This floating time will help the organization to change the supplier, contractor if the concerned does not perform.
Monitoring the performance	: The performance of the supplier, contractor shall be monitored to confirm the actual results. If the actual results are not as per desired results then the total selection process shall restart, in the organization's interest.

STORES AND MATERIALS MANAGEMENT

INTRODUCTION:

Most of the activities in the construction industry are connected with men, material, machinery and its management. The effective co-ordination of these key factors lead to planned progress & successful completion of projects.

In any construction project, the materials play an important role, as it constitutes 40% to 60% of the total project cost. Hence the success of the project depends upon effective MATERIALS MANAGEMENT. It is very necessary to have proper planning for the materials management before and during the work. Material arranged at proper time in quality & quantity results in substantial saving in cost & time . The overall quality of construction improves with effective material management, proper storage arrangement and watchfulness.

MATERIALS MANAGEMENT:

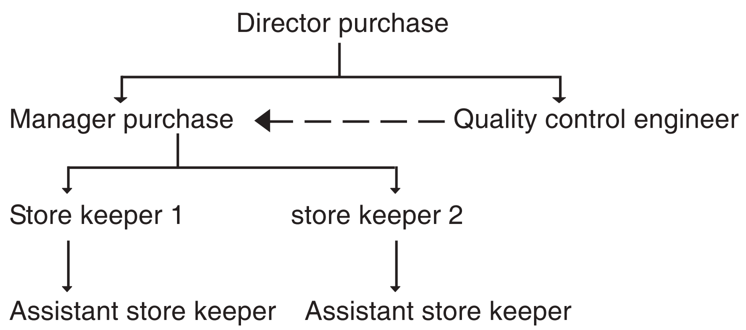
Material management is a recent field of management and it deals with, planning of materials as required for a project, before & during the construction. It decides what to purchase, where to purchase, from how to store, where to store

The material management covers all aspects of materials: costs, supply and utilization. It is a technique to improve the productivity of the capital by reducing the material costs, preventing blocking of funds for long periods. This improves the capital turn-over ratio.

OBJECTIVES OF MATERIALS MANAGEMENT:

a) Provision of materials in specified quantity, quality and at optimum cost.
b) Minimize investments in materials and cost of inventories by assuring high inventory turnover.
c) Minimize the handling costs at various junctures.
d) Timely purchase of materials to fit-in the construction schedule.
e) Proper arrangement for storing of materials and proper inventory control.
f) Avoid wastage of materials.
g) To watch the market conditions for probable fluctuations in price and to take proper decisions regarding purchase.

ORGANISATIONAL SET UP OF PURCHASE DEPARTMENT



FUNCTIONS OF MATERIAL MANAGER:

A) Material planning & programming.

B) Material purchase.

C) Receiving, Inspecting, & Storing of materials.

D) Inventory control.

E) Store keeping.

F) Material handling & issue of materials.

G) Transfer of surplus materials.

H) Co-ordination between staff & agencies.

I) To plan economic use of materials.

J) To keep watch on supply & use of materials.

K) Control over security of materials.

L) Proper accounting of materials.

M) Control on wastage.

REQUISITIONS, STORE RECORDS, ISSUE OF MATERIALS :

REQUISITION :

To streamline the total process of purchase of materials, it is necessary to lay down systems from the root of demand of materials till the purchase of it. Various formats are therefore prepared as per the designed system. Specimen requisition format is as below :

<table>
<tr><td colspan="5" align="center">REQUISITION SLIP</td></tr>
<tr><td colspan="5">COMPANY……………..........................
NO. ….   DATE ………………</td></tr>
<tr><td colspan="5" align="center">MATERIAL REQUISITION SLIP</td></tr>
<tr><td colspan="2">SITE………..</td><td colspan="3">Requisition shall be submitted seven days in advance.</td></tr>
<tr><td>Sr No.</td><td>Description</td><td>Unit/Quantity</td><td>Required Qty.</td><td>Remarks</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">APPROVED BY   PROJECT MANAGER
Order placed with …………………   by …………………   On ………………</td></tr>
</table>

STORES AND DOCUMENTS RELATED TO STORES.

In construction projects, various materials are required simultaneously. Hence storing and maintaining of store records is required to be done systematically. This helps to store and issue the materials without any difficulty.

The stores consist of sheds, open areas with compound walls. Proper arrangements are necessary for security of materials from theft & during handling. Materials are stored as per their nature and their costs.

FORMAT OF STOCK RECORDS IS SHOWN BELOW:

MATERIAL ISSUE REGISTER

PROJECT:................................ BUILDING NO...................

Sr. No.	Date	Contractor	Material	Qty. issued	Qty. returned	Qty. consumed

COMPANY:.......................................

GOODS RECEIVED NOTE

SITE NAME:................................ NO...................

Sr. No.	Date	Time	Challan No.	Supplier	Item	Qty.	Vehicle No.	Remark

COMPANY:..

INWARD BOOK

Inward No.	Date	Time	Material	Qty.	Supplier	Vehicle No.	Qty.	Signature		Remark
								Receiver	Deliverer	

MATERIAL RECEIPT ENTRY BOOK

PROJECT :........................... MATERIAL:........................ BUILDING NO....................

Sr. No.	Date	Time	Inward/ GRN No.	Supplier	P.O. No.	Challan No.	Vehicle No.	Quantity received	Progressive No.	Remark

ISSUE OF MATERIALS:

Any issue of materials from the stores shall be done against authorized issue slip only. If the stores are centralised, then the issue can be managed by allocating different days/dates of issue, for different materials or for different activities. However the stock book must be up-dated and stock of every item shall be worked out everyday.

SPECIMEN FORMAT OF ISSUE SLIP:

<table>
<tr><td colspan="3" align="center">ISSUE SLIP</td></tr>
<tr><td colspan="3">SITE ………………………. DATE :……………
BUILDING NO. …………………. FLAT NO. …………………….
NAME OF THE CONTRACTOR : …………...……..
PURPOSE: ………..........................…………………</td></tr>
<tr><td align="center">MATERIAL</td><td align="center">QUANTITY</td><td align="center">REMARKS</td></tr>
<tr><td>1)……………………………………………………......
2)……………………………………………………......
3)……………………………………………………......</td><td>.................................
....
.................................</td><td>.................................
....
.................................</td></tr>
<tr><td colspan="3">SIGN OF THE STOREKEEPER. SIGN OF THE ENGINEER.
....
SIGN OF THE CONTRACTOR.
....</td></tr>
</table>

A NOTE ON ABC ANALYSIS

This is a method of inventory control . It is generally observed that a small percentage of items, constitute the bulk percentage of cost. In civil engineering projects, items like cement, steel, tiles, plumbing and sanitary materials, C.P. fittings etc. constitute the high percentage of the total cost.

If we analysis the total yearly turnover of these materials, we observe that approximately 10 % of the items which are used repetitively cost 70 % of the total material cost. 20% items may account for 20 % of the total material cost & remaining 70 % of the items may cost 10% of the total material cost.

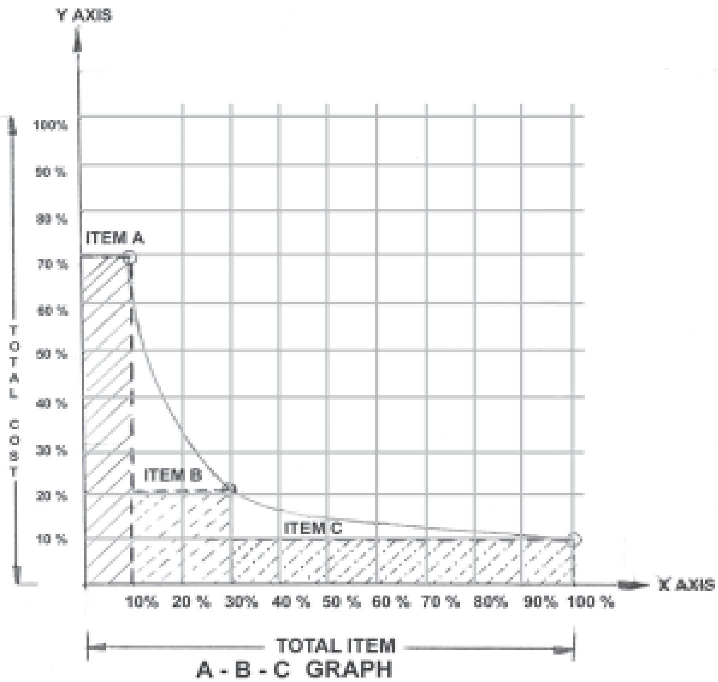
Therefore:

10% items costing 70% are classified as “A” items.

20% items costing 20% are classified as “B” items

70% items costing 10% are classified as “C” items.

Therefore we can conclude that, the items in class ‘A’ need a vigorous careful record keeping & the reconciliation of these materials must **be done on monthly basis, on priority.**



A - B - C GRAPH

The items in class 'B' may be given lesser weightage and may be reviewed monthly. The items in class 'C" may be reviewed quarterly or yearly.

INVENTORY MANAGEMENT

The purpose of preparation of inventory is to ensure availability at any given time and simultaneously to see that the cost of materials is kept minimum. This is achieved by making minimum stock of materials to such an extent, which would be required for continuous work progress of the project. Thus, stock holding is an integral part of inventory control and stock control deserves special attention in planning. Basic reasons for holding inventories:

1) To create a buffer or safety stock between input and output.
2) To ensure against the delays in deliveries of materials.
3) To allow for possible increase in the output if necessary.
4) To take the advantages of quantity discounts.
5) To ensure against the scarcity of the material in market.
6) To purchase the material when the prices are low.

THE OBJECTIVES OF INVENTORY CONTROL:

The management of inventory control is very complex, as it is affected by different factors and hence the management of inventory control should be with following objectives:

i. There should not be excessive inventory.
ii. There should neither be shortage of inventory, which may lead to stopping of construction and delay in project duration.

iii. There should be acceptable consumer service.

STEPS IN INVENTORY CONTROL:

i. Planning the operation of purchase of different materials.
ii. Physical verification of the materials in stock from time to time.
iii. Proper arrangement for stock of the materials.
iv. To ensure that, there is no damage to the materials during the storage.
v. To ensure security of stock of materials.
vi. Maintenance of proper records of receipts and issues of inventory.
vii. Fixing responsibilities of consumption and wastage of materials.

TESTING OF MATERIALS ON SITE:

Even if the material is tested in laboratory, its testing on site is essential. The Samples selected for testing in the laboratory, might have been selected by random sampling method. To overcome the errors in laboratory testing, actual field tests of materials shall be designed.

Following are some field tests for various materials.

1) REINFORCEMENT STEEL:

a) TOR: 'T O R' or equivalent Mark on every meter length of each bar.

b) WEIGHT PER METER LENGTH:

Sr. No.	Diameter of Bar	Weight per meter Kg/meter
1.	6mm	0.222
2.	8mm	0.395
3.	10mm	0.617
4.	12mm	0.888
5.	16mm	1.578
6.	20mm	2.466
7.	25mm	3.854
8.	32mm	6.313
9.	36mm	7.99
10.	40mm	9.864

c) CORROSION:

Avoid accepting corroded steel.

d) BENDING TEST:

A sample bar shall bend easily and without cracks, when bent with hands.

e) LENGTH OF BAR:

11 to 12 meter. Cut pieces shall not be accepted.

2) CEMENT:

A) CONFIRM THE GRADE: 33 / 43 / 53 .

B) CONFIRM THE FRESHNESS BY CHECKING THE FOLLOWING:

Day, Date and Year of manufacture, Batch no.

C) FINNESS TEST: Feels cold if hand is immersed in cement. Also, cement shall feel smooth.

D) FLOAT TEST: Cement shall float on water before it reacts with water.

E) PASTE TEST: The paste shall get the desired strength after 24 hours.

F) WEIGHT: Each bag contains 50 Kgs of cement. The weight shall be cross-checked for one bag out of every 10 bags, or as per decided sample size for the size of the batch.

3) METAL (COARSE AGGREGATE OF STONE):

A) SHAPE—Angular.

B) SIZE – As Desired (10mm, 20 mm etc.)

C) PHYSICAL APPEARANCE—Blackish gray, hard, uniform.

d) WATER ABSORPITON–Increase in weight when immersed in water shall not be more than 5%.

4) SAND:

a) SILT CONTENT—Not more than 7% by volume.

b) SIZE: Well graded (F.M. not more than 3.2).

c) OTHER IMPURITIES: Sand shall be free, from dust and chemical impurities.

5) BRICKS:

a) COLOUR—Uniform reddish.

b) SIZE AND SHAPE: size shall be as desired and allcorners shall be in right angle and edges shall be sharp.

c) WATER ABSORPTION: Weight shall not increase by more than 20% after soaked in water for two hours.

d) SOUND: Metallic ringing sound assuring well burntness.

e) HARDNESS: It should not break if thrown from 0.60 m.height.

6) MISCELANEOUS ITEMS:

Every miscellaneous material shall be defined for its quality- norms, before purchase. The testing norms shall be designed accordingly. The suitable field tests shall also be designed.

UNITS OF MEASUREMENTS FOR DIFFERENT CONSTRUCTION MATERIALS & ACTIVITIES:

Sr.No.	Particulars	Unit
1.	Cement	Bag or Kg.
2.	Sanala	Bag (20,40,50Kg/bag).
3.	Steel	Metric Tonnes.
4.	Binding wire	Guage and Kg.
5.	Sand	Cubic meter.(cum)
6.	Metal	Cubic meter.
7.	Dubber (Rubble)	Cubic meter.
8.	Bricks	No.
9.	Murrum / Soil	Cubic meter.
10.	Door frames & shutters	No.
11.	Aluminum windows	SQM.
12.	Glass	SQM.
13.	Rolling shutters	SQM.
14.	Top cover of rolling shutter	Running Meter.
15.	Tiles	SQM.
16.	Natural stones	SQM.
17.	R.C.C	SQM / CUM.
18.	Masonry	SQM.
19.	Plaster	SQM.
20.	Plumbing (Sanitary/ C.P)	No.
21.	Plumbing pipes	Running Meter.
22	Carpentry (Labour work)	SQM or Per No.
23.	Painting	SQM.

SAFETY PRECAUTIONS

INTRODUCTION :-

The indirect losses, due to inadequate safety during construction, are quite high. Therefore, the personnel working at site shall give equal importance to safety measures along with the urgency of the work.

As we know that, 'Prevention is better than cure,' sufficient preparatory arrangements shall be made to ensure safety.

Safety at work site is related to the valuable human lives, costly materials and the overall moral of the people working at site.

It is the duty and responsibility of every person working at site to work carefully to ensure safety for one & all.

In this view, some suggestions are made hereunder: -

1. The site office shall be equipped with first aid box & shall have a list of following emergency telephone numbers.
   - Fire Brigade
   - Ambulance services
   - Nearest hospital and doctors
   - Nearest police station
   - Municipal ward office
   - Security Agency
   - Maintenance Manager

During the work following precautions shall be taken to avoid accidents.

2. If the excavation in rock is required to be carried by controlled blasting; utmost care should be taken. This type of blasting shall be carried out ONLY UNDER THE SUPERVISION OF EXPLOSIVE CONSULTANT.
3. Every machine, equipment shall be handled & used as per the 'Directives" given by the manufacturer of the machine.
4. Electrical, drainage, water supply, telephone lines etc passing through the excavation area are to be traced out before excavation.
5. These existing lines shall be rearranged on priority, considering their final locations.
6. Make sufficient lighting arrangement in & around the working area.
7. Restrict children & trace passers in & around the working area by providing barricades.
8. Arrange for necessary strutting & shoring if excavation depth is by more than 2.0 meter
9. Proper precaution should be taken while excavating near existing structures.
10. The stacking or disposal area shall be well defined before starting the excavation work.
11. The excavated material should be stacked away from the excavated area.
12. Safe walkways, ladders, temporary stairs shall be provided for R.C.C. works at abnormal depths.

13. Irrespective of the location of the work- station, safety belts, helmets& all such safety equipments shall be mandatory.
14. Extra precautions shall be taken while deshuttering of R.C.C. work.
15. Sturdy barricades or brickwork shall be provided near lift wells and other such ducts.
16. While working on higher floors, additional safety measures shall be provided like nets, barricades etc.
17. Material handling lift shall not to be used as a passenger lift.
18. Restrict the overall movement of people in the vicinity of the deshuttering area.
19. Deshuttering shall be done in a systematic, phased manner by avoiding instant collapse of shuttering material.
20. Bricks shall be unloaded manually & dumping shall be avoided.
21. Debris and any material should not be thrown from the ducts, windows and terraces.
22. Proper erection of scaffolding should be carried out only by skilled workmen.
23. The scaffolding should be erected on firm base with sufficient working space.
24. Scaffolding should be strong enough to sustain the moving load & should be designed considering all safety aspects.
25. Removing of scaffolding should be done in systematic phased manner.
26. All temporary electrical connections shall be made only by authorized electricians.
27. Every machine or equipment shall be earthed against leakage of electricity.
28. All meter rooms, machine rooms & transformer room shall always be locked so as to avoid misuse.
29. All U.G.W.T., O.H.W.T., Septic tanks, open wells, chambers etc should be covered.
30. Adequate signboards and speed breakers shall be provided on the internal roads.
31. Visitors and customers shall be guided for safety precautions.

SECURITY SERVICE

The Security Service employed on a project plays a vital role throughout the project duration. Therefore, the agency selected to deliver the security service shall confirm the following norms.

1) It shall protect all the movable and immovable properties in the campus under its control, from thefts, misuse etc.
2) It shall protect the human life, livestock of animals (if any), the finished and semi-finished products from any type of loss.
3) It shall protect the campus from any type of trespassing by unauthorized persons, animals, etc.
4) It shall maintain the records of incoming and outgoing men, material with all the relevant information like vehicle No. etc.
5) It shall allow to enter visitors only after the confirmation from the authority.
6) It shall be always alert and watchful for finding out any type of abnormality in the routine.
7) The personnel, guards, appointed should be healthy, clean, neat and well dressed.
8) The guards, constables, supervisors shall possess the necessary equipments like whistles,stick, guns (if directed for), Torch, etc.
9) The guards should have good communication skill, manners and behaviour.
10) Every individual guard shall be physically fit, brave and prompt.
11) All the involved personnel shall be trained for basic minimum life saving methods and equipments.
12) All the employed servicemen shall be aware of the functioning of the premises they are protecting.

SURVEYING

INTRODUCTION:-

To obtain the accurate measurements, of horizontal and vertical angles and to determine relative heights or elevations of different points and locations of a land; various methods are used. All these methods are collectively called as **'SURVEYING'**. A branch of this science dealing only with the relative heights of various points / locations, is called as **'LEVELLING'**.

Every engineer shall possess the knowledge of surveying and levelling. Every engineer shall therefore have the skill of handling various instruments for accurate line out & levelling work.

In the building construction industry, the required surveys are comparatively for smaller areas of lands. The demarcation of main plot, demarcation of individual building (lineout) and the levelling of the plot (contour survey) are the three main objectives of survey.

These surveys are carried out with the help of the instruments namely; Theodolite, Dumpy level and Plain table.

The methods to use the instruments for various purposes are as follows:

LINE OUT BY THEODOLITE

Necessity of Theodolite :

Theodolite is used for line out to overcome the discrepancies / errors occurring in the conventional 'manual line out methods'.

Setting of Theodolite :

This includes operations i.e.

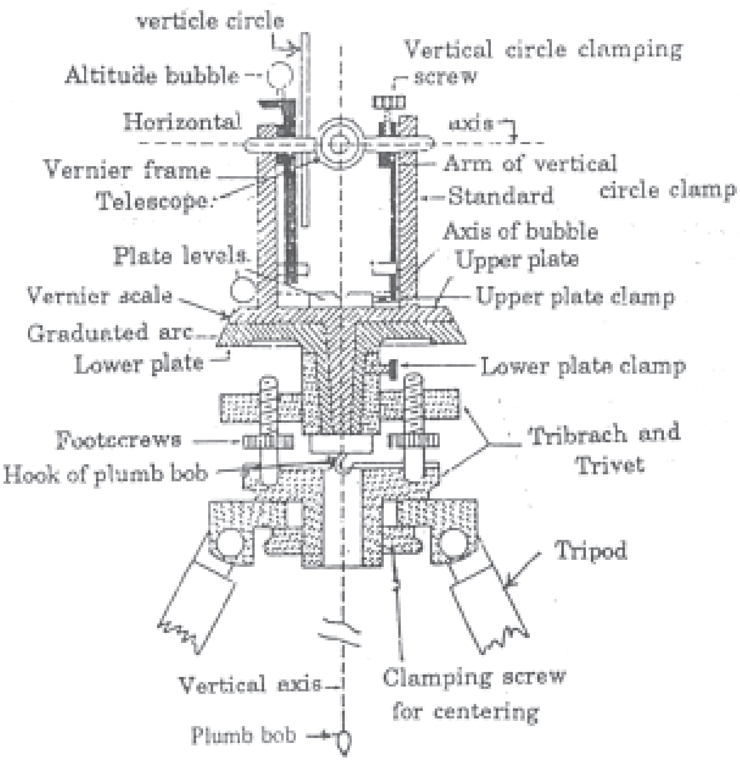
(a) Centering the instrument over the station mark, such as a tack or a station peg and

(b) Levelling the instrument approximately, by adjusting the tripod Legs only.

(c) For centering the instrument perfectly on the point a plumb bob is suspended from the hook and chain beneath the instrument

i) Set the instrument on the firm ground in such a position that the plumb bob is approximately over the station point.

ii) Move the legs radially and sideways so that the plumb bob is exactly over the tack and at the same time the top of tripod



Sectional view of a theodolite

is approximately horizontal. It may be noted that moving the legs radially, shifts the plumb bob in the direction of the leg without affecting the plate levels. While moving the leg circumferentially or sideways tilts the instrument considerably, without disturbing the plumb bob.

LEVELLING THE INSTRUMENT:-

The instrument is levelled by means of the levelling screws with reference to the plate bubbles.

To level the instrument:

i) Turn the upper plate until one of the bubble tubes is parallel to the line joining any pair of levelling screws. The other bubble tube will then be perpendicular to the line joining the first pair.

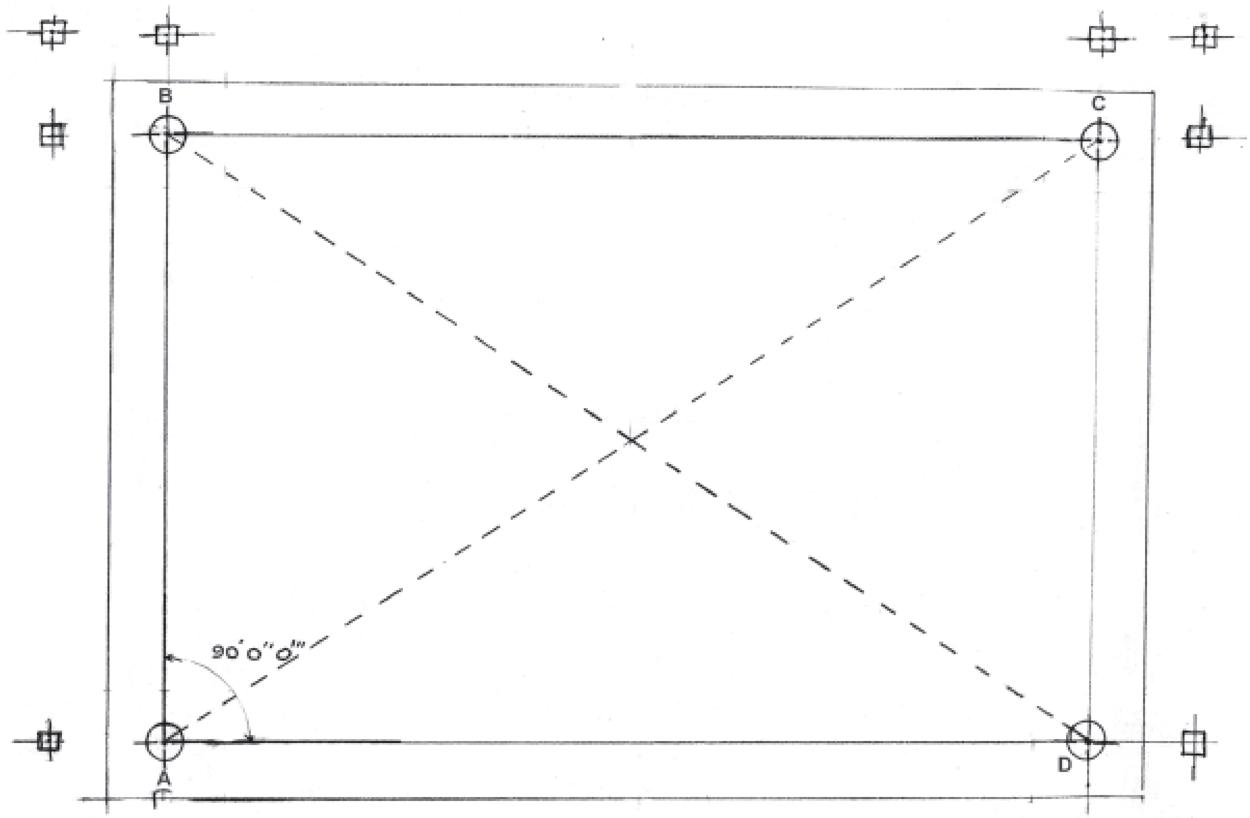
ii) Bring the bubble to the center of its run by turning both screws simultaneously and evenly. Similarly bring the other bubble to its mid-position by turning the third levelling screw.

iii) Repeat the process until finally both bubbles are exactly centred. Now rotate the instrument about its vertical axis. Each bubble will now traverse, provided the plate levels are in correct adjustment.The vertical axis will then be truly vertical.

FOCUSING THE EYEPIECE AND OBJECT GLASS:-

The object of this adjustment is to make the foci of the eye- piece and object-glass coincide with the plane of cross-hairs, i.e. to eliminate parallax. It is made in two steps.

i) Focusing the eyepiece: - The object of focusing the eyepiece is to make the cross hairs distinct and clear. To do this, point the telescope towards the sky or hold a sheet of white paper in front of the object



LINE OUT BY THEODOLITE

glass and move the eyepiece in and out until the cross-hairs are seen quite distinctly and clearly.

ii) Focusing the object glass: - The objective of focusing the object-glass is to bring the image of the object formed by the object-glass in the plain of the cross-hairs. It must be noted that the correct position of the eyepiece depends only upon the eye-sight of the observer. It is however, necessary to use the focusing screw whenever the distance of the object from the instrument is changed

LINE OUT BY THEODOLITE

STEPS:-

a) Mark the boundaries of the plot as per city Survey plan.
b) Mark the set back & side margins as per the architectural plan to decide the building line.
c) Fix points 'A' & 'B' by tape measurements on the building line.
d) Fix the theodolite at point 'A' and level it properly .
e) Orient the instrument in the line of point 'B'
f) Mark the point 'D' exactly in 90^0 angle to the line AB & exactly of length AD.
g) Shift the theodolite to point 'B'.
h) Set the instrument and sight the point 'A'.
i) Mark the point 'C' exactly in 90^0 angle to the line AB; and BC=AD.
j) Check the length AB=Length CD & Length AC= Length BD.
k) If all above measurements are correct then the rectangle ABCD (Building corners) is correct.
l) Fix the points E & F in the line AB & points G & H in the line CD at a desired distance on permanent Brick pillars.

LEVELLING

a) Necessity of dumpy level: Dumpy level is an instrument, which is used for levelling work. Levelling by Dumpy level is most effective to ascertain the exact relative ground levels precisely.
b) Setting of dumpy level :
1) Fix the tripod in level by adjusting the tripod legs.
2) Levelling of the instrument:
    a) Fix the instrument on the tripod; confirming all the foot-screws to be in centre.
    b) Align the tube level on the Dumpy, parallel to the pair of foot screws and get the bubble in the center by adjusting two parallel foot-screws in clockwise and anti-clockwise direction simultaneously.
    c) Turn the telescope through 90^0 angle to the first foot-screw and adjust the bubble by using third foot-screw.
    d) Repeat above procedure until exact centering of bubble is achieved.
3) Levelling with Dumpy level
    i) Decide the grid of points in such a manner that maximum realistic topography of the land can be ascertained after taking the relative levels.(Contour interval, size of the survey, objectives of the project will govern the interval of the grid.

ii) Set the levelling instrument on such a point from where all the points of the grid are in range of the telescope..

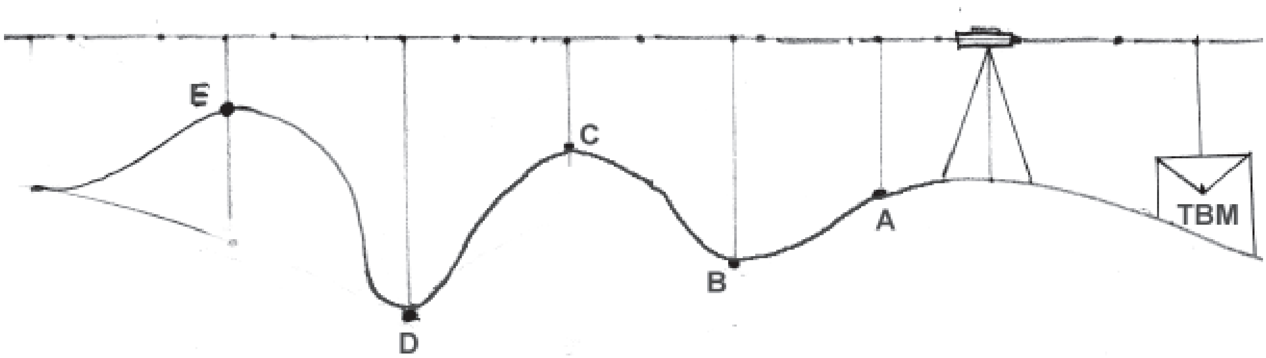
iii) Hold the staff in plumb, on the benchmark. A relatively permanently constructed structure can serve the purpose of a Benchmark. Assume the reduced level (R.L.) of the temporary benchmark as 100.00 m.

iv) Take the first reading on the (T.B.M.) Benchmark (B.S.).

v) Take intermediate readings at various required points of the grid.

vi) Take the reading on the last point. (i.e. F.S.)

vii) Take the reading again on the benchmark & check for any errors.



RECORDING SPOT LEVELS BY USING DUMPY LEVELS

Sr. No.	Station	Backsite	Intersite	Foresite	R.L. of H. I.	R.L. of Station	Remarks
	A	1.5			101.5	100.00	MILESTONE
1	B		1.57		99.93		AT SITE
	C		1.32		100.18		
	D		1.60		99.90		
	E			1.22	100.28		

SECTION

III

1) CONCRETE MIX DESIGN
2) FORMWORK DESIGN
3) PROCEDURE FOR PLACING READY MIX CONCRETE.
4) PILE FOUNDATION.
5) R.C.C. WORK
6) MASONRY
7) PLASTERING AND POINTING
8) PLUMBING AND SANITATION
9) WATERPROOFING
10) TILING
11) DOORS AND WINDOWS
12) FABRICATION WORKS
13) ELECTRICAL WORKS
14) ELEVATORS
15) FIREFIGHTING
16) EXTERNAL GLAZING
17) PAINTING
18) CHECKLISTS
19) COMPLETION PROCESS
20) MAINTENANCE
21) LEGAL ASPECTS RELATED TO CONSTRUCTION INDUSTRY
22) MACHINERY RELATED TO CONSTRUCTION INDUSTRY

CONCRETE MIX DESIGN

1. INTRODUCTION

Concrete is a composite material having various ingredients like cement, fine aggregate (sand), coarse aggregate & water.

Concrete is popularly used in various constructions for its various qualities such as:

- Its economy over other materials.
- Good durability.
- Ease in manufacturing.
- Very good mouldability.
- Its plasticity when it is green (wet) & subsequent hardening & gaining strength.
- Being an engineering material, concrete is also required to design for its various properties.

The strength, durability, workability & cohesiveness of the concrete changes with the properties of various ingredients. The properties of concrete also depend upon the properties of the ingredients. The requirements of the properties of concrete also change with the requirement of the structure to be constructed.

For all the above reasons, concrete mix is required to be designed suitably. Therefore it is a science in itself, to design a mix of concrete.

The relative properties of ingredients are decided for the desired properties without compromising the quality in the most economical way. This is known as procedure of "CONCRETE MIX DESIGN."

2. INGREDIENTS OF CONCRETE

WATER

Water used for mixing of concrete should be free from alkalis and organic materials. Water to cement ratio (W/C ratio) is the most important factor governing the strength of concrete. Strength of concrete depends upon, W/C ratio rather than the cement content. Higher the water cement ratio lower is the strength of concrete. As a thumb rule every 1% increase in quantity of water added, reduces the strength of concrete by 5%. A water cement ratio of only 0.38 is required for complete hydration of cement. Water added for workability over and above this water cement ratio of 0.38, evaporates, leaving cavities in the concrete. These cavities are in the form of thin capillaries. It reduces the strength and durability of concrete. Hence it is very important to control the water cement ratio on site.

CEMENT

Cement is the core material in concrete, which acts as a binding agent and imparts strength to the concrete. From durability consideration, cement content should not be reduced, below 290Kgs/M^3, considering moderate conditions of exposure. IS 456 recommends higher cement contents for more severe conditions of exposure or weathering agents to the concrete. It is not necessary that higher cement content would result in higher strength. Higher cement content helps in getting the desired workability at a lower water cement ratio.

AGGREGATES

Aggregates are of two types.

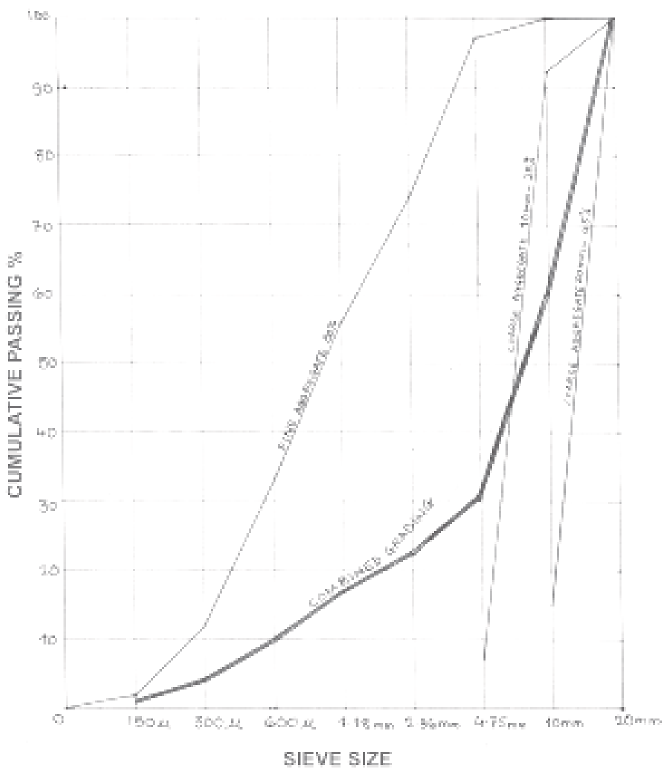
Coarse aggregate (Metal): These are particles retained on standard IS 4.75mm sieve.

Fine aggregate (Sand): These are particles passing through standard IS 4.75mm sieve.

Proportion of fine aggregates to coarse aggregate is decided with the help of the gradation curves.

Seive Size	Cumulative Passing %			
	Fine Aggregate (30%)	Coarse Aggregate 10 mm (25%)	Coarse Aggregate 20 mm (45%)	Combined Grading
20 mm	100	100	100	100
10 mm	100	92	15	59.75
4.75 mm	97	7	0	30.85
2.36 mm	74	0	0	22.2
1.18 mm	56	0	0	76.8
600 μ	33	0	0	9.9
300 μ	12	0	0	3.6
150 μ	2	0	0	0.6

CALCULATION FOR COMBINED GRADING-- 97 x 0.3 + 7 x 0.25 + 0 x 0.45 = 30.85



COMBINED GRADATION FOR FINE & COARSE AGGREGATES

The coarse aggregates of 20mm & 10mm are generally used for concreting. 20mm coarse aggregate is defined as the one that passes through 20mm sieve and is retained on 10mm sieve. While 10mm metal shall pass the 10mm IS sieve and should be retained on 4.75mm sieve. Some common problems of metal available in Pune are as follows: -

The Metal has considerable proportion of over-size aggregate varying from 20mm to 40mm size. Generally when the sand is fine, smaller proportion of it is enough to get a cohesive mix; while coarser the sand, greater has to be its proportion in the concrete. Excess sand increases the water requirement of concrete and reduces the strength, while under-sandy mix results in segregation and honeycombed concrete.

USE OF ADMIXTURES

Admixtures can change the properties of concrete.

Types of admixtures used are :-

- Plasticizers
- Retarders
- Accelerators
- Air Entraining Agents
- Shrinkage compensating Agents
- Water proofing Agents

3. IMPLEMENTATION OF MIX DESIGN ON SITE

Items necessary on site for Mix Design

a) Set of 12 Cube moulds of size 150 x 150 x 150 mm
b) A slump cone, tamping rod and a scale.
c) Weighing balance of 5Kg, with accuracy of 2gms and corresponding weights. Electronic Balance is highly recommended.
d) Spring balance of 100kgs
e) Liquid Measuring cans of 5,2,1 liter capacity for addition of water.
f) Measuring cylinder of 250ml capacity for silt test.
g) Set of sieves as under:
   40mm, 25mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 600 microns, 150 microns 90 microns & 75micron along with a pan
h) Conical cans of 5 liter and 1 liter capacity for calibration.

4. IMPORTANT POINTS FOR IMPLEMENTATION OF MIX DESIGN:

a) Brand of cement to be used shall be standardized in advance
b) All materials should arrive at-least one week in advance on site to enable proper testing prior to their use.

c) Make regular corrections on the proportions of mix design for,

- Moisture in sand
- Absorption by metal
- Bulk density of sand
- Changes in fineness of sand

d) Regularly check the weight of cement bags. Average weight of at least 5 bags should be taken each day prior to concreting. If the average weight of cement bags is below 49 Kgs, proper correction should be made by reducing the weight of aggregates in order to maintain the cement consumption. Cement should not be used if average weight falls below 46 Kgs.

e) The water cement ratio shall be strictly controlled, by maintaining the slump as per the design specifications.

f) The slump readings should be taken after 25 bags of concreting. The slump readings should be specially taken for the batches from which casting of test samples (cubes) is done.

g) Cement to be used shall not be older than one month. Cement used shall not have lumps and shall give a cool feel on hand.

h) Extremely coarse sand or silty sand shall not be used.

Note: If any of the above conditions are not satisfied, a trial mix shall be conducted in the laboratory, to determine fresh proportions.

5. STANDARD CORRECTION FOR IMPLEMENTING MIX DESIGN

5.1 CORRECTION FOR SURFACE MOISTURE IN SAND

Sand contains some fraction of water as surface moisture. This moisture affects the water cement ratio of concrete. Water Cement ratio takes into account the total water available for hydration of cement.

Calculating Surface moisture of sand

Take 500gms. of sand and heat it in a tray gently till it dries and starts flowing freely. Dry sand is weighed again to find the loss in weight.

Surface moisture = W / (500-W)%

NOTE: The sand shall not be overheated.

To get a rough estimate of surface moisture, following thumb rule may be used when sand is not extremely wet.

Moisture in Sand	Bulkage	
	Medium Sand	Coarse Sand
1%	8%	6%
2%	16%	12%
3%	22%	15%
4%	27%	17%
5%	29%	18%

Procedure to decide the quantity of water to be added in each batch of concrete.

Water to be added per batch = (Water cement ratio x 50) – (surface moisture x Wt of sand per batch)

If moisture content = 4%

Wt. Of sand = 119kgs

Water cement ratio = 0.45

Water to be added per batch = 0.45 x 50 – 4% x 119

= 22.50 - 4.76 = 17.74 ltrs

Wt. Of sand per batch should be increased correspondingly equivalent to the weight of surface moisture in sand e.g. 4.7 kgs.

Moisture content in sand will vary from day to day and also with different lots of sand. It is therefore very important to make correction for moisture in sand to maintain w/c ratio. If slump of concrete is kept under control, the w/c ratio is automatically controlled.

Calculating Aggregate absorption

For any mix design, the coarse aggregate is considered to be in saturated surface dry condition. Where as, the metal on the site is often in bone-dry condition. (Especially during summers). This dry aggregate often absorbs the water added in concrete and reduces the workability of concrete. Correction for surface absorption is necessary to maintain the water cement ratio.

A correction of 1% to 2% of weight of coarse aggregate may be made. In case aggregate is 192kgs then

Aggregate absorption = 0.02 x 192

= 3.84 liters

Hence quantity of water added (From previous example) = 17.74 + 3.84

= 21.58 Liters

5.2 VOLUME BATCHING

Every mix is designed by considering weights of different ingredients In case volume batching is done on site; the weights of aggregates need to be converted into volume. This is done with the help of bulk densities of aggregates.

$$\text{Bulk density} = \frac{\text{weight of material in kgs}}{\text{Volume in liters}}$$

Bulk density can be measured on site by filling a standard 35 liters 'Form' with aggregate and then weighing the aggregate filled in the form.

e.g. Wt. Of sand in 35 liters form = 58kgs.

Bulk density = 58/35 = 1.66. Kg/liters.

$$\text{Volume of sand per batch} = \frac{\text{Weight Of aggregate per batch}}{\text{Bulk density}}$$

If wt. Of sand per batch = 119kgs.

Vol. Of sand = 119/1.66 = 71.7litrs. Say 70litrs

Hence, use 2 forms of 20 litres. And one forms of 30litres.

Bulk density of sand changes with Bulkage. Hence correction for bulk density of sand should be made every day.

Bulk density of metal is between 1.4 Kg/Lit to 1.5 Kg/Lit where as bulk density of sand varies and usually lies between 1.6 to 1.8 Kg/Lit.

5.3 CORRECTION FOR BULKAGE

This is done in case of volume batching of concrete. When sand is moist it 'bulks' i.e. it occupies greater volume. Hence, less weight of sand is taken in the given volume. In other words, the bulk density of sand changes. If correction for bulk density is done, effect of bulkage is taken care of & correction for bulkage need not be done. Otherwise, volume of sand needs to be increased in proportion of bulkage.

Measuring Bulkage on site

Take 100 ml. of sand in 250 ml. beaker and add water so as to completely submerge the sand. Shake the beaker well and the keep it steady for some time. Note the level to which it settles.

$$\%\text{bulkage} = \frac{(\text{Original level} - \text{New level}) \times 100}{\text{New Level}}$$

5.4 CHECK THE SILT CONTENT

Excessive silt in sand affects the bond between cement and sand. This reduces the strength of concrete. This problem is quite severe during monsoon. Therefore a sand, containing silt, shall not be used beyond a certain proportion. Therefore, it is necessary to measure the silt content in sand.

Measuring silt content on site

Take 50ml. of water in 250ml beaker and add some salt to it. Add sand to it till 100ml, mark is reached. Again add water up to 150 ml. Stir the sand well to wash it in salt water. Keep the beaker still for 3 hours.

Observe the thickness of the silt layer.

$$\%\text{silt content} = \frac{\text{Height of silt layer (ml) x 100}}{\text{Height of sand (ml)}}$$

Sand with silt content greater then 7% shall not be used for concreting.

5.5 CORRECTIONS FOR CHANGES IN GRADATION OF SAND

Sand shows lot of variation in gradation, because of change in source of supply. The fineness modulus of sand in Pune varies from 3.2 to 3.8 The IS specifies a limit of 2.2 (fine sand) to 3.2 (coarse sand) for fine aggregate. This means that, sand available in Pune is extremely coarse. This is partly because of absence of fines in the sand. 10% to 15% of the sand is retained on 4.75mm sieve as chal or shingle. Hence, in case of extremely coarse sand, use of stone dust up to 10ltrs. is recommended. If sand available on site is coarser than the one used for mix design, following correction may be made.

A. WEIGH BATCHING

Increases the weight of sand up to 15kgs and reduce the weight of metal by equal quantity. Total weight of aggregate (fine + coarse) per batch should remain constant

If the mix does not improve with above correction, replace up to 15kgs of sand by dust in the weights mentioned on mix design.

B. VOLUME BATCHING

i) Increase the volume of sand by 5 litres and reduce volume of metal by 5 litres. The above correction may be made up to 10 litres.

ii) If the mix does not improve with above correction, replace 10 litres of sand in mix design proportion by 10 litres of dust.

The new mix should be tested for compressive strength before being used at site..

Following precautions should be taken when stone dust is to be used.

Stone dust should not be too fine powdery (FM. should be between 2.0 to 2.5) It shall be used in limited quantity as mentioned above, unless higher quantity is recommended by the laboratory / consultants.

Strict control on water cement ratio should be kept. Stone dust reduces the workability; hence, the water cement ratio is likely to increases. The slump may be maintained 2cms below the value given in the mix design.

Note: - If above corrections in the proportions do not yield satisfactory mix, fresh trials shall be conducted in the laboratory for a revised Mix design.

6. CASTING AND TESTING OF CUBES

Test sample:- Cubes of concrete shall be casted to estimate the strength of concrete.Concrete for filling the cubes shall be taken from the middle discharge of concrete mixer. Concrete from beginning or at the end of discharge should be avoided. Cubes should be filled in 3 equal layers. Each layer should be uniformly tamped at least 35 times with a 16mm blunt rod. Cubes should be properly levelled and finished using hand trowel. Cubes should be kept in shadow properly covered with wet gunny bags.

Cubes should be demoulded after 24 hours and immersed in water for curing. It is important to keep the cubes away from the shocks or vibrations especially for initial 3 days of casting.

DESIGN OF FORMWORK

1. INTRODUCTION

Formwork is an essential part of concrete construction. It is to give FORM to green concrete as per the structural and Architectural requirements. For concrete construction at higher elevations, FORMWORK supporting structure called centering (scaffolding) is necessary. Both can be called as enabling facilities to create permanent Members of a Structure. Design of formwork is the theme of this presentation and the same only will be dealt with hereafter.

For small and medium size works, provision of formwork is left to the carpenter's / contractor's hitherto experience at site. Naturally this method is more by experimentation rather than proper structural design. For safe, economical and sound provision of formwork, it is essential to design the same as structural member even though it is of temporary nature. Assessment of correct loads from the stage of pouring green concrete to the end stage of concrete member gaining self-supporting strength is most important. Secondary effects of above loads need to be duly considered and provided for in the design

Formwork can be designed and provided for permanent construction in different materials as follows:

a) Timber in natural form or in plywood form. Plywood is used to achieve the shapes and forms required.

b) Structural steel is quite versatile and useful for formwork. It is economical, durable, accurate and reusable. Use of shuttering plates made in mild steel is quite common due to their repetitive use.

It is essential to study the local environment to arrive at the best solution for best usage of right materials for formwork. Essence of safety, time and cost should govern the right choice for the materials to be used.

2. PRIME REQUIRMENTS OF FORMWORK DESIGN

a) Quality:

The forms shall be designed and constructed to the desired size, shape and finish of the concrete required. The accuracy in the form, makes the structure stable and economical.

b) Safety

Formwork should be capable of supporting all dead and live loads without collapsing. Safety to workmen and wet concrete shall be focus of control.

c) Economy

Economy in material as well as time shall also be considered.

3. IMPORTANT PARAMETERS FOR FORMWORK DESIGN

a) Correct assessment of vertical loads over forms due to

- i) Weight of reinforcement.
- ii) Weight of fresh concrete, with impact due to drop height
- iii) Weight of workmen and equipment

iv) Self-weight of formwork.

b) Correct assessment of lateral forces exerting pressure on side forms and bracings.

c) Wind forces on side forms.

d) Concrete, concreting methodology and member data

i) Density of concrete

ii) Slump of concrete

iii) Rate of pour

iv) Method of discharge

v) Height of discharge

vi) Temperature of concrete

vii) Dimensions of sections to be casted.

viii) Reinforcement detail

ix) Type of vibrations of concrete used for compaction of concrete.

E) Formwork data

i) Formwork material

ii) Stiffness of forms

4. LOGIC OF FORMWORK DESIGN

a) Green concrete exerts hydrostatic pressure on forms which is a function of its density D (gr) and height of pour H (gr).

i) For horizontal forms for slabs. design vertical load will be

D (gr) x H (gr) + D (dr) x H (dr) + allowance for heaping of concrete & impact + self weight

Where; D (gr) = Density of green concrete

H(gr) = Height of the pour of green concrete

D(dry)= Density of dry concrete.

H(dry)= Height of temporary heap of concrete.

ii) For vertical forms for walls, columns and similar contained sections etc. design hydrostatic pressure will vary from zero at top to D (gr) x H (gr) at lowest level of green concrete + impact pressure (uniform) of 1 T/sq. m. on account of falling concrete from height of about 2m. For pour rate of 0.6 m/hr hydrostatic pressure at lowest level will be 1.8 to 2.5 /sqm & double these valves for pour rate of 1.5 m/hr. (lower value will be for tropical climates). Above figures are given for the use of ordinary Portland Cement. Hydrostatic pressures on shuttering will lower for quick setting cements as well as for higher temperatures and vice versa.

It is recommended to just go by hydrostatic head pressure as above.

iii) Allowable deflection for shuttering as per I.S. Code is Span/270 where span is spacing between bearers.

5. IMPORTANT REFERENCE

a) IS 4990 : 1993 for use of plywood for Concrete Shuttering

b) IS 800 : Latest for use of structural Steel Shuttering

c) The code of practice for Design and Construction of Formwork for Concrete by P.W.D. Govt. of Maharashtra..

6. IMPORTANT FORMULAE

It is very important for the engineers to revise basics and fundamentals of design to understand the logic of structural behavior. Although typical examples in design are given hereafter, engineers shall be able to apply their mind and logic understood, to variety of problems in the field. Hence, it is absolutely necessary that engineers are clear about fundamentals.

Legend:

W = Point Load in T, w = UDL T/M, (uniformly distributed load)

L = Span in Meter, I = Moment of Inertia of section in M^4

Z = Section Modulus in Cub.M., E = Mod. Of Elasticity T/Sq.m

A = Area of Cross Section in Sq. m.

Fb = Permissible stress in bending in T/Sq.m.

Fs = Permissible stress in shear in T/Sq.mm.

M.R. = Moment of Resistance in T.M. = Fb x z

S.R. = Shear Resistance in T = Fs x A

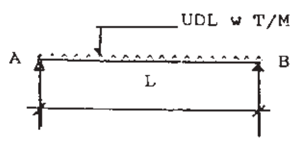
All the above units used are in Tonne and Meter. Proper multipliers should be used while changing T to kg. and M to cm.

To calculate the maximum bending moment, following formulae are useful.

a) Max.B.M. @ Centre = $(w L^2/8)$ T. m

Max. Shear @ A & B = (wL/2) T

Max. Defl. @ center in M. = $\frac{5WL^4}{384xExI}$

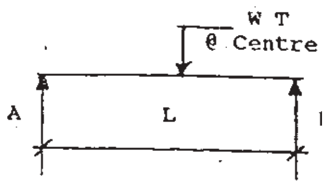


If partial fixity or continuity over support is assumed, design B.M. can be derated to $(WL^2/10)$ T.M.

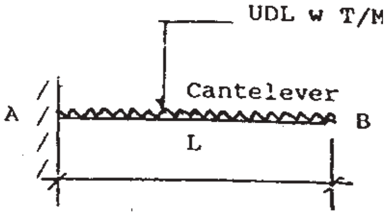
b) Max. B.M. @ Centre = (WL/4) T.M.

Max. Shear @ A & B = (W/2) T

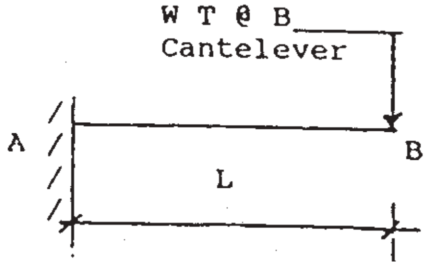
Max. Defl. @ Centre in M. = $\frac{W L^3}{48xExI}$



c) Max. B.M. @ A = ($W L^2/2$) T.M.
Max. Shear @ A = (WL) T
Max. Defl. @ B In M. = $\frac{(WL^4)}{8xExI}$

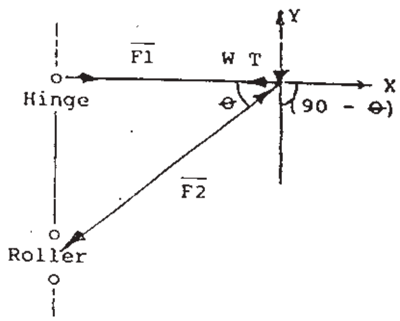


d) Max. B.M. @ A = (Wx L) T.M.
Max. Shear @ A = (W) T
Max. Defl. @ B In M. = $\frac{(WL^3)}{3EI}$



e) Typical vectorial Resolution of Forces following principle of static Equilibrium at any Junction of Forces:

Resolving along 'X' $\overline{F1}$ = $\overline{F2}$ Cos Ø = 0
Resolving along 'Y' $\overline{F2}$ Sin Ø - W = 0
Solving above simultaneous equations,
$\overline{F2}$ W/ Sin Ø ,$\overline{F1}$ = W Cos Ø / Sin Ø
(COMPRESSION) (TESNION)



7. DESIGN EXAMPLES

1. When Timber is used in Natural form for shuttering Form (modulus of elasticity 80 T/sq. cm.)

a) Permissible stress parallel to grains in-

i)	Bending, compression and tension	84 kg/ sq. cm.
ii)	Direct compression	50 kg/ sq. cm.
iii)	Shear	9 kg / sq. cm.
iv)	Modulus of elasticity	80 T / sq. cm.

b) Permissible stress perpendicular to grains in:

i)	Direct compression	15 kg / sq. cm.
ii)	Shear stress	6 kg / sq. cm.

Note : Above values should be reduced by 20% for wet timber .

: It is important to use GOOD QUALITY of timber to match with above minimum permissible stresses.

: It is preferable to be conservative about unknown quality of timber.

c) Moment of Resistance (in bending) for different depths for one cm width

M.R. = 84 x (bd^2) / 6 = $14d^2$ kg. cm. shear Resistance for different depths for one cm. Width S.R. 6 (conservative) x d kg

Item	Thickness or Depth	M.R. in kg. Cm. /cm..	S. R. in kg. /cm.
Planks	2.5 cm thick	88	15
	4.0 cm thick	224	24
	5.0 cm thick	350	30
Joists	7.5 cm thick	788	45
	10.0 cm deep	1400	60
	12.5 cm deep	2188	75
	15.0 deep	3150	90
	20.0 cm deep	5600	120

Props: Load capacity reduction factor R.F. (multiplier)

For slenderness are as follows:

Effective Length 'L' Least Lateral Dimension 'd'

	1 to 10	10 to 15	15 to 18	18 to 24	24 to 30
R.F.	1	0.75	0.70	0.60	0.50

7.2 Plywood formwork will have different permissible stresses depending upon Type of timber used. Hence, recommendations of Approved Manufactures /suppliers of plywood for permissible stresses etc. should be used in design.

7.3 Formwork in structural steel work will have reference to. I.S. 800 for Permissible stresses. Shuttering plates of 3mm thickness with angle Framing are commonly used directly below slab. For joists columns and channel or beam sections are used. Alternatively, ACROW make or equivalent Spans (steel trusses) and steel props are used.

READY MIX CONCRETE

In order to achieve maximum control on the quality & consistency of concrete, the concept of readily mixed concrete was introduced. This method ensures mixing of ingredients in a précised proportion. The criteria of water cement ratio which directly affects the strength of concrete, is brought under total control by this method. This enables the structural designers to have more flexibility & economy in the design as they are assured of the desired strength. This method also generates more options of variety of designed mixes as per the necessity of a structure & as per the availability of the local materials.

The problem of concrete getting set during transit from R.M.C. Plant to the work station & till it is placed in the desired place, is solved by using various admixtures which retards the initial setting time of concrete. This method offers flexibility in the workability & pumpability of concrete, without affecting the strength of concrete. Truck mounted mixers are used to carry the readily mixed concrete to the worksite. The mixer ensures the freshness of the concrete till it reaches the worksite.

A generalized procedure given here under will help to minimize the cost, time & fatique while concreting by R.M.C. method.

1. Derive the required quantity of the volume of concrete precisely.
2. Confirm the grade of the concrete.
3. Decide the workability of the concrete in terms of slump; as per the method of pouring of concrete (i.e. pumping or conventional).
4. If the concreting is done by pumping, the quantity in side pumping system & pipeline shall be worked out precisely. This ensures the consumption of quantity inside the pipeline at the end of the pour and helps to avoid wastage.
5. Check the stability of centring (shuttering) work as per the requirement of the method of concreting.
6. Check the stability of the scaffolding of the concrete pumping pipeline.
7. Plan the stoppages in pumping as per the sequence of placing the concrete.
8. Make the necessary arrangement for proper communication between pump operator & the foreman placing the concrete at desired workstation so as to facilitate the stoppages as per the plan.
9. **Plan the delay** in the **speed of the concreting** at the congestion of reinforcement **to assure proper compaction**.
10. Plan the manpower, tools to match the rate of pumping & pouring of concrete.
11. Decide the exact starting time of curing & make the necessary arrangements accordingly.
12. The rate of pouring shall be controlled as per the requirements of workstation.
13. The mechanical limitations due to a lengthy stoppages shall be considered while concreting the rate of pumping, to avoid the clogging of pump..
14. Heaps of concrete due to faster rate of pouring shall be avoided for ensuring the stability of the shuttering.
15. Carry on the curing as per the predecided schedule.

ADVANTAGES OF R.M.C. OVER CONVENTIONAL CONCRETING METHOD:

1. Controlled and assured quantity of concrete for strength and workability.
2. It facilitates the saving in every aspect of the related activities from procurement topouring.
3. The R.M.C. combined with pumping increases the speed of the work and helps to reduce indirect overhead costs.
4. It facilitates the flexibility in the design of even a specified smaller part of a structure. This helps to avoid the unnecessary heavy sections of columns and beams, which in turn reduces the cost.
5. This method helps to maintain the workstation neat, clean and pollution free.

LIMITATION OF R.M.C.:

1. Initial establishment cost and the higher capacity of the plant exerts financial pressures. This compels to run the plant continuously overnight, transferring the pressure & creating fatique in the manpower working at workstation.
2. The size & shape of the transit vehicles creates trouble in the accessibility & the overall road traffic at the workstation.

PILE FOUNDATION

INTRODUCTION :

This type of foundation is useful: -

a) In widely varying layers of strata,

b) In different types of soils; where foundations are required to be taken to a certain depth,

c) To avoid the undesirable effect of seasonal moisture changes, as in expansive soils

d) To obtain adequate capacity for downward, upward and lateral loads;

e) Or to take the foundations below scour level and for moments.

For the satisfactory design and construction of pile foundation, the following information is necessary.

i) Soil investigation data

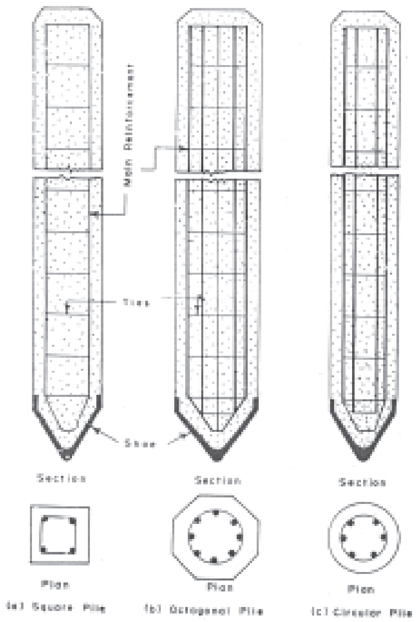
ii) A quantitative indication of the expansive nature of the foundation soil, which may be obtained from the free swell test.

iii) The general layout of the columns and load bearing walls sharing estimated loads, including moments and torques to the top of pile caps and piles.

iv) A hydrological data, such as highest subsoil water level with seasonal variation, flood/ tide levels at different times of the year, depth of scour, amount and rate of seepage etc.

v) Chemical properties of soil and ground water, with particular attention to change of any deleterious effect on concrete or steel.

The design particulars of pile foundations shall give the structural data of the orientations of the piles, the bearing capacity of each pile type, the levels at which each pile should finally be finished to suit the site conditions, details of pile caps and grid beams, together with winds coming on to them.



PILE

MATERIALS USED IN PILE FOUNDATION:-

1) Cement used in concrete piles should be OPC or as per requirements specially demanded, rapid hardening cement confirming to IS: 269-1966.
2) Steel requirement shall confirm to IS:226-1969, for bored compaction piles. The reinforcement cage shall be prepared by welding the hoop bars to withstand the driving stresses.Any reinforcement used in, cast in situ or bored piles should be made up into cages, sufficiently well wired to withstand handling without damage. The Bars should be so placed as not to impede the placing of concrete. The lateral ties or spiral binding should not be closer than 15 cm c/c. Reinforcement in the pile may be provided in the top section only or in entire length depending upon the manner of transmission of load by the pile to the soil and need not normally exceed 0.8% of the cross-sectional area of the pile. Care should be taken to maintain correct cover and alignment of reinforcement throughout the whole operation of placing of concrete.
3) Concrete:- The high slump (15 to 20 cm) concrete which is generally used shall not be less than M15 grade. For underwater concreting, the mix of concrete shall have 10% more cement than what applied for normal situations. The specifications of various grades of concrete shall be as laid down in IS: 456-2002. Coarse aggregate may also be natural rounded shingle of approximate size. It helps to give high slump with less water-cement ratio.

Materials used should confirm to the requirement of IS 456-2002, code of practice for plain and reinforced concrete. For concrete to be placed through tremie pipe, gravel aggregates and fine aggregates from natural sources will be preferable to crushed aggregates, for better workability. For 20 cm diameter tremie pipes, a slump of 12.5 to 17.5 cm shall be allowed. If concrete is transported from a central mixing place, a higher slump will cause segregation.

PILE CAPS

i) The pile cap along with the column pedestal shall be deep enough to allow for the necessary anchorage of column and pile reinforcement.
ii) The clear anchorage of the pile cap beyond the outermost pile in the group shall, normally be 10 to 15 cm, depending upon the pile size.
iii) A levelling coarse of mass concrete of about 8 cm thickness may be provided under pile caps as required.
iv) The clear cover for the main reinforcement from the bottom of cap shall not be less than 6 cm.
v) The reinforcement from the pile should be tied properly to the pile cap.

CONCRETING

After completing the boring, the concreting shall be done as early as possible. Should a bore hole, which is not cased, be left unconcreted for more than two hours, it shall be cleaned thoroughly before placing the concrete. Concreting under water shall be done in one operation.

Concrete should preferably be placed by means of a tremie pipe in those bore holes which are not dry.

It should, however be ensured that, concrete entering the tremie pipe does not get mixed with the slurry. This is achieved by pouring ¼ kg of granulated vermiculite in the tremie pipe before pouring concrete. The vermiculite granules will form a plug separating concrete from the fluid below. The tremie pipe shall extend up to the bottom of the bore hole at the start and may be withdrawn in sections as the level of concrete rises in the bore holes, but its discharge end shall, at all times be embedded in the concrete to a minimum depth of 1 meter. Placing of concrete should be held concentric in the hole.

DISPOSAL OF MUD

The borehole should be maintained full with the drilling fluid, wherever used, throughout the concreting operation. Mud displacement from the borehole by the concrete shall be channeled away or pumped into suitable receptacles for disposal to waste or reuse.

WITHDRAWAL OF CASING:

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place. During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed up to at least 15 cm above the cut off level. During extraction of the casings, special slump records should be maintained.

ALLOWABLE WORKING LOADS:

A. Vertical compressive load:-

2/3 of the minimum load causing net settlement of 2% of diameter, subject to the maximum net settlement being 25 cm, may be taken as the allowable working load on the pile. The settlement should, however, be restricted to 4% of the diameter. For this purpose, load increase shall be put in an equal time intervals.

Assessment on the basis of mechanical properties of soil:- In clayey soils, the working load may be determined as follow-

Working load = 3 x base area x shear strength at formation level

+ 015 to 0.20 x shaft area x average cohesion.

B. Pull out load:-

Where design conditions necessitates the use of anchor piles, the allowable pull- out load should be determined by

(a) Pullout test on a pile.

(b) Assessment on the basis of mechanical properties of soil.

PERMISSIBLE TOLERANCES:

As a general guide, the permissible positional deviation for bored piles should not be greater than 7.5 cm for piles up to 75 cm diameter and not greater than 10 cm for piles of 180 cm diameter at the level of the bottom of the pile cap. For pile diameter in the range 75 cm to 180 cm , the tolerance may be interpolated linearly. The deviation from the vertical plumb should not be more than 2 in 100 in ratio.

FINISHING OF PILE HEADS:

The top of pile should be brought up above the finished level to permit all laitance and weak concrete to be removed and to ensure that it can be properly keyed into the pile cap. The minimum distance of keying pile into pile cap shall be 5 cm. Any defective concrete in the head of the completed pile should be cut away and made good with new concrete. The clear cover between the reinforcement in the pile cap from the top of the pile shall be not less than 10 mm. The reinforcement in the pile should be exposed for a sufficient distance to permit it to be adequately bonded into the pile cap.

REPLACEMENT OF DEFECTIVE BORED PILES:

Defective piles shall be removed or left in place as judged convenient without affecting the performance of adjacent piles or capping above and additional piles shall be provided to replace them.

CASED PILES:

In case of boring with casing, the casing should be used atleast from the level of subsoil water. The casing shall be kept ahead of boring in case where there is danger of caving- in, due to sub-soil water entering into the bottom of the hole occuring due to difference in hydrostatic head.

Example for Bored cast in situ pile.

Consider a pile of 500 mm diameter.

Let the weight of chisel be 1000Kg.

Area of pile = 0.1963 Sq.meter.

If fall of chisel limited to 2.0 meters,

Energy of each blow = 1 Tonne x 2.0 m = 2.0 Tonne

The energy of 2250 Tonne-meter / Sq.m. is converted into equivalent energy for 500mm diameter pile,

Equivalent energy = 2250 x 0.1963 = 441.68 Tone meter.

To achieve this no. of blows of 1.0 Tonne chisel with 20. m fall will be;

= 441.68 / 2.0 = 220.84 blows (say 300 Nos.)

The no. of blows are increased to account for submerged weight of chisel and wire rope tension on drum while releasing the chisel so the chiseling criteria for 500 mm diameter pile will be:-

The penetration should be less than 10 cm for 300 blows of chisel with weight of 1.0 Tone and falling through a height of 2.0 m.. Generally 240 blows can be applied within 30 minutes while checking the chiseling criteria; the chisel shall be withdrawn after half an hour hole cleaned and penetration measured.

CALCULATION OF CHISELING ENERGY:

Diameter of pile (D)= 400mm.

Weight of chisel (w) = 0.75 Tonne

Height of fall (h) = 1.5 m

No. of blows (n) = 240.

Penetration for 'n' blows = P

Energy per blow = wh x w1/w2 x c

W1= Unit weight of steel chisel in water.

W2=Actual unit weight of steel chisel in air.

C = correction factor for a fall of chisel.

Therefore, for energy per blow

= 0.75 x 1.5 x 6.8/7.8 x 0.8 = 0.7846 Tonne -meter.

Area of 400 mm diameter of pile = pi x $(0.4)^2$ /4 = 0.1257 m^2.

Therefore, equivalent energy for 400 mm diameter at pile for 'n' blows.

= 240 x0.7846/ 0.1257

= 1498.06 T.m/m^2

SOCKETING STRATUM:

It is defined as the layer where the penetration is equal to or less than 10 cms for chiseling input energy of 750T.m./m^2 of pile area.

This criteria must be satisfied for three consecutive trials. The socketing layer is assumed to have started from the end of such third consecutive trial.

FOUNDING STRATUM:

It is defined as the layer where the penetration is equal to or less than 10 cms for chiseling input energy of 2250 Tm/m^2 of pile area. This criteria must be satisfied for three consecutive trials. The founding strata is assumed to have been reached after third successful consecutive trial. In the event where founding stratum as defined above is not encountered, the pile would be sealed after ensuring minimum socketing length i.e. 5D where D is diameter of pile in the acceptable socketing stratum, to realize various load carrying capacities. This means for 60 cm diameter pile the socketing length will be 3.0 m. If criteria of 2250 Tm/m^2 per 10cm is not satisfied.

DETAILS OF CHISELING CRITERIA

For drop chisel using Bailer / Bentonite method:-

The weight of chisel in Kgs shall not be less than 1.6 to 2 x Diameter of pile (mm). (For 600mm diameter pile, 1 Tonne chisel is accepted).

The weight of chisel shall be checked by actually weighing it on a weigh Bridge. The chisel shall be of non-energy absorption type.

The founding strata is considered suitable if penetration is less than 10cm after an energy input of 2550 Tm/m^2 of the pile base area.

During the checking of founding strata, the fall of the chisel shall be limited to 2.0m. This criteria shall be checked and satisfied at least twice consecutively. The method of working out the chiseling criteria is as follows.

Chiseling energy per 10 cm penetration

$$= \frac{\text{Equivalent energy x10}}{\text{Penetration}}$$

$$= 1498.06 \text{ x10 / p T.m./m}^2\text{/10 cm.}$$

R.C.C. WORK

Actual work on site can be started, only after completing the Detailed planning. Following are some key steps for actual execution of work at site.

PREPARATION :

1) Check that all approved drawings related to the project are on site.
2) Check & demarket all the boundaries of the plot with the help of city survey plan.
3) Check that, cleaning & levelling of the plot is done.
4) Take the trial pits for collecting the data necessary for design of foundations.
5) Mark the **line out** using Theodolite.
6) Fix the railing for line out, with the following conditions :
   a) Railing should not be more than 0.6 meter in high from highest ground level.
   b) Top of railing should be in one level.
   c) Vertical supports of the railing should be at 2.0 meter center to center.
   d) Railing should be at least at a distance of 3 meter away from building line.
   e) Cross bracing should be provided at all corners of the railing.
   f) Railing should be in right angle.
7) Mark the center line of columns on Railing.
8) Side margins & center lines should be checked by engineer & got approved from the architect.
9) Decide the plinth level of building before starting excavation work..

EXCAVATION :

1) Before starting the excavation, check the existing electrical cables, drainage lines & water lines, which may foul in excavation area. Shift these lines suitably and permanently away from the new structure to be built.
2) Get permission from Municipal Corporation for removal or replantation of existing trees, fouling in the area to be excavated.

3) The size of pit to be excavated shall be increased by 0.15 m on either sides than the length and breadth of P.C.C.
4) If the area to be excavated, is water logged, make proper arrangement of pumps for dewatering.
5) Make sufficient lighting arrangements if the work is to be done at night.
6) Excavate the earth to a depth as specified by the RCC consultant.
7) Store the assorted excavated material for refilling.
8) Proper precautions should be taken during excavation work to avoid damages to the existing structures.
9) Necessary safety precautions should be taken if the depth of excavation is more than 1.5 m.

DEWATERING:

1) Self-priming pumps may be used for dewatering.
2) Arrangement of diesel & electrical connection for pumps shall be made, well in advance..
3) Chicken mesh can be fixed over foot valve to avoid clogging of the pump.
4) Pump should be fixed on good foundations.
5) Pump cover is necessary to avoid damages to the pumps.
6) Dry running of pumps should be avoided.
7) The disposal of water shall be planned properly to avoid hindrance to other activities.

P.C.C :

1) R.L. of excavated pits should be taken before starting P.C.C.
2) All the pits should be cleaned & watered before starting P.C.C.
3) Shuttering for P.C.C. should be done in the desired level.
4) Concrete **should not be poured** from a height more than 1.0 meter.
5) Grade of Concrete for P.C.C. should be as specified by R.C.C. consultants.
6) Deshuttering & curing should be done, properly.
7) If specified, antitermite treatment should be carried out.

R.C.C.

FOOTING

1) Reinforcement & grade of concrete for footings should be as per R.C.C. consultants drawing.
2) Centre of Column should be marked on P.C.C. confirming the orientation of the column.
3) Shuttering should be checked as per footing dimensions
4) Footing reinforcement should be checked for each column.
5) Depth of footing concrete should be checked as per drawing.
6) Concrete should not be poured from a height more than 1.0 meter.
7) Proper compaction should be done by rodding & needle vibrator.

8) Slope of footings & top of footings should be finished, properly.

9) Footing should be covered by gunny bags for curing after deshuttering.

CASTING OF STUB COLUMN

1) Centre of Column should be marked on footing
2) Covering to the reinforcement should be as specified by the RCC consultant.
3) Shuttering work of Stub Column should be checked for plumb, right angle and dimensions.
4) Concrete Mix should be as specified by R.C.C. consultant.
5) Proper compaction should be done while concreting.
6) Plumb of Stub Column should be checked even after concreting.
7) Deshuttering & curing should be done properly.

BACK FILLING

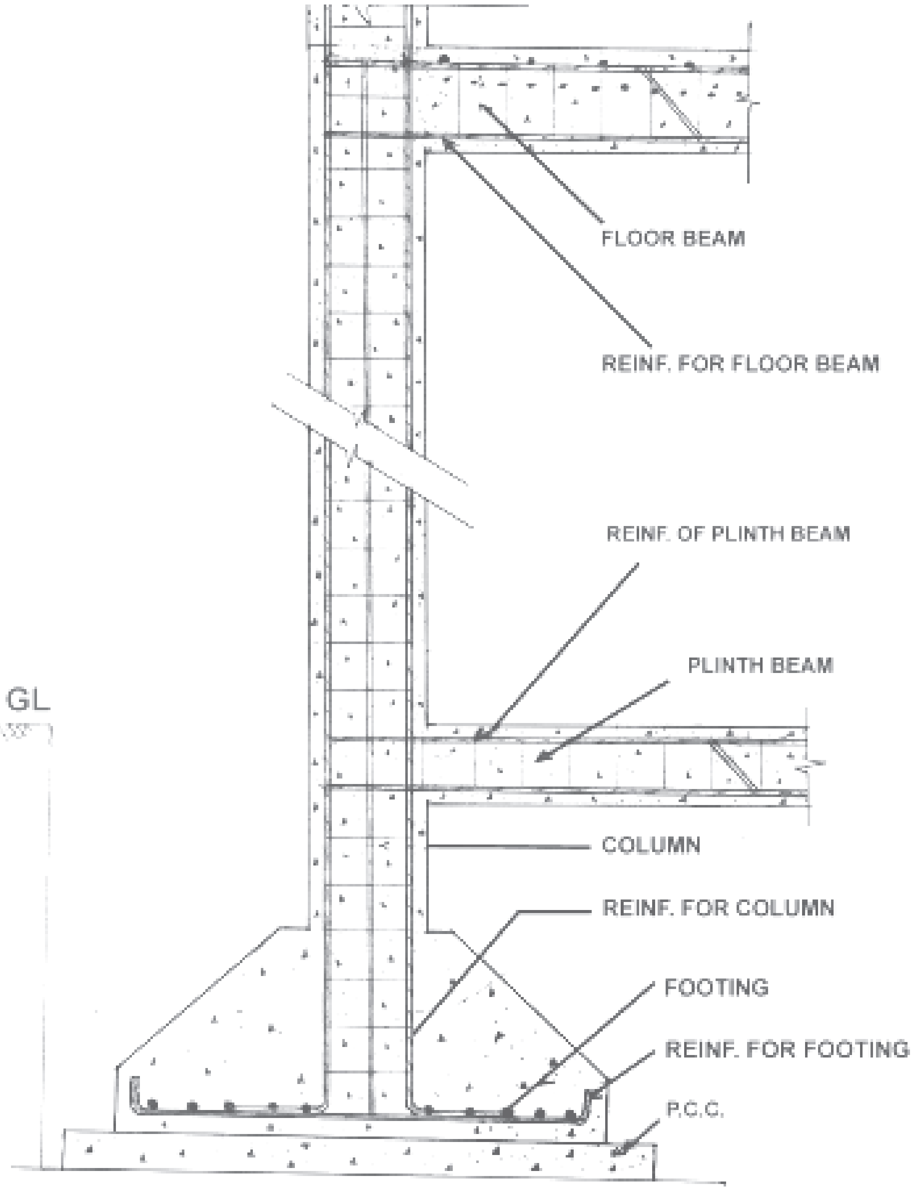
1) Drainage/ Electrical & fire fighting pipes should be laid as per pre planned drawings.
2) Position for meter room, electrical duct, fire fighting duct etc should be finalized.
3) Black cotton soil shall not be used for back filling / refilling.
4) UCR/BB Masonry or curtain walls should be constructed up to plinth level.
5) Back filling should be done up to 1.5m from all external faces of building also.
6) Murrum filling should be done in layers of 0.3 meter in height.
7) Watering & compaction should be done simultaneously, for each layer.

PLINTH BEAM

1) Shuttering & Reinforcement of plinth beam should be checked as per drawing.
2) Proper side supports at every 0.6 meter c/c should be provided.
3) Provision for any dowels and strut columns shall be confirmed before concreting.
4) The number of top bars, bottom bars, curtailed bars and details of stirrups should be checked..
5) Beam reinforcement should be placed in position with proper anchorage in column.
6) Beam bottom covers and side covers should be provided as specified in drawing.

COLUMN (STARTERS)

1) Height of starter should be 100 mm.
2) The size, right angles & centers of starter should be checked.
3) Starter should be fixed intact on its position
4) After concreting of starter, Metal should be inserted partially in the cage of starter for bonding purpose
5) The side railing of the building should be removed only after casting of all starters.



CROSS SECTION OF A TYPICAL R.C.C. STRUCTURE

R.C.C. IN SUPERSTRUCTURE:

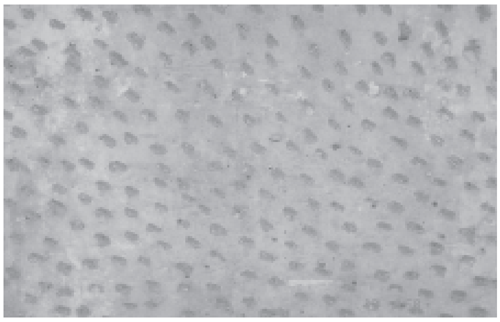
1) Height of parking slab should be finalized by Architect. Soling and consolidation should be done properly. P.C.C. (Sub base flooring) is to be done as per norms.
2) P.C.C. should be done after completion of underneath service lines.

COLUMN IN SUPERSTRUCTURE :

1) Column should be casted up to beam bottom level.
2) Reinforcement & lap lengths of Columns should be checked.
3) Shuttering of Column should be checked for its quality, line, plumb, size, diagonal, covering and support.
4) Concreting of Column is required to be done from a height of 2.4 meter. Hence proper care should be

taken in order to avoid segregation and honeycombing of concrete.

5) Proper compaction should be done by rodding, during concreting. Tamping should be done by wooden malate from outer side.
6) Metal should be partially inserted on the top of fresh concrete of column for proper bonding with the next pour of concrete.
7) Deshuttering should be done only after 24 hours of concreting.
8) Hacking should be done only after 48 hours of concreting.
9) Specified level should be marked immediately on each and every column for maintaining the levels and heights of the slab.



BEAM :

1) All the beam faces should be marked before fixing the beam bottoms as per the orientation.
2) The beam bottom levels should be checked as per drawing.
3) The side of beam bottom should be checked for line, level & room dimensions, before fixing the beam sides.
4) All the supports for beam bottom should be truly vertical.
5) The first vertical support of beam bottom should be at 0.23 meter from both ends & the remaining should be at 0.45 to 0.6 meter interval.

BEAM SHUTTERING:

1) Beam sides should be fixed in plumb, line & level.
2) Proper supporting shall be done to the beam sides.
3) Horizontal joints should be avoided to the beam sides
4) Oil should be applied to all beam bottom & sides shuttering for helping in demoulding.

SLAB SHUTTERING :

1) Slab plate should be supported by 75 mm x 75mm wooden section at 0.6 meter c/c distance or M.S. span may be used.
2) M.S. Plates should be of uniform thickness & size.
3) The plates should be laid on short span & ensure no gaps are found.
4) Plate should be laid in right angle.
5) Provided supports should be truely vertical.
6) Slab should be levelled properly by using Dumpy level.

7) Oil should be applied to plates before laying reinforcement.

8) All the supports below the slab should be braced in both directions.

SLAB REINFORCEMENT :

1) Reinforcement of slab and beam should be checked precisely, as per R.C.C. drawing.

2) The main steel should be laid with specified covering

3) The distribution steel should be laid over the main steel.

4) The c/c distance of the bars should be checked for slab reinforcement.

5) The slab bent up bars should project in adjacent slab to the desired length.

6) Proper chairs should be provided for every bent up bar.

7) Electrical concealed conduiting work should be carried out, only after completing the reinforcement.

BEAM REINFORCEMENT :

1) The number of top bars, bottom bars, curtail bars & details of stirrups should be checked..

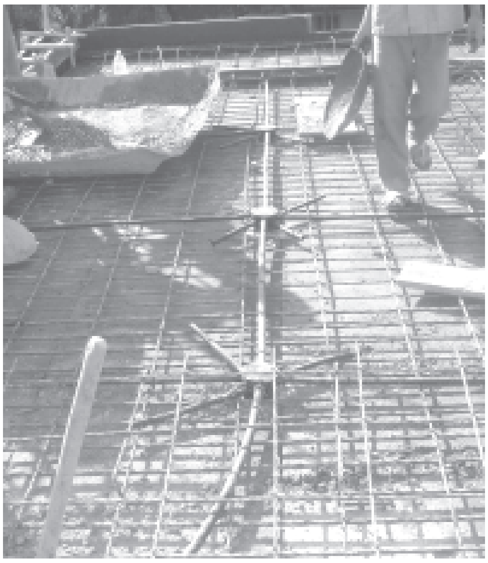
2) Beam reinforcement should be placed in position with proper anchorage in column.

3) Beam bottom covers and side covers should be provided as specified in the drawing.

4) Extra top bars at supports should be checked.

5) Reduction of column section should be done within the beams, if required.

BEFORE CONCRETING :



1) Required material should be made available on site in sufficient quantity.

2) Metal and sand should be stacked near the concreting location.

3) Weigh batcher and mixer should be installed in proper level and on firm ground.

4) The calibration of weigh batcher should be done before concreting.

5) Machineries such as lift, mixer, vibrator and its needle should be in good working condition and with necessary fuel. Standby needles should also be made available

6) Suitable and safe arrangement should be made for temporary walkways on reinforcement.

7) Sufficient labour strength and supervisory staff should be appointed at the workstation.

8) Temporary barricades, safety belts, helmets, first aid box and temporary diversions should be made.

9) Sufficient and safe electric supply should be made available during night shifts.

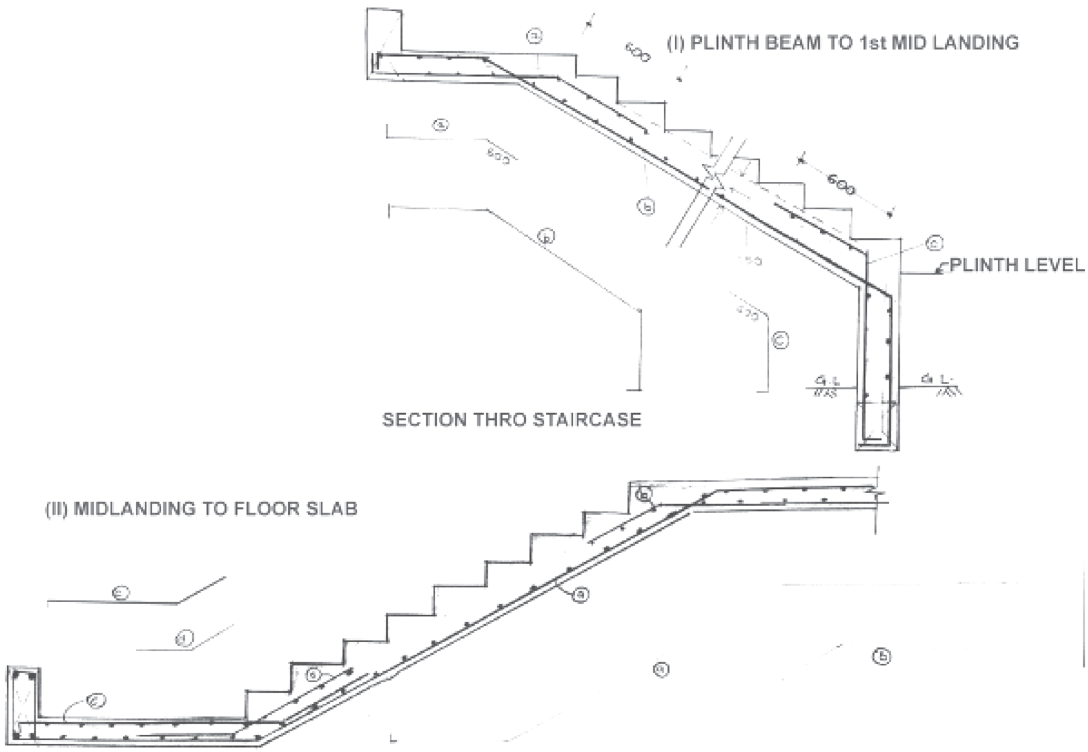
DURING CONCRETING :

1) The slab should be cleaned thoroughly.
2) Skilled & sufficient man power should be made available at work station- like on the slab, below the slab & near the mixing unit.
3) The weights of weigh batcher should be set as per the mix design.
4) Concreting should be dispensed at the rate of 25 bags per hour per mixer.
5) The concrete should be placed in suitable layers in the various sections to avoid overloading of shuttering at single point.
6) Proper compaction of concrete should be done by rodding and appropriate vibrator needle.
7) Extra care should be taken during compaction where the reinforcement is congested.
8) The temporary wooden templates should be fixed to ensure the thickness of concrete in bays.
9) The concrete should be placed in bays and proper compaction should be done.
10) Finishing should be done by wooden floats.
11) Metal should be partially inserted on the top of fresh concrete at column, to provide proper bond.
12) Curing should be done at least for 21 days by ponding method.

PRECAUTIONS:

1) Water cement ratio should be controlled throughout the concreting process.
2) Excess vibration to beams should be avoided.
3) Movement of labour on the fresh concrete should be avoided.
4) Proper attention should be given to remove wooden pins in the sunken slabs.
5) Replacement or repairing of damaged electrical conduits or boxes should be done immediately.
6) Sufficient clamping should be done to the shuttering.

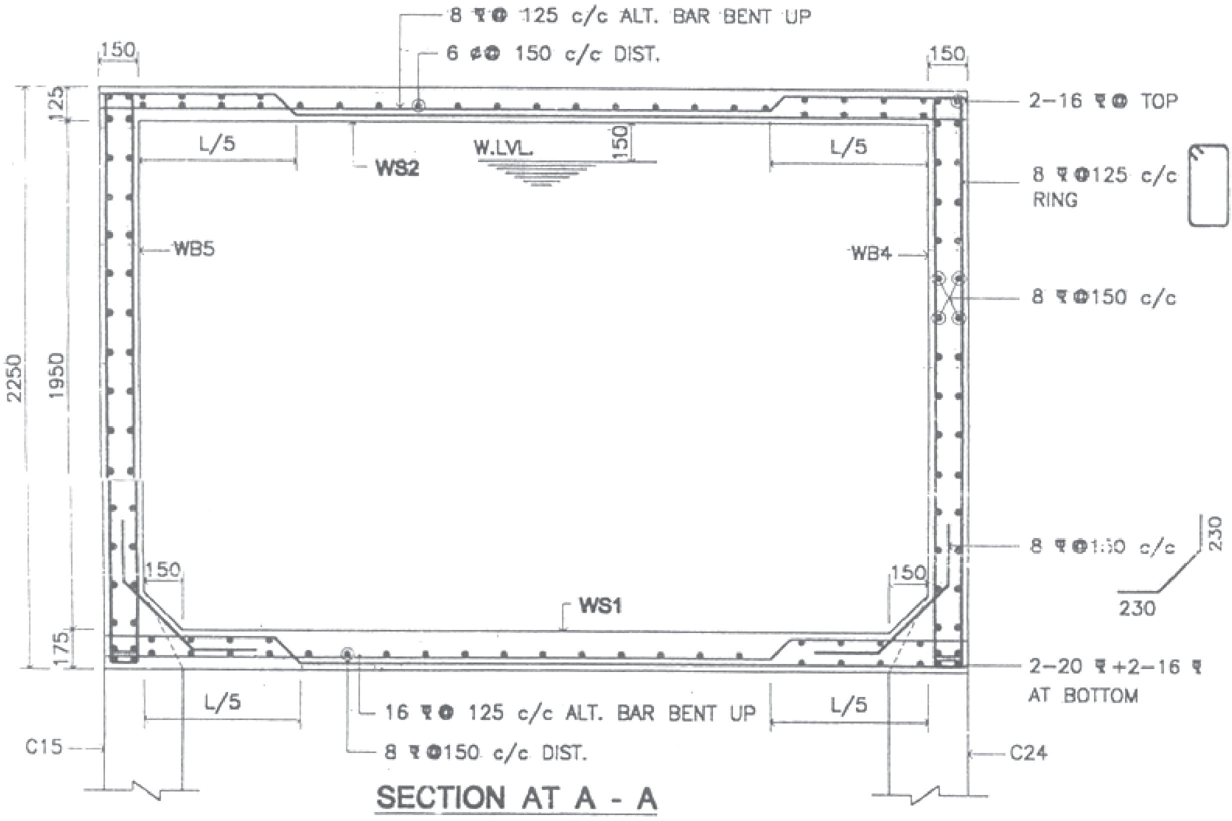
STAIRCASE:



In addition to checking norms of slab shuttering, special care and precautions should be taken during staircase shuttering as follows.

1) Concrete thickness of the waist slab shall be measured and maintained in the right angle to the inclination of the waist slab.
2) Height of all risers and width of the treads shall be maintained as per the drawing. This could be done easily by marking temporarily on the side walls.
3) Proper bracing shall be provided to maintain the stability of the shuttering of the risers.
4) While maintaining the treads and risers, the size of landing should be maintained as per drawing.
5) Nitches, if any, for service lines and provisions for elevational features should be made.
6) The reinforcement should be provided as per drawing.
7) The various dowels at various locations should be maintained.
8) The electrical conduiting should be carried out as per drawing.
9) Proper covering should be provided at the scissor junction.
10) The water cement ratio should be maintained.
11) Concrete should be poured from the lower end to the upper end of the staircase.
12) Staircase pardi should be casted at the earliest, after the concreting of staircase.

WATER TANK:



In addition to the checking norms of slab shuttering, specific care & precautions should be taken during shuttering of water tank.

Shuttering should be watertight.

1) All necessary plumbing outlets in the shuttering should be provided at required levels as per drawing.
2) Haunch bars should be provided as per drawing.
3) Concreting of the champers should be done along with the bottom slab.
4) Concreting of pardi should be carried out in uniform layers.

REPAIR OF HONEY COMBED SURFACE:

1) All the loose particles should be chiseled out till firm,cavity free surface is met with.
2) Surface should be watered.
3) The cement slurry should be applied to the honeycombed surface.
4) Mortar/ concrete should be applied over honey-combed surface.
5) Any further application if required should be done after six hours.
6) Honey combed surface should be cured for 7 days. Honey combing repairs shouldbe done immediately after deshuttering.

MASONRY

INTRODUCTION :

Masonry is defined as the construction of stone, brick or tile bonded with mortar .The selection of material for masonry work depends on following properties of the material :-

1) Strength
2) Durability
3) Porosity
4) Thermal insulation
5) Fire resistance
6) Dead weight
7) Economy

Masonry is generally defined as a walling material. Masonry walls are divided into two categories:

1) Load bearing walls
2) Non-load bearing walls

Masonry can also be broadly divided depending upon the type of material used, into following types:

1) Stone masonry
2) Brick masonry
3) Reinforced brick masonry
4) Composite masonry
5) Hollow concrete block masonry
6) Load bearing wall tile masonry

Most commonly used masonry types are stone masonry & brick masonry.

STONE MASONRY:

It is a process of masonry construction by using stone & mortar.

Stone masonry is further classified in two types depending on arrangement of stones, shapes, finish etc.

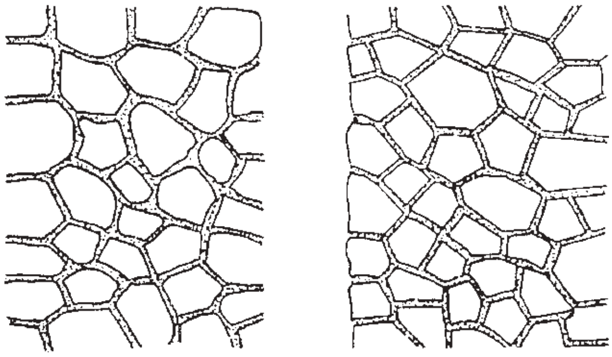
1) Rubble masonry
2) Ashlar masonry

A) Different categories of RUBBLE MASONRY:
   1) Uncoursed rubble masonry
   2) Random rubble masonry
   3) Coursed rubble masonry
   4) Dry rubble masonry

B) Different types of ASHLAR MASONRY:
   1) Ashlar fine

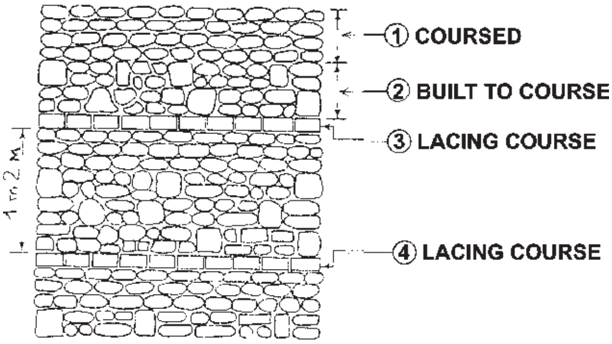
2) Ashlar rough tooled
3) Ashlar rock, rustic or quarry faced
4) Ashlar chamfered
5) Ashlar facing

POLYGONAL RUBBLE MASONARY

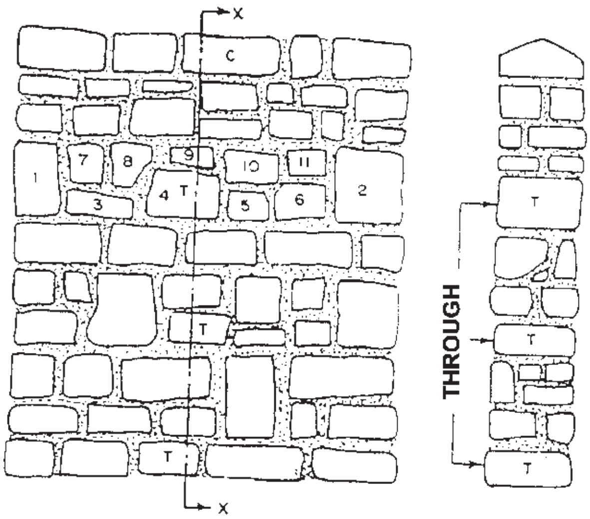


ROUGH PICKED   CLOSE PICKED

FLINT RUBBLE MASONARY

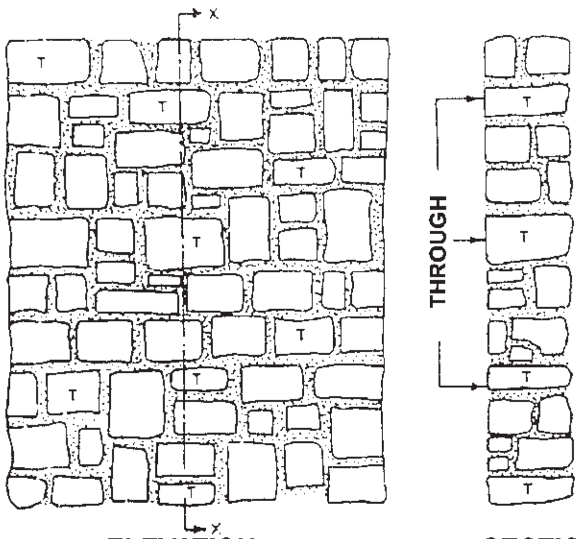


RANDOM RUBBLE : BUILT TO COURSES



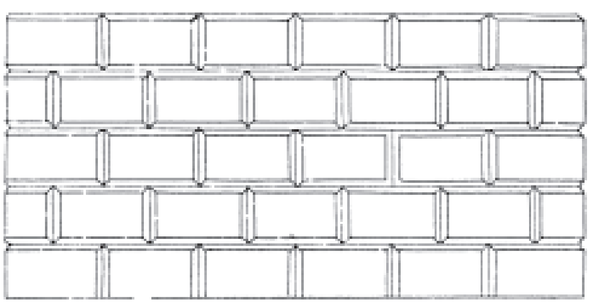
ELEVATION   SECTION

RANDOM RUBBLE UNCOURSED

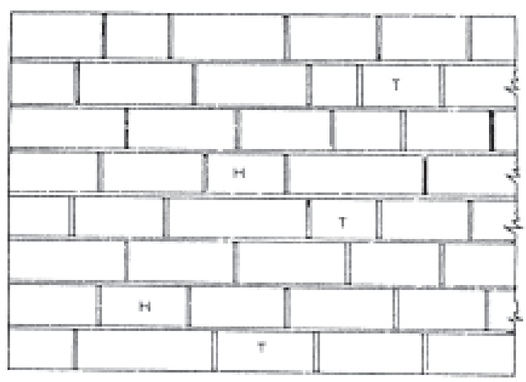


ELEVATION   SECTION

ASHLAR CHAMFERED

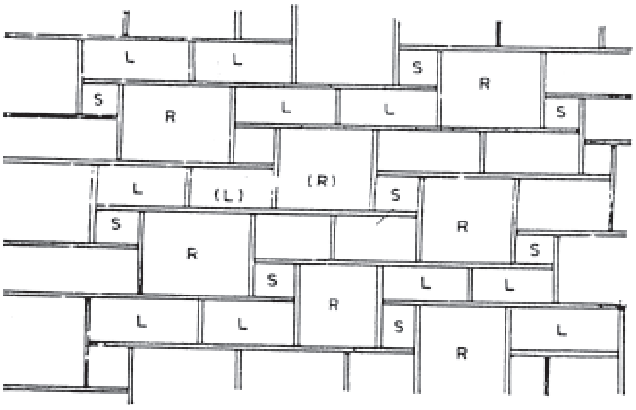


SQUARE RUBBLE : REGULAR COURSED



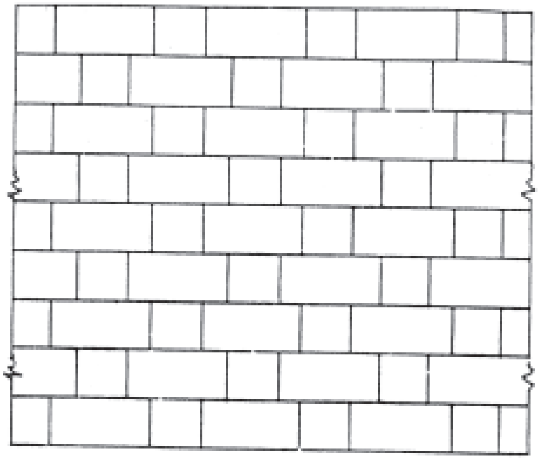
H= HEADER
T= THROUGH

UNCOURSED SQUARE RUBBLE

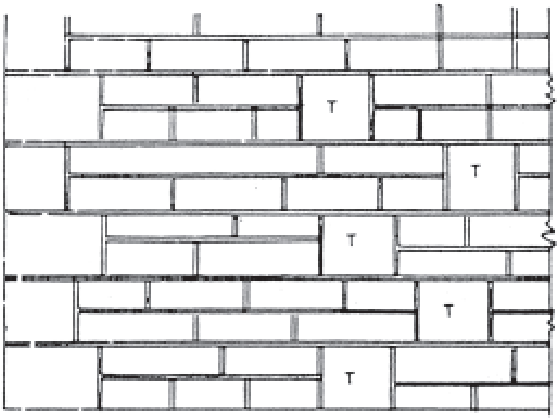


R-RISER
L-LEVELLER
S-SNECK

FINE TOOLED ASHLAR MASONRY

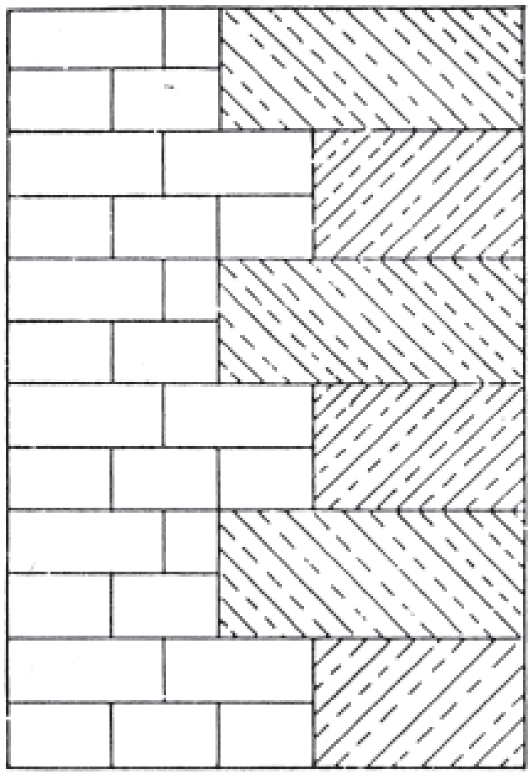


SQUARED RUBBLE : BUILT TO COURSES



T-THROUGH STONES

ASHLAR FACING MASONRY



Following are the general points to be observed in stone masonry construction:

1) Stone used should be free from cracks, flaws, cavities, veins and patches of soft or loose material i.e. it should be hard ,tough and uniform in texture.
2) Stones should be laid upon their natural bed i.e. position occupied by the stone during its formation.
3) Proper bond should be maintained throughout the masonry work.
4) Through-Stones should be used for good bonding in facing and backing of wall.
5) Through-Stones should be laid in a staggered manner in the successive course.
6) As far as possible, all connected walls in a structure should be raised up uniformly & regularly.
7) Pockets & hollows left, should be filled with mortar and stone chips
8) The joints should not be too smooth & dressed hollow.
9) The vertical joints should be staggered.
10) The vertical surface should be truly vertical & checked by plumb bob.
11) Development of Tensile stresses in masonry should be avoided.
12) Pointing is necessary for exposed joints.
13) All joints shall be filled with mortar to a depth of 25mm.
14) RCC coping of 100 mm thickness, is necessary on the top of wall
15) The entire work should be cured for atleast 15 days.

BURNT BRICK MASONRY:

INTRODUCTION :

Brick masonry is defined as construction of bricks by bonding them together with mortar.

The strength of brickwork depends on quality of material used and process adopted for work. Burnt brick masonry is classified as first class and second-class according to the type of bricks used & method adopted for laying.

MATERIALS REQUIRED FOR BRICK MASONRY:

1) Bricks
2) River sand/Crushed sand/Stone Dust
3) Cement
4) Water

BASIC REQUIRMENTS BEFORE COMMENCEMENT OF BRICK WORK:

1) Site engineer to prepare & mark out different types of brick masonry on floor plan. i.e. thickness of wall and get it approved from higher authority.
2) Line out of every wall on the floor is most important part of the masonry work. Approval has to be obtained from higher authority for this work.
3) Lineout must be done before starting of brick masonry work. The Project-Incharge must check the same with working drawings, for wall thickness, openings and room dimensions, before commencement of

masonry work.

4) All the materials required i.e. bricks, sand, cement, water, door frames, m.s.windows, tools plants& required manpower; should be made available in advance.

5) All the changes or alterations or omissions should be confirmed in advance.

CHECKING OF LINE OUT WORK:

1) Check the face of the layer in plumb with respect to face of beam.
2) Confirm the top of 1st layer is in one level.
3) Check room dimensions with diagonals of the room.
4) Check overall out to out dimensions of the floor.
5) Get the line out work checked by Project Incharge & approval by higher authority.
6) All positions of windows, doors and openings should be finalized at the time of line out,

CONSTRUCTION OF BRICK MASONRY:

1) Cleaning of floor slab should be done before starting of work and after daily masonry work.
2) All materials and mortar mixing trays should be shifted to work place.
3) Bricks should be thoroughly soaked in water.
4) The bond to be used shall be decided beforehand for the masonry work.

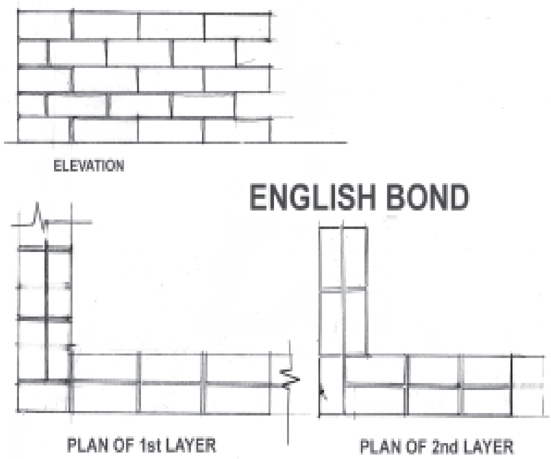
Some of the bonds are:

   1) ENGLISH BOND
   2) FLEMISH BOND

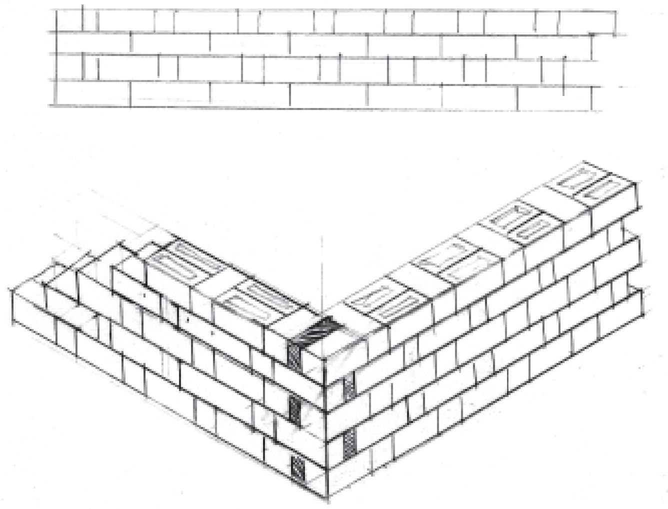
5) Making line out work and getting approval for the same.
6) Proportion of mortar may be kept as 1:6 for wall thickness more than 100 mm and as 1:4 for 100 mm thick walls.
7) The bricks should be laid on full bed of mortar. All the courses should be laid truly horizontal and all the vertical joints should be truly vertical, i.e. use of level tube and plumb bob is necessary.
8) Avoid use of brickbats except when it is absolutely necessary for specified bond
9) Thickness of joint should be 12 mm to 15 mm
10) Bricks must be laid **'frogs pointing upwards'** and avoid laying of brick on edge.
11) The face of joints should be raked to a minimum depth of 10mm.
12) Required provision shall be made to collect the mortar falling down during construction to avoid wastage.
13) Brick work should be done simultaneously in uniform level and is to be raised not more than 1.2m everyday .
14) Check and confirm the lintel level to place the RCC lintel.
15) Fill the masonry and RCC junctions with rich mortar (i.e. 1:2 proportion) and insert 20mm metal in the joint.
16) Place RCC band 100mm thick on half brick thick wall at an interval of 1.2m. Place RCC band at all

window and opening sills with minimum penetration of 150mm in walls.

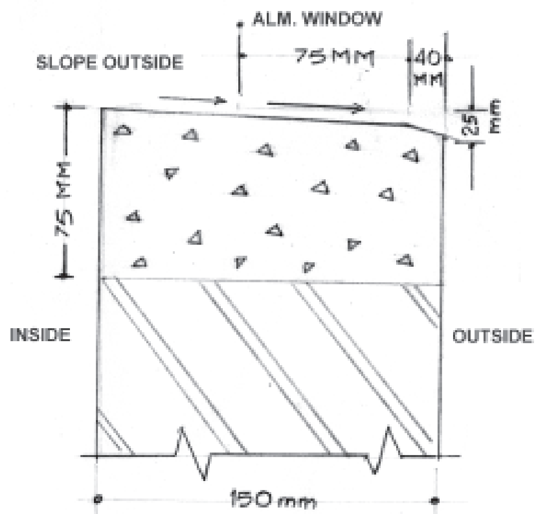
17) All the finished masonry work must be cured at least for 7 days.



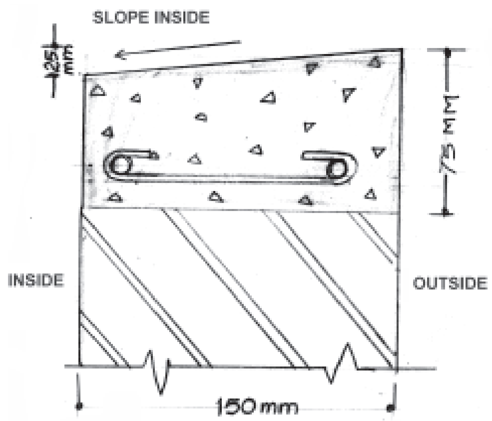
ENGLISH BOND



FLEMISH BOND



PCC COPING AT WINDOW SILL
(WITH 150 mm BEARING ON BOTH THE SIDES)



RCC COPING AT PARAPET

FIXING OF WOODEN DOOR FRAME OR M.S WINDOW:

1) Check the size of section and design of frame as per specification.
2) Check the size of doorframe. Fix minimum 3 holdfast/column Patti on each side before fixing the frame.
3) Concreting for holdfast is necessary.
4) Apply coal tar to the hidden side and wood primer to exposed side of the frame.
5) Check if the temporary supports are provided at bottom, middle and top two corners.
6) Check inner dimensions of the frame at bottom middle and top.

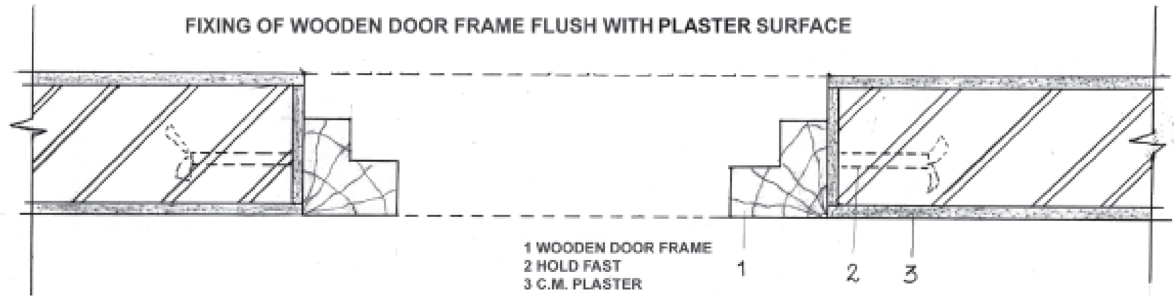
7) All the frames should be at one level.

8) The frame should be in plumb and level.

9) An offset should be maintained between the outer faces of the frame and the brickwork; to accommodates the required thickness of plaster.

10) Temporary supports provided to the frames shall be maintained in place till the completion of masonry.

11) Cleaning of the frames & floor shall be done immediately after the day's scheduled work.



PLASTERING AND POINTING

INTRODUCTION:

Plastering is a method of coating the internal and external surfaces of walls and ceilings with cement mortar to achieve the required finish and aesthetic view to the bare R.C.C. and masonry surfaces. It protects the R.C.C. and masonry work from atmospheric effects and increases the durability.

FINISHES OF PLASTER:

1) Nerru finish
2) Sand faced
3) Rush plaster
4) Textured
5) Pebbled
6) Scrapped

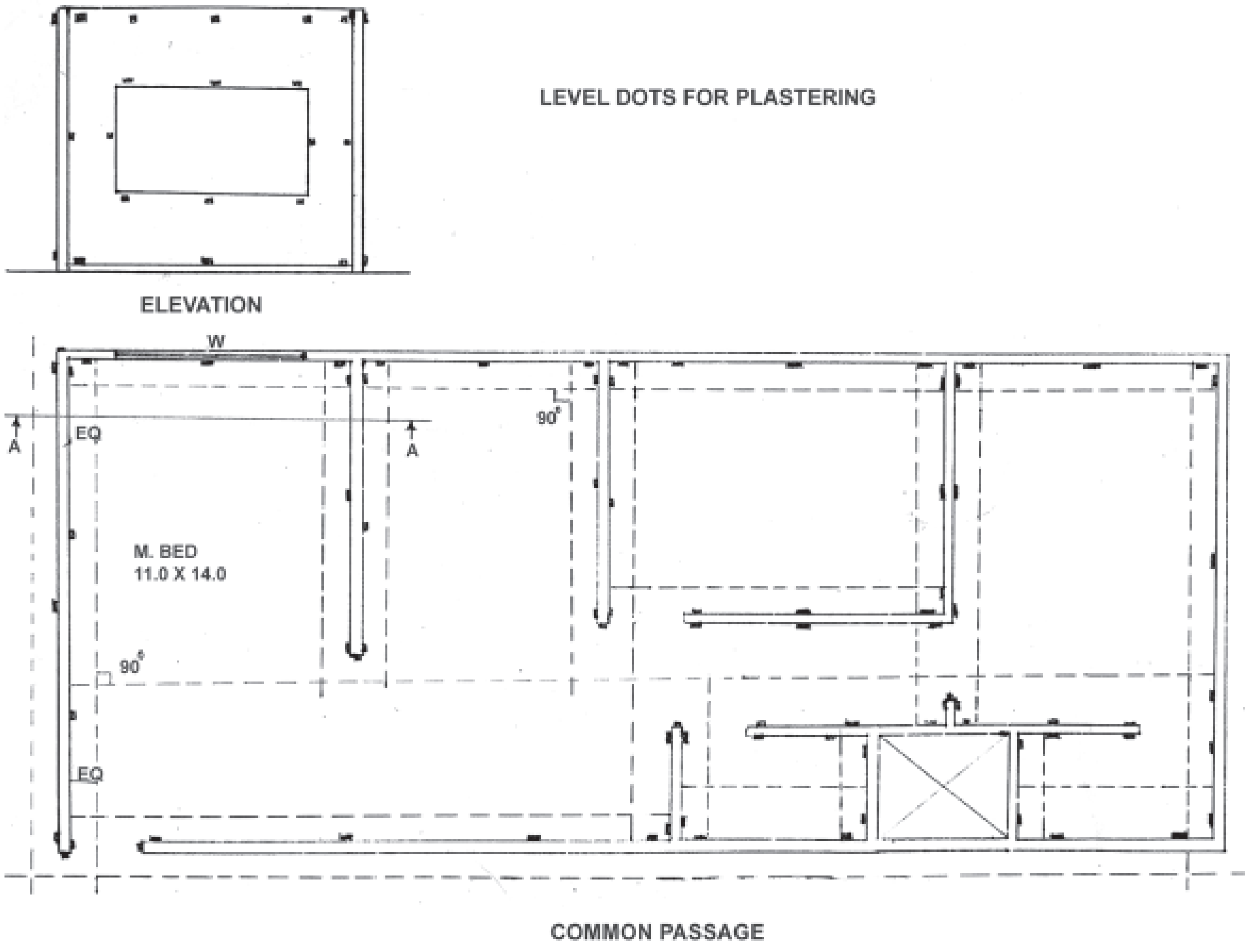
The most commonly used finishes of plaster are nerru finish and sand faced finish. The nerru finished plaster is usually preferred for the surfaces, which are not directly exposed to weathering. The sand faced finish plaster is usually preferred for the surfaces, which are directly exposed to weathering.

REQUISITES FOR PLASTER WORK:

A) Raw materials: - cement, sand, sanla, water and admixtures.
B) Scaffolding materials.

PREPLANNING PROCESS:

1) After completion of brickwork, mark guideline dots (thiyya) in line, plumb diagonals and levels
2) Complete concealed electrical piping and fixing of concealed boxes. The face of concealed boxes should be flush with plaster surface.
3) The chiseled grooves for pipe and boxes should be finished with cement mortar.
4) Fix the chicken mesh of 24 gauge and 12mm x 12mm size openings at all the joints of RCC, Masonry and for all electrical pipes.
5) Dress all the surfaces to be plastered, with wire brush to remove the dust and loose particles.
6) Preparation of freestanding scaffolding without holes through walls, with extra supports to the scaffolding shall be done.
7) The surface to be plastered should be thoroughly watered.
8) Sand should be sieved with screen of 10 holes/cm^2.
9) The trays for mixing of mortar and water storage tank shall be made available at workplace.



NEERU FINISH PLASTER:

Plaster work shall be started only after, all the prerequisites are fulfilled.

1) Mixing of mortar shall be done in a tray only.
2) Usually the mortar mix for internal plaster is: -
a) Ceiling C.M. 1:4.
b) Walls C.M.1: 6.
3) Cement and sand should be dry mixed properly before adding water.
4) Required quantity of water shall be added to achieve workable mix.
5) Admixtures, if any, shall be added to the mortar.
6) The mortar mix should be consumed within half an hour from mixing. The quantity of mortar shall be mixed accordingly.
7) Plastering work shall be started from ceiling, in C .M. 1:4 and then proceeded further with walls.
8) Trowelling of excessive C.M. is done for bringing the surface in level/line & plumb.
9) Finish all surfaces in level, line with respect to guideline dots.
10) Finish all the edges, corners and offsets in plumb, right angle and level.
11) Check sizes of all the openings for right angles.
12) Neeru shall be soaked atleast for two hours in water, before application

13) All the electrical points shall be finished neatly.
14) Desired quantity of cement shall be added in nerru for stiffness of edges.
15) A thin film of nerru shall be applied over the plastered surface and shall be finished smoothly.
16) The entire surface where dado tiles are to be fixed and shall be marked and made rough.Neeru shall not be applied on this surface.
17) The portion of the side walls, where the skirting of the tiles is to be fixed; shall not be plastered. If some mortar is stuck there, then it shall be scrapped properly upto 0.15 m from the top of the floor slab.
18) Curing should be done after 24 hours and carried out atleast for 14 days.

SAND FACED PLASTER:

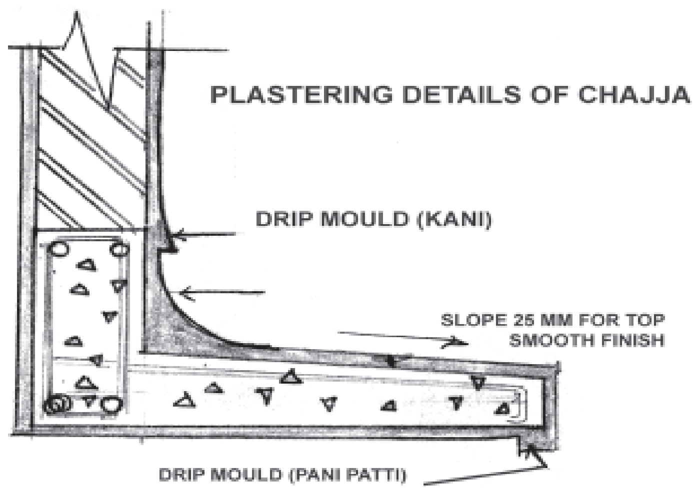
1) Proper erection of scaffolding should be carried out with the help of skilled workmen. It should be erected on firm base and should have sufficient working space. It must be strong enough to sustain the moving load and should be designed for all safety aspects.
2) Mark the guide line dots in line, level and plumb.
3) Complete all the elevational brickwork. Fill all the gaps and holes if any, with rich cement mortar. Insert metal, at all junctions of R.C.C. & brickwork.
4) Fix chicken mesh of 24 gauge and 12mm x 12mm holes at all the joints of RCC and masonry.
5) Dress all the RCC/masonry surfaces for any projections.
6) Rub the entire surface to be plastered, with wire brush for removing dust and loose particles.
7) Surface to be plastered should be thoroughly watered.
8) Sand should be sieved with screen of 10 holes/cm^2. For finishing coat, use the sand sieved from screen of 13 holes/cm^2.
9) Confirm all the elevational and plastering details given by architect/ consultants.
10) Mixing of mortar to be done in a tray only.
11) Usually the mortar mix for external plaster is C.M.1: 4.
12) Cement and sand should be dry mixed properly before adding water.
13) Add required quantity of water to achieve workable mix. Admixtures shall be used, if specified.

14) The mortar mix should be consumed within half an hour and mix the quantity accordingly.
15) Ensure that tray for mixing of mortar and water storage tanks are available at work place.
16) Plastering work to be started from inside the parapet wall. Avoid the joints on top of parapet walls and proceed downwards.
17) Trowelling of excessive C.M. is done for bringing the surface in line & plumb.
18) Apply C.M.1:4 using sand sieved from sieve of 13 holes/cm2 for minimum thickness. Use sponge to achieve proper effect of sand faced plaster with uniform grains.
19) Finish the entire surface in line &plumb with respect to guideline dots.
20) Finish all the edges, corners and offsets in plumb, right angle and level.
21) Check all the openings for sizes and diagonals.
22) Clean all the mortar splashed on door frames, window frames, railing and all floors, thoroughly.
23) Curing should be done after 12 hours and shall be carried out atleast for 14 days.

PRECAUTIONS DURING THE EXTERNAL PLASTER:

1) Before starting plaster work, place plastic sheets/empty cement bags underneath the area to be plastered, to collect the falling mortar.
2) No supports for scaffolding should be taken from M.S. windows, frames, railings and grills etc. If unavoidable take supports by making holes at skirting level only.
3) Necessary precautions and safety measures are to be taken while removing the scaffolding, shifting of wooden planks and other scaffolding material.
4) All the workers working near the scaffolding area should wear helmet and safety belts. Safety belts to be tightened to firm supports only.
5) Fill the pocket holes of scaffolding supports with well soaked bricks and rich cement mortar with proper compaction and finish on the external as well as internal surfaces..
6) Utmost care should be taken to cure soffits of chajjas, cantilever portion, hidden portions etc.

Refer Sketches for Various Plaster Details of chajja with drip mould :-



MISCELENEAOUS PLASTER WORK:

1) Butt finish: - It is a process of plastering the surface in between skirting top and previously left plaster, Necessary care shall be taken to match the surfaces. Proper curing and cleaning shall be carried out.

2) Minor repairs: - All minor repairs shall be carried out by skilled mason only. The curing of the repaired works shall be done properly.

POINTING:

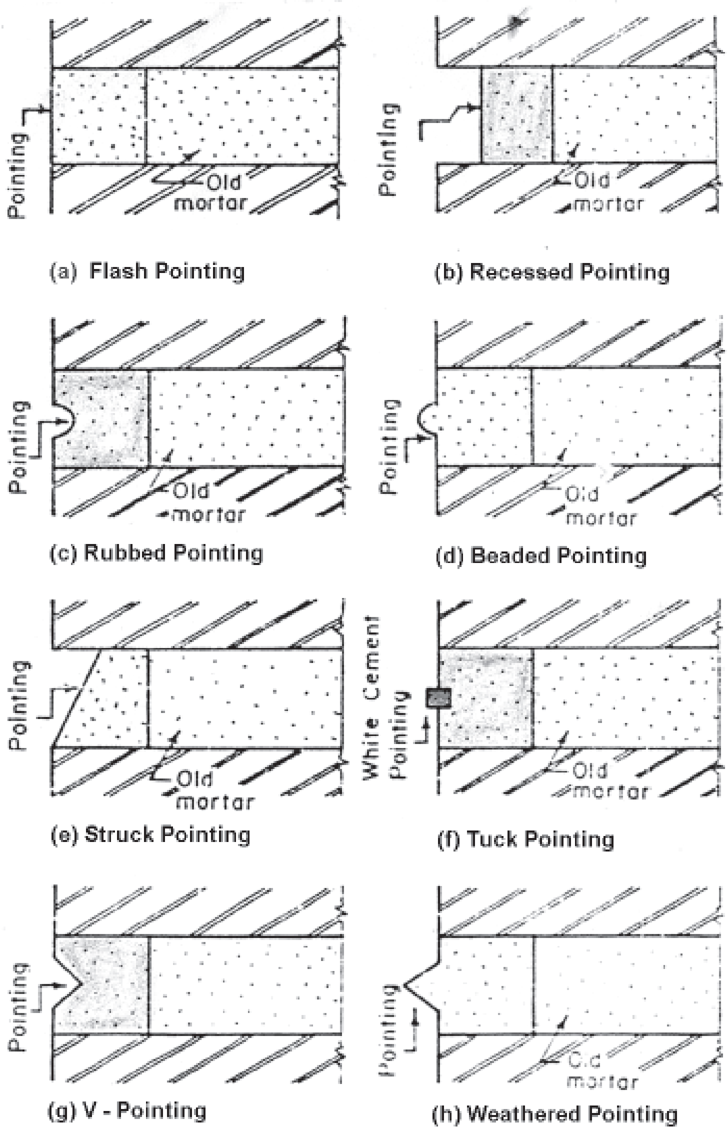
Pointing is a process adopted to protect the joints in the masonry from atmospheric conditions. It also improves the asthetic view of the masonry walls.

Types of Pointing: -

1. Raised pointing
2. Sunk pointing
3. Flush pointing
4. Vee pointing

WORK PROCESS OF POINTING:

1. Rake all the joints for U.C.R. 25mm deep & 20 mm deep for brick masonry.
2. Remove all the loose mortar & cleaning the joints.
3. Watering to the joints to be done.
4. Filling & finishing of joints as per designed type of pointing with cement mortar to be done.
5. Curing for 7 days to be done.



TYPE OF POINTINGS

PLUMBING AND SANITATION

INTRODUCTION :

The term plumbing includes water supply and sanitation system. Water supply and sanitation is an essential service required for continuous supply of water and efficient disposal of water.

PRE-REQUISITE:

1) Consultant
2) Contracting agency
3) Engineer
4) All the necessary materials.

A) ROLE OF CONSULTANT:

1) Preparing layout of drainage and water lines with reference to existing drainage and water lines as per municipal norms.
2) Approval from client and municipal authorities
3) Design of OHWT, UGWT, Septic tank and distributaries for their capacities.
4) Preparing of toilet layout, downtake and service lines.
5) Monitoring the work at various stages as an when required and certifying the same.
6) Getting the required NOC's from the relevant authorities, after completion of the work.

B) ROLE OF CONTRACTING AGENCY:

1) Detail study of drawing, verifying for feasibility as per site conditions and suggest necessary changes.
2) Coordinating with consultant and site engineer.
3) Make arrangement for men & machines as and when required.

C) ROLE OF ENGINEER:

1) Study the existing water supply and drainage lines.
2) Ensure that the concealed plumbing layout matches with tiles layout.
3) Ensure the feasibility of concealed and external layouts, OHWT, UGWT.
4) Day to day supervision & conducting different tests as required.

D) MATERIAL SPECIFICATION :

Ensure that all materials to be used are of approved quality and specifications.

WORK PROCEDURE:

1) GI concealed plumbing on walls

a) Mark the plumbing layout on the walls with respect to tile layout after completion of plaster .

b) Use cutter machine for chiseling groves.

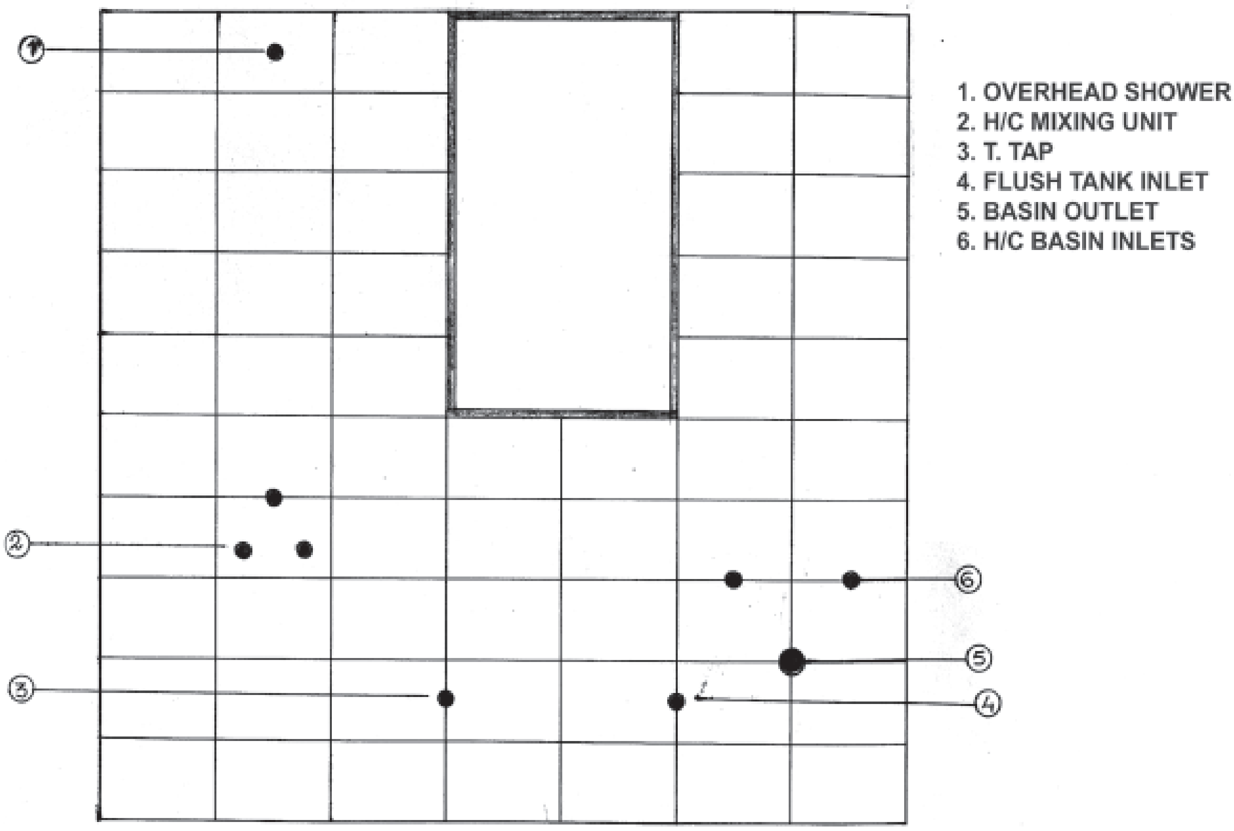
c) Take measurements of required lengths of pipes, make a assembly of pipes as per layout. Fix it on the wall and ensure all heights and measurements.

d) Apply coal tar to all pipes, asbestos rope for hot water line and jute cloth for cold water line.

e) Fix the total assembly firmly in position.

f) Check for leakages by pressure testing..

PLUMBING LAYOUT MATCHING WITH TILE LAYOUT



Pressure test:

i) Plug the inlets and outlets excluding two end points where Pressure Testing Machine is to be connected.

ii) Apply pressure from the pressure pump. Ensure that the air in the pipeline is released completely. Develop the pressure upto 7 kg/cm$^{2.}$ Keep the pressure intact, atleast for 30 minutes. Ensure that there is no pressure drop.

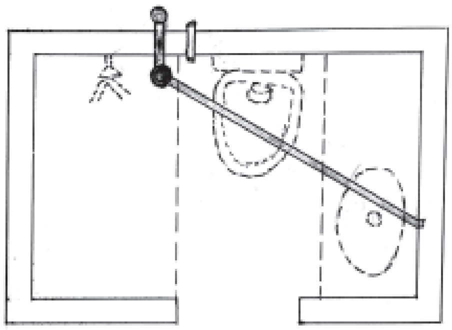
g) After assuring that there is no pressure drop and any leakage from joints, finish the chiseled groove in cement mortar. Make the surface rough.

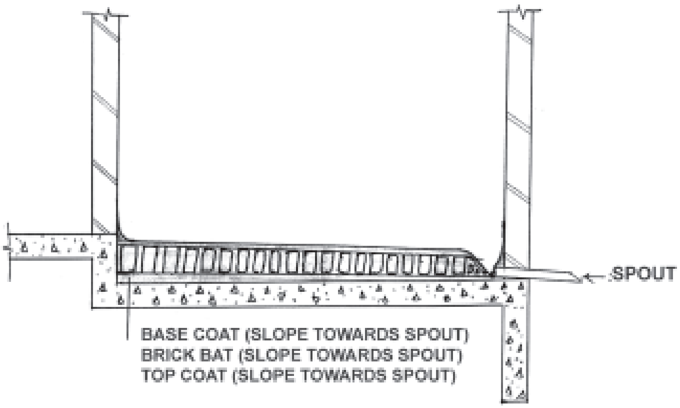
h) Cure the finished surface atleast for 7 days.

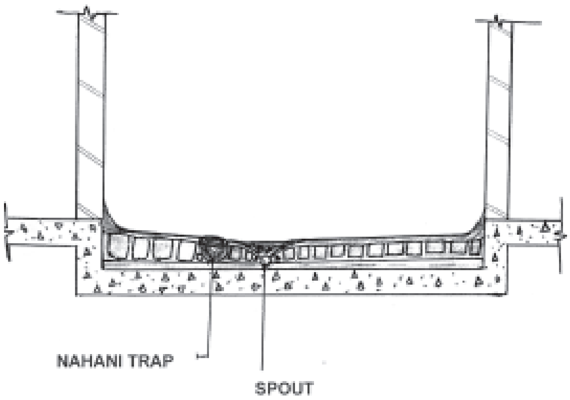
G.I./C.I. LINES CONCEALED UNDER FLOOR :

1) After the base coat of waterproofing is completed, fix the nahani trap/P trap and 100 mm C.I. bend in position as per drawing.
2) The joints of nahani trap, connecting pipe, bend, P trap and connecting pipes should be sealed properly with cement and should be tested for any leakage before the next coat of waterproofing of the toilet.
3) Place the G.I. outlet for basin and washing machine over the nahani trap with adequate slope. The outlet should rest on the nahani trap edge. Test the outlet for leakage.
4) Curing should be done for cement joints. Proceed further with waterproofing work. .

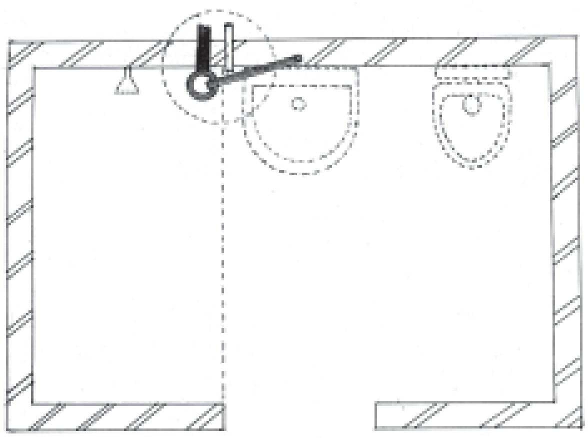
Refer figure: -

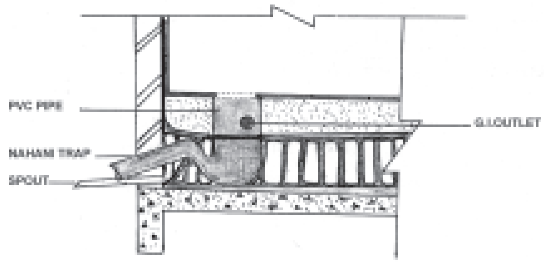






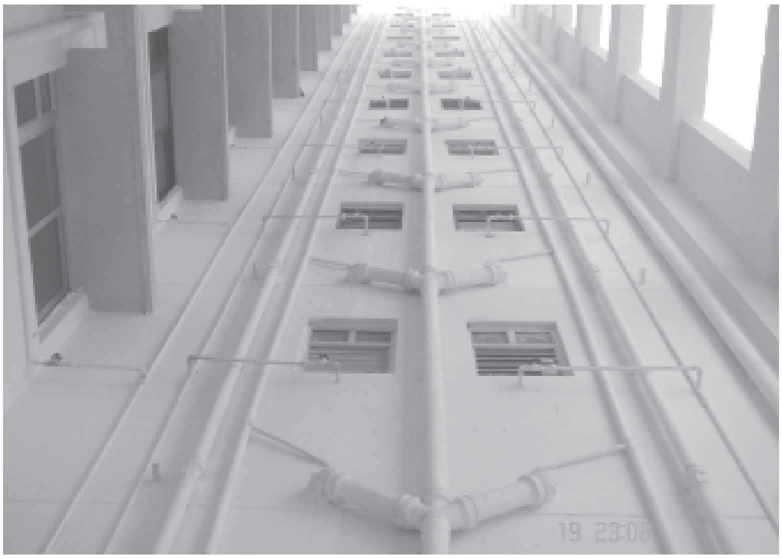
DETAILS OF FIXING SPOUT IN TOILET





DETAILS AT NAHANI TRAP

EXTERNAL PLUMBING LINES:



A) PVC soil, and waste water line.

1) After completion of external plaster, mark all vertical lines on the wall in plumb as per layout and changes.
2) Fix the C.I./ PVC pipes including specials, in line, level and plumb with proper clamping.
3) Ensure that, all the joints are vertical .
4) Ensure that all horizontal joints are leak proof.
5) Minimum 3 clips should be fixed for every pipes, one at center and one at each joint. Fix the clamps using drill machine.
6) All the connections below 1st floor level should be in C.I. pipes only.
7) Connect 100 mm soil line to drainage chamber with proper slope and finishing.
8) Connect 75mm waste water line to gully trap at ground level. Connect gully trap to drainage chamber with S.W.G pipes in proper slope and finish.

B) Antisyphonic lines: -

Antisyphonic lines are provided to release the traped air and foul gases. These lines are to be fixed as per the procedure followed for 75 mm and 100 mm lines given above.

C) Rainwater line: -

Purpose of rain water line is to drain out the water from top terrace, individual terraces, and balconies.

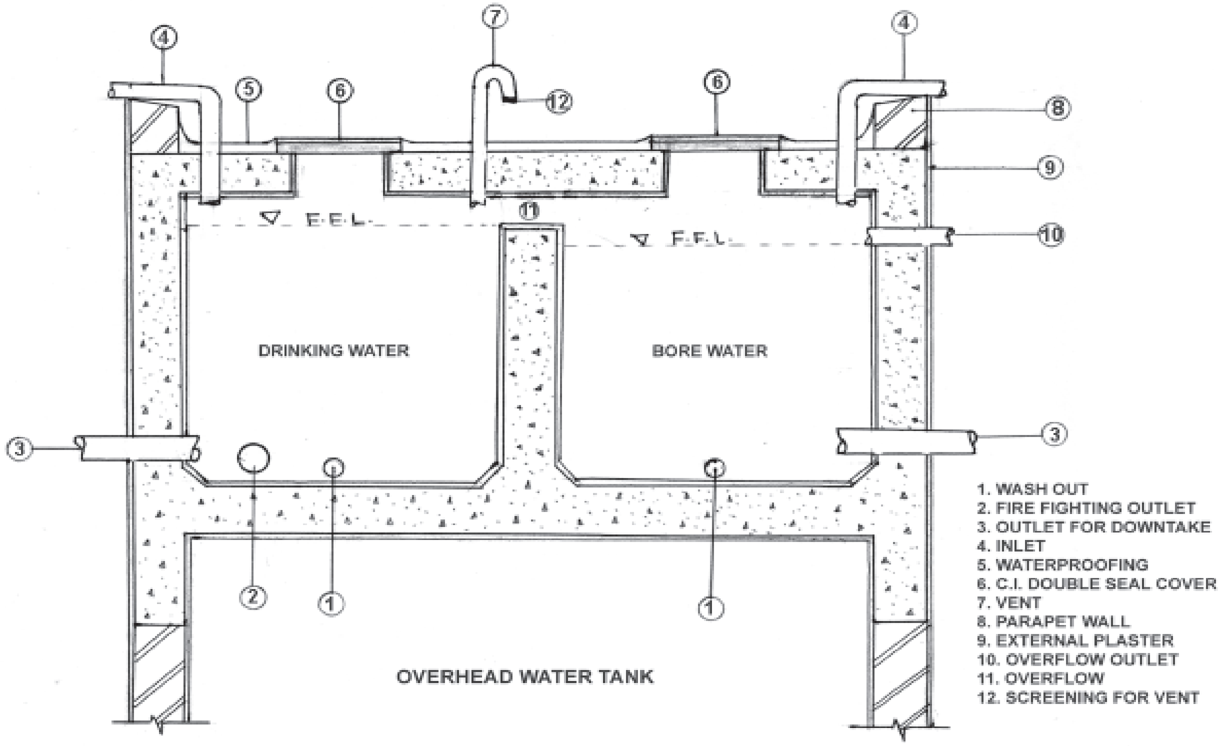
1) Rainwater outlet should be fixed considering waterproofing level.
2) Vertical line to be done as per the procedure of C.I./PVC lines given above.
3) Provide shoe at parking level 6" above FFL.
4) Rain water to be drained through rainwater gutter to rain water-harvesting system.
5) Do not connect rain water line to drainage chamber.

D) G.I. down take:

1) Mark all the G.I. lines on the wall in plumb as per layout and design, after completion of external plaster.
2) Fix all the vertical G.I. pipes in line and level with proper clamping.
3) Minimum 3 clamps should be fixed one at center and one at each joint for each pipe. Fix clamps using drill machine only.
4) Ensure that all the joints are watertight.
5) Provide control valves/ pressure valves as per design.
6) Provide control valves for all toilets, kitchen and master valve at terrace level as per design, location and specification.

E) Terrace :

1) G.I. work on the terrace should be done after waterproofing of the terrace is completed.
2) It should be laid as per given layout and design.
3) Preferably terrace looping pipes to be run 0.6 m above the waterproofing level, on the parapet wall with clamping.
4) Ensure that outlets from OHWT including fire fighting outlets are fixed before waterproofing.



F) Supply of water to and from under ground water tank:

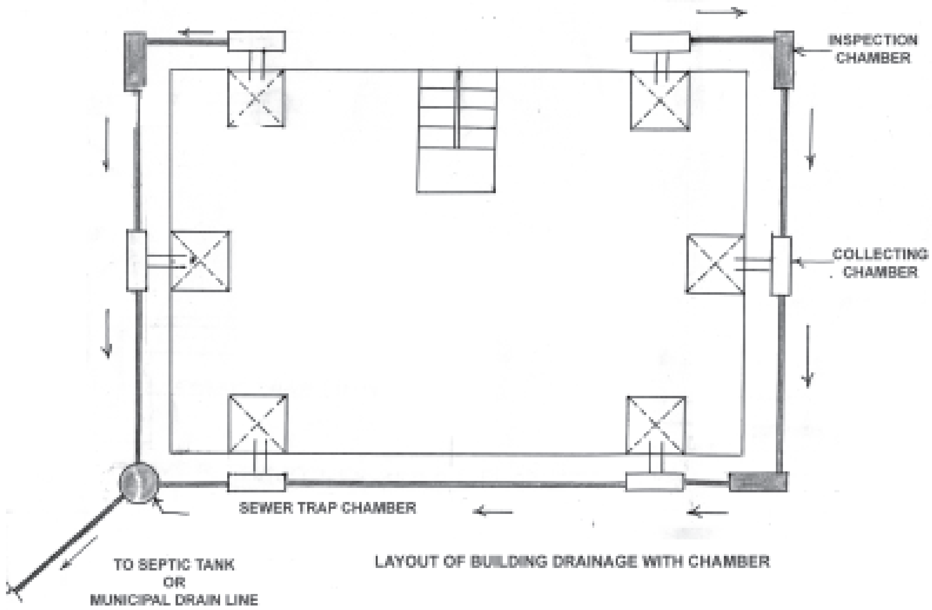
1) **Before doing the roadwork**, lay the required water supply lines from the source such as, municipal line, bore well, open well , treatment plant, up to the underground water tank.
2) Lay the delivery lines from UGWT to OHWT .
3) Check the positions of delivery lines, air vents, wash out, drain pipes, manholes for both the tanks.

DRAINAGE SYSTEM:

A network consisting of collecting chambers, drainage lines and sewer trap chambers for collecting and disposal of excreta and waste water, in a hygienic manner is known as a drainage system.

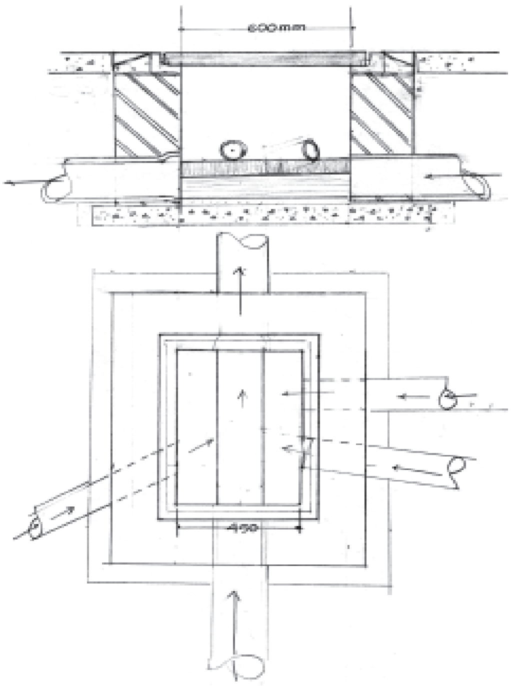
A] **Collecting chamber: -** These chambers collect the wastewater and excreta coming from the down take lines.

Soil pipes are connected directly to the collecting chambers where as the wastewater lines are connected to the collecting chambers through a gully trap chamber.

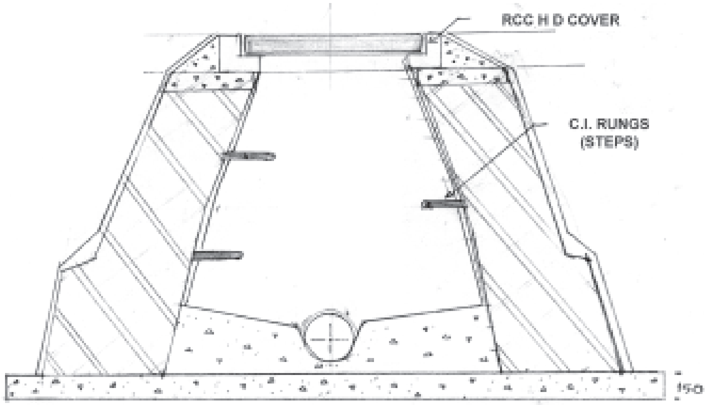


B] **Inspection chambers: -**

These chambers are provided wherever the direction of the line changes. For straight lengths, the chambers shall be provided at an interval of 15 meters for 150mm line and 30 meters for 250mm line for the purpose of Inspection..



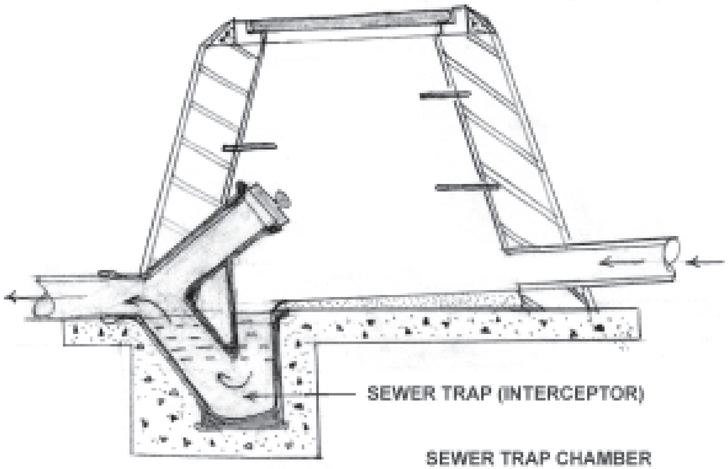
TYPICAL 600MM x 450 MM INSPECTION CHAMBER WITH CONNECTIONS



CROSS SECTION OF ROUND CHAMBERS

C] **Sewer trap chamber: -**

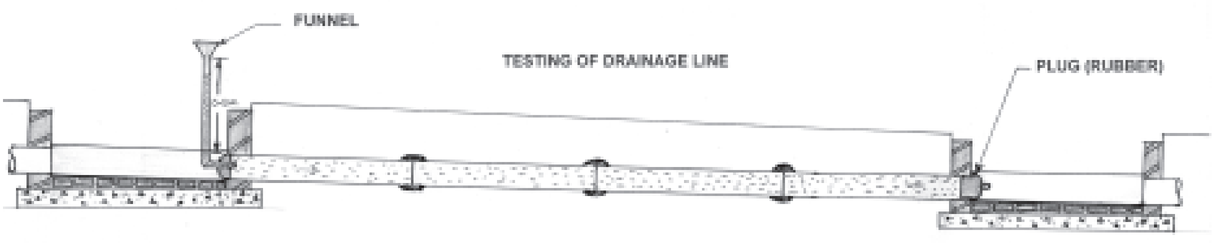
This is a well-designed trap, which connects the internal drainage system to public drainage/ septic tank. The purpose of fixing sewer trap in a chamber is that, it has a deepwater seal to prevent foul gases from entering into line in case of choke up.



LAYING OF DRAINAGE LINE:

1) Drainage line to be constructed as per the design and layout.
2) Excavation to be done considering the invert level of chambers.
3) Drainage line should be laid in straight line and the length of the chamber should be parallel to the flow.
4) The line should be laid on well compact and firm base.
5) Minimum slope for 150mm diameter drainage line should be 1:100 and for 250mm diameter line it should be 1:200.
6) The joints of the collar should be packed with packing rope, soaked in cement slurry and sealed with rich Cement mortar to the cemented joints.
7) Proper curing should be done atleast for 7 days.
8) Construction of collecting chambers, inspection chamber, manhole, drop chamber and sewer trap chamber should be done, as per the requirement.

TESTING OF DRAINAGE LINE:



1) This test is carried out between two consecutive chambers/manholes.
2) Lower end of the drain should be plugged with rubber stopper.
3) Fill the upper end of the drain with water by funnel. The funnel should have a head of 0.9 meter.
4) Plug the upper end of the drain and pass the funnel through it.
5) Wait for 2 hours.
6) Check the level of water in the funnel. If there is any drop in water level, it indicates the leakage in the drainage line.

7) Carry out back filling work only after ensuring that there is no leakage in the line.

8) Place the chamber cover of Medium duty or Heavy duty as per the requirement.

SANITARY FITTINGS:

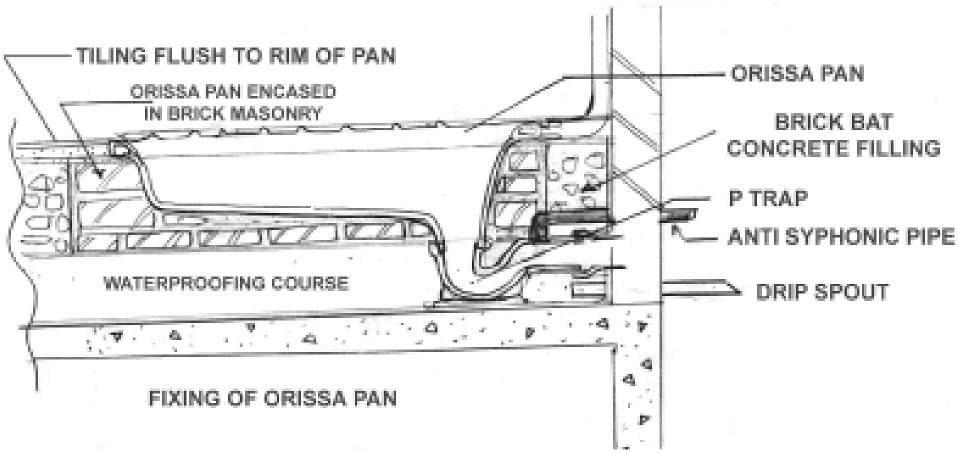
A] **Water closet: -**

1) Indian type water closet.

2) European type water closet.

3) Anglo Indian water closet.

1) Indian W.C.: - It is to be fixed on ‘P’ trap which is built solid with brick and cement mortar up to the rim of the W.C.pan.



FIXING OF ORISSA PAN

2) European/ Anglo Indian W.C.: - EWC is fixed after toilet flooring is completed and on the bend provided in case of ‘S’ trap.

In case of ‘P’ trap, the outlet is connected to the external lines by the connector through the wall. Wall hung commodes are fixed on brackets which are fixed on walls & the legs of the bracket are embedded in waterproofing.

B] **Wash hand basin: -**

The wash hand basin is fixed firmly on a pair of brackets. Brackets are fixed in line & level with fasteners.

CHROMIUM PLATED FITTINGS:

All the C.P.fittings (Wall mixers, bib cocks, angle cocks, basin mixers, showers etc.) should be fixed only after all the other works and the cleaning work is completed. It is the last activity done before handing over possession of any unit.

- All the fittings should be fixed firmly and checked for leakages.
- Proper precautions should be taken to see that the fittings shall not be damaged by the tools used for fixing.
- C.P. fittings should be fixed by a skilled plumber only.

WATERPROOFING

INTRODUCTION :

Waterproofing is a precautionary measure to provide impermeability to the surface which comes in contact with water and exposed to weather by chanalising and draining out the water through outlets.

WATERPROOFING IS NECESSARY FOR :

1) Structures in waterlogged areas (basement).
2) Structure below ground levels.
3) Toilets and W.C.
4) Balconies and flat terraces.
5) Roof terraces.
6) OHWT/UGWT.

TYPES OF WATERPROOFING

1) Box Type waterproofing.
2) Brickbat coba
3) Integrated waterproofing.
4) Glazed china mosaic waterproofing.
5) Membrane waterproofing.
6) Tarfelt waterproofing.
7) Chemical waterproofing.

PRECAUTIONS FOR BOX TYPE WATERPROOFING :

1) Clean the surface where waterproofing is to be done. Remove any wooden pieces, binding wire, nails, loose materials etc.
2) Ensure shahabad tiles should not be less than 40mm thick and preferable sizes are 0.45mx0.60m or 0.6mx0.6m
3) Sand used should be free from silt.

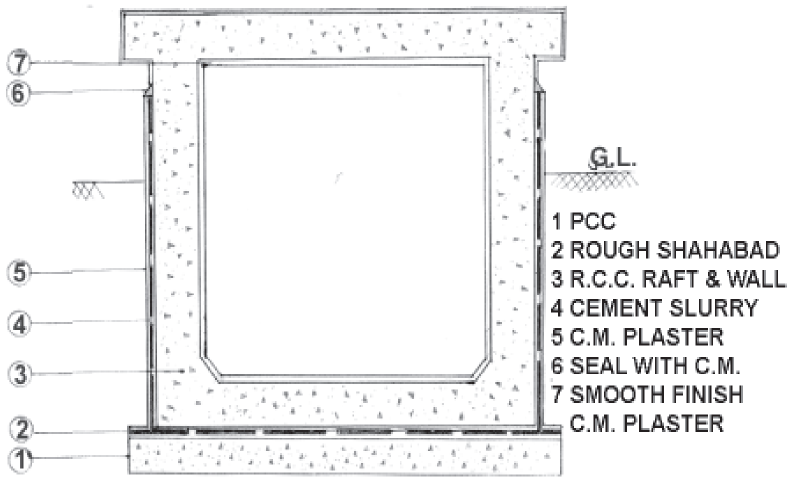
WORK PROCEDURE FOR BOX TYPE WATERPROOFING: -

1) After completion of P.C.C. the above activity should start.
2) Make the level dots on all corners of PCC bed.
3) Prepare a cement mortar of 1:4 proportion.
4) Level the mortar on the P.C.C bed with proper compaction.
5) Keeping minimum joint thickness, lay the shahabad tiles with break joint patterns. Shahabad tiles should

project minimum 0.15m from the raft and on all sides.

6) Fill all the joints with thick cement paste and finish it properly.

7) Curing should be done atleast for 7 days.



SIDE WALLS:

1) After completion of RCC walls, hacking & cleaning of surface to be done properly.

2) Mark the level dots on all sidewalls in right angle.

3) Start fixing of rough shahabad tiles on vertical wall in plumb with thick cement paste.

4) Ensure that vertical tiles should rest on the horizontal tiles projecting beyond the raft.

5) After completion of two layers of tiles, joints to be filled properly with thick cement paste.

6) Grouting should be done with thick cement slurry in layers of one tile only. On the next day follow this procedure up to the required level of waterproofing to be done and subsequently complete the work upto the required level.

7) Seal the top layer of shahabad tiles with C.M.1: 2.

8) Carry out smooth cement finish plaster over entire exposed rough shahabad surface up to foundation PCC level.

9) Before backfilling, curing should be done for atleast 7 days.

BRICK BAT WATERPROOFING

WORK PROCEDURE: -

a) Material required for brickbat waterproofing.

   1) Bricks should not be less than half width.

   2) Bricks should not be over burnt/ under burnt.

   3) Bricks should have Sharp edges.

   4) Sand should be free from silt

   5) Admixtures/chemicals as specified.

b) Clean the surface where waterproofing is to be done. Any wooden pieces, binding wires and wire nails are to be removed.

c) Clean all loose mortar over RCC surface.

d) Rub the surface where waterproofing is to be done with wire brush

BASE COAT: -

1) Fix G.I. spout at the locations where slope of base coat is to be given.
2) Wet the area where base coat is to be done.
3) Provide the base coat of 25mm to 32mm thick with slope of 1:100. from door frame towards spout.
4) Continue the base coat up to 0.3m height on the walls.
5) Curing should be done by ponding for atleast 7 days.
6) Check for leakages.

BRICK BAT COBA: -

1) After fixing of all nahani traps, ‘p’ trap, bend and all outlets, start with brickbat coba.
2) Brick bats should be soaked in water thoroughly before fixing. Cover the spout with chicken mesh and place small quantity of 15mm metal over it for porosity.
3) Prepare C.M. 1:6 and start fixing the brickbat.
4) Fix the brickbat with staggered joint and with slope towards spout.
5) The joints of brickbat should be 12 to 15mm.
6) Cure it for atleast 7 days.

TOP COAT: -

1) Top coat shall be finished in C.M. 1:4 and specified admixtures/chemicals.
2) Dry mix the cement and sand properly in trays and add adequate quantity of water to prepare a workable paste.
3) Spread the mortar over the brickbat. Fill the joints properly by tamping with trowel.
4) Finish the top coat with wooden float up to 0.3m above floor level and slope towards spout.
5) Spread the cement paste on top and finish with float.
6) Use of dry cement should not be allowed.
7) Curing should be done atleast for 7 days.

TERRACE WATERPROOFING: -

1) Clean the surface where W/P is to be done. Any wooden pieces, binding wire, wire nails and loose mortars are to be removed.
2) Rub the surface to be waterproofed with wire brush.
3) Finalize the location and size of the rainwater outlet considering the catchment area of water and slope to be given.
4) Fix the rainwater outlet with the bottom of the pipe minimum 50mm above the slab level.
5) Cure it by ponding for atleast 7 days.
6) As per finalized levels and slope, mark the level dots on floor and fix the line string.

7) Brickbat should be soaked in water thoroughly before application.

8) Prepare C.M. 1:6 and start fixing brickbat.

9) Fix the brickbat with staggered joint and with slope towards spout.

10) The joints of brickbat coba should be 12 to 15mm only.

11) Plug the rainwater outlet.

12) Fix small pieces of brickbat along with 20mm metal for covering along the bottom of parapet wall and adjoining walls.

TOP COAT: -

1) Top coat to be finished in C.M. 1:4 and specified admixtures/chemicals.

2) Dry mix the cement and sand properly in trays and add adequate quantity of water to prepare a workable paste.

3) Spread the mortar over the brickbat. Fill the joints properly by tamping with trowel.

4) Finish the top coat with wooden float, up to 0.3m above floor level on the wall and slope towards spout.

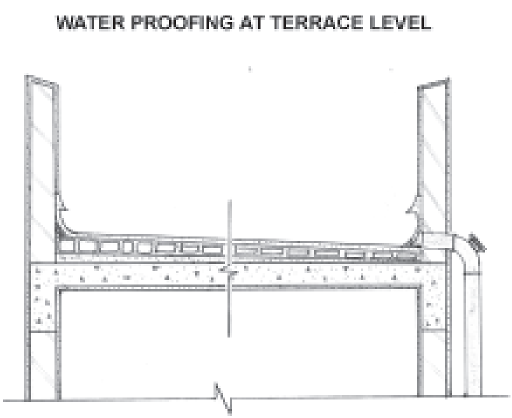
5) Spread the cement paste on top and finish with float.

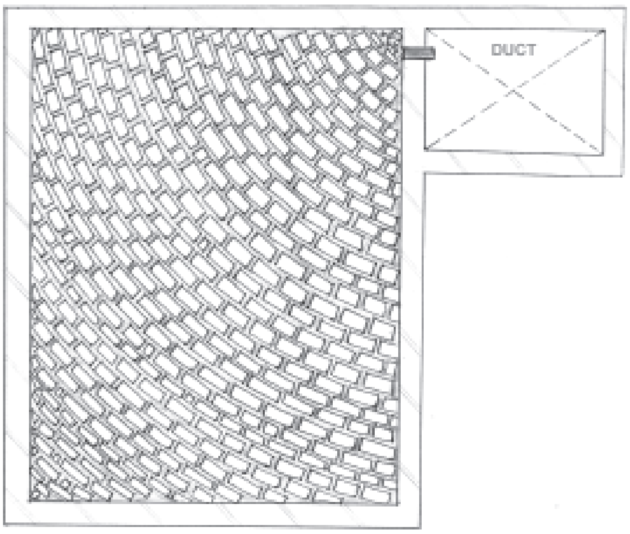
6) Use of dry cement should not be allowed.

7) Mark the lines forming a grid of 0.3m x0.3m with the help of cotton line string of minimum 3mm thickness to avoid cracking of top layers.

8) Check for local depression and footmarks if any and finish the same immediately.

9) Curing should be done for atleast 21 days by ponding.





EXPANSION JOINTS: -

A special waterproofing treatment along with the expansion joint is required for:

1) Vertical expansion joints.

2) Horizontal expansion joints.

A] ***Vertical expansion joints: -*** Bituminous sheets are used at the exposed surface base and accelerator component sealants are used for sealing exterior parts of the joints.

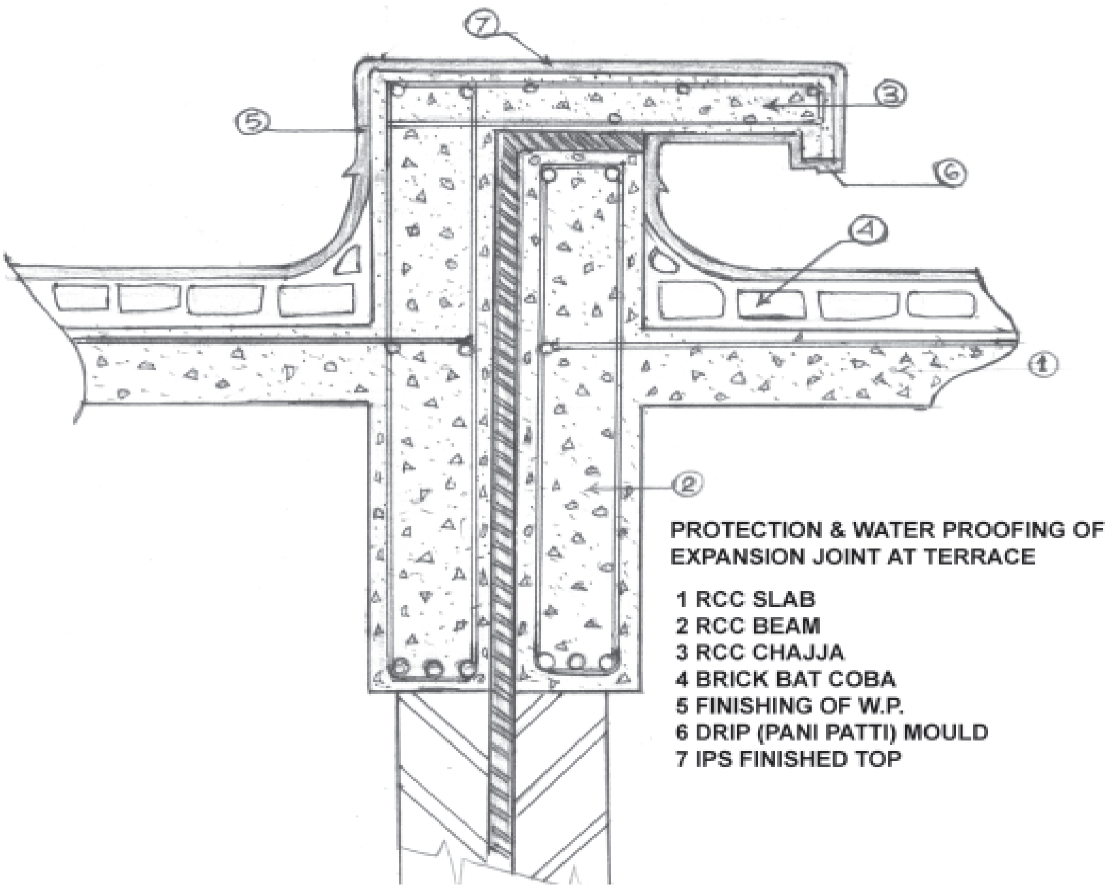
PREREQUISITE: -

1) Clean the joint surface from dust, cement mortar and remove oil and grease, and other residuals if any, from the surface
2) To avoid over filling of sealant, protect the edges of the joint by a masking tape.
3) Work is carried out by suspended scaffolding with various tools.

WORK PROCEDURE: -

1) Apply primer at the joints.
2) Prepare sealant by mixing base and accelerator by weight until homogeneous mix is obtained.
3) Apply this mix is applied with a spatula or hand held gun in required position.
4) All extra material is cut off and removed by putty knife.
5) Remove the masking tape and clean the surface.

1) Horizontal Expansion Joint At Terrace Level: - For horizontal expansion joints at terrace level; care should be taken from R.C.C. stage as shown in figure.



TILING WORK

INTRODUCTION :

Tiling is done, in order to give appearance, durability and elegance to the floors and walls. This is a very important activity and involves precision; as it directly affects the beauty, serviceability and elegance of a house.

TILING BY NATURAL STONES:

Stones are naturally available i.e. these are available in quarries in huge blocks. These blocks are taken out by machineries and brought on shop floor for getting the required shape, size, polish and thickness etc.

The natural stones used for tiling are :-

1)	Shahabad stone	2)	Tandoor stone
3)	Kota stone	4)	Marble stone
5)	Granite stone	6)	Kadappa stone

1) *__Shahabad stone__: -* This stone is preferred where the floor is subjected to heavy pedestrian traffic due to which more wear & tear occurs. It is used for flooring on footpaths/kerbings; parking areas etc. This stone is used for waterproofing also, due to its non-porosity. For a good quality of flooring in shahabad, minimum thickness of shahabad tile should be 40mm. Shahabad tile can be polished as per requirement.

2) *__Tandoor stone__*: - This stone tiling offers a better alternative to shahabad tile. This tiling gives better elegance & durability. This stone is more mouldable than shahabad stone. Both the edges of this stone, when dressed very sharply, are not durable.

3) *__Kota stone__*:- This stone gives a richer look and durability. It does not get affected when dressed and polished. The joints between tiles of this stones can be made very much thin to add to the beauty and durability of the flooring. Kota is easily mouldable than tandoor and gives better appearance. The appearance of Kota flooring goes on improving over a period of time therefore this stone is preferred for tiling in corridors, in public buildings and in staircases.

4) *__Marble stones__*: - There are various types of marble recognized by specific names as per the location of quaries. The properties of the stone vary slightly from quarry to quarry. The durability, porosity, mouldability and consistency of colour, governs the selection of specific types of marble. The rich appearance and the ethnic myths attached to it, is also a key factor while selecting this material.

5) *<u>Granite stone</u>*: - To overcome the limitations of the other stones, another natural stone i.e. granite stone was experimented for flooring & cladding. This stone proved its versatile use for the required purposes. The variety of attractive colours grains, textures, the mouldability, the durability and the excellent look after polishing, are some of the properties, tempting to select this stone for tiling.

6) *<u>Kadappa stone</u>*: - This stone is named as Kadappa as it is available at village Kadappa in Andhra Pradesh. This stone is used for very limited purposes due to its heavy density (dead load). The limited range of colours and increasing brittleness with decreasing thickness restricts the use of this stone. But still, thicker slabs (25 mm to 40 mm) of this stone are properly used for shelves; supports of the cup boards & in kitchen platforms etc.

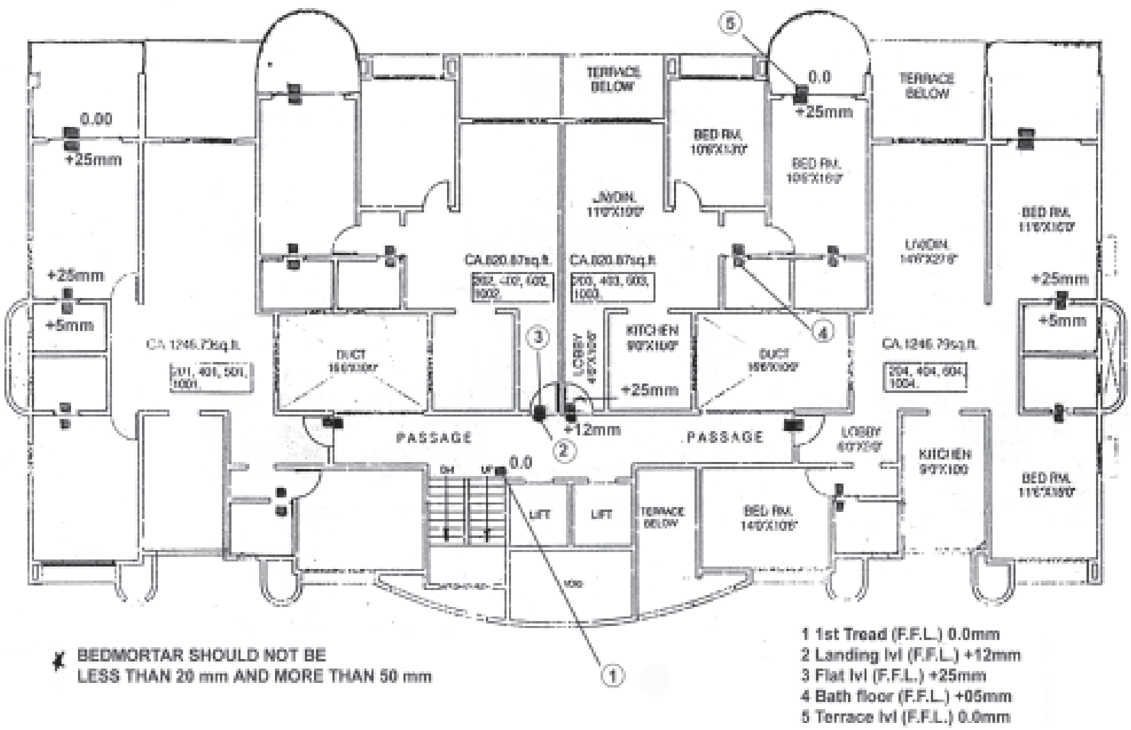
PREPLANNING:

Finalizing The Levels For Various Items: -

1) Finalize the FFL of entrance foyer.
2) Fix level dots near staircase on first floor landing considering mortar thickness of 12mm.
3) Provide 12mm slope for floor landing from main door towards staircase.
4) Keep flooring (inside a flat/shop)12mm above the floor landing.
5) Maintain floor levels for all flats on one landing at same level.
6) Mark the levels of all the successive floor landings considering the level on the earliest floor landing as the datum. (Near the staircase).
7) This process helps in finalizing the levels of various items such as plumbing, electrical etc.

Refer Sketch: -

FINALISING LEVELS FOR TILING WORK



PROCEDURE FOR FIXING OF NATURAL STONE:

1) As per the requirement, the natural stones are dressed and brought to the required size and shape by using template, farma etc.
2) The sides of the stone are chiseled and dressed to obtain minimum thickness of joints and to maintain proper levels.
3) The procedure for mixing mortar and fixing the tiles with respect to various desired levels is common for all material used for flooring. The necessary change in the procedure can be made as per the peculiarity of the stone adhering to the engineering norms. General common procedure is given subsequently.

METHOD OF POLISHING FOR NATURAL STONE:

1) Polishing work should be done only after proper curing period is over.
2) Ensure that the surface is cleaned properly. Masking is done to all walls and door shutters to a height of 60cm from the floor.
3) Carry out the polishing work by using stones as follows: -

a) First coat Stone no. 60
b) Second coat Stone no 120
c) Third coat Stone no 320
d) Fourth coat– Stone no 600

Grouting is done in between first and second coat of polishing work. Take necessary precautions to avoid damages to the polished surface. Plan the succeeding activities accordingly.

ARTIFICAL FLOORING:

1) Ceramic/ glazed floor tiles.
2) Vitrified flooring tiles.
3) Wooden flooring.
4) PVC flooring.

All the above artificial tiles are man made and are available in various sizes, shapes and colours. They are widely used as flooring tiles. Some of the advantages of using these flooring materials are speedy work, clean job and aesthetically good look.

PROCEDURE FOR FIXING OF FLOORING:

1) Before starting the tiling work, all surfaces shall be cleaned for excessive mortar.
2) Clear margin for skirting shall be maintained in bedding mortar thickness.
3) Confirm the flooring layout and changes if any..
4) The various F.F.L's shall be decided and marked accordingly in the respective areas such as landings at entrance, attached terraces, all the toilets etc. The required slopes, wherever necessary, shall be decided

beforehand. The mortar thickness shall also be maintained between 20 to 50 mm while deciding the levels and slopes.

5) Flooring tiles shall be sorted for size and colour.

6) Tiles should be soaked for atleast 2 hours before fixing or as specified by manufacturer..

7) Cement and sand mortar is prepared in required proportion of 1:6 for bedding.

8) Make the level dots on all four corners of the room and tie a string atleast 150 mm away from the walls and check the diagonals.

9) After finalizing all level dots and diagonals, start with the bedding work. The bedding should be properly compacted and levelled.

10) The bedding process should be revised as per the thickness of the flooring material.

11) Prepare cement slurry of approximately 1.5 bags in 100 liters of water.

12) Spread the cement slurry on the mortar bed as and when the tile fixing progresses.
By tamping gently with wooden mallet, ensure all corners of tiles are in level.

13) Bedding material between the joints should be cleaned with brush before it dries.

14) Unless and otherwise specified, use spacers in the joints.

15) Tiles and joints should be cleaned with water.

16) The joints shall be filled using tile joint filler on the next day.

17) Curing shall be carried on atleast for 7 days.

18) Fixing of skirting should be done only after curing period is over.
In case of natural stones flooring, polishing work is done after proper curing.

19) Soak the masonry at the skirting level before skirting is fixed.

20) Skirting should be fixed in line, level and plumb.

21) Ensure that, no voids are left between the skirting and walls.

22) Match the skirting joints with the joints of flooring.

23) Fix the skirting, using mortar proportion 1:1.

WALL CLADDING:

Wall cladding work should be carried out after completion of waterproofing, concealed plumbing and electrical work is completed. Confirm changes if any, confirm the pattern also.

1) Tiles shall be sorted out for size, shape & colour.

2) Tiles shall be soaked in water atleast for two hours or as specified by manufacturer..

3) The verticality and right angles of the walls shall be checked.

4) The wall shall be wetted with water.

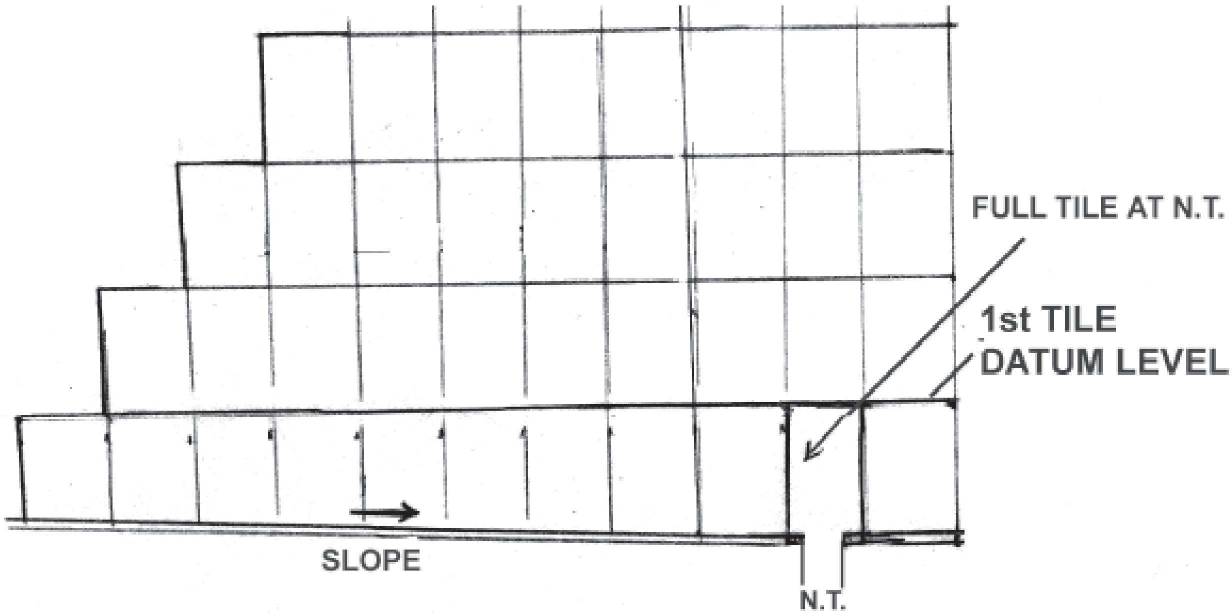
5) The dots shall be marked for plumb and right angle.

6) Cement sand mortar shall be prepared in 1:1 proportion.

7) The bottom of the cladding tile shall be decided, confirming the full tile at nahani trap (Excluding the margin of floor tiles).

8) Mortar thickness shall not exceed 20mm.

9) Fixing of tile shall start from bottom to top in layers.



DADO WORK OF BATH : FULL HEIGHT TILE AT NAHANI TRAP

10) The verticality of tiled surface and right angles at corners are to be checked.

11) The vertical and horizontal joints shall be matched during the work.

12) Tile joints shall be raked at the end of the same day & the joints shall be filled by joint filler on the next day.

13) While fixing each tile, see that the mortar covers the full tile area and no voids are left behind.

14) All openings for electrical and plumbing points shall be provided simultaneously & precisely.

15) Curing shall be done atleast for 7 days.

BATHROOM/TOILET FLOORING:

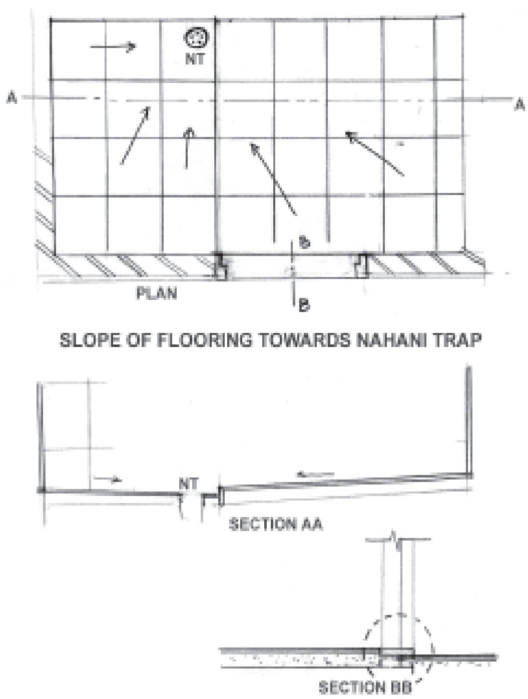
1) Bathroom floor tile work shall be started after fixing of room flooring, bath dado / fixing orrisa pan, is completed.

2) Levels shall be marked properly for drops and slopes to be given towards nahani trap.

3) Procedure for preparation of sub base remains same as per tile flooring

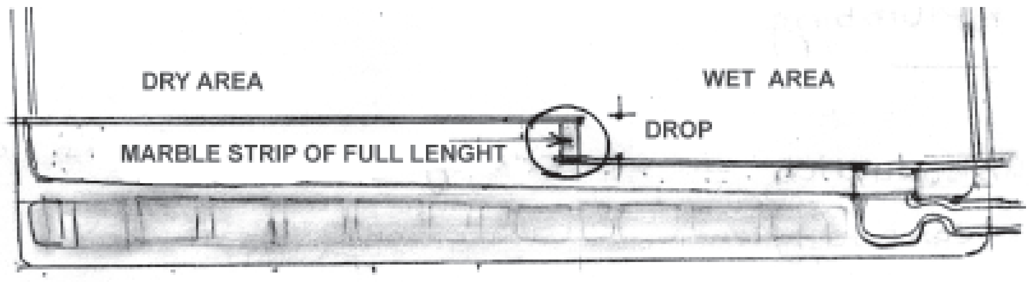
4) The dado tiles shall rest on floor tiles at all junctions of floor & dado.

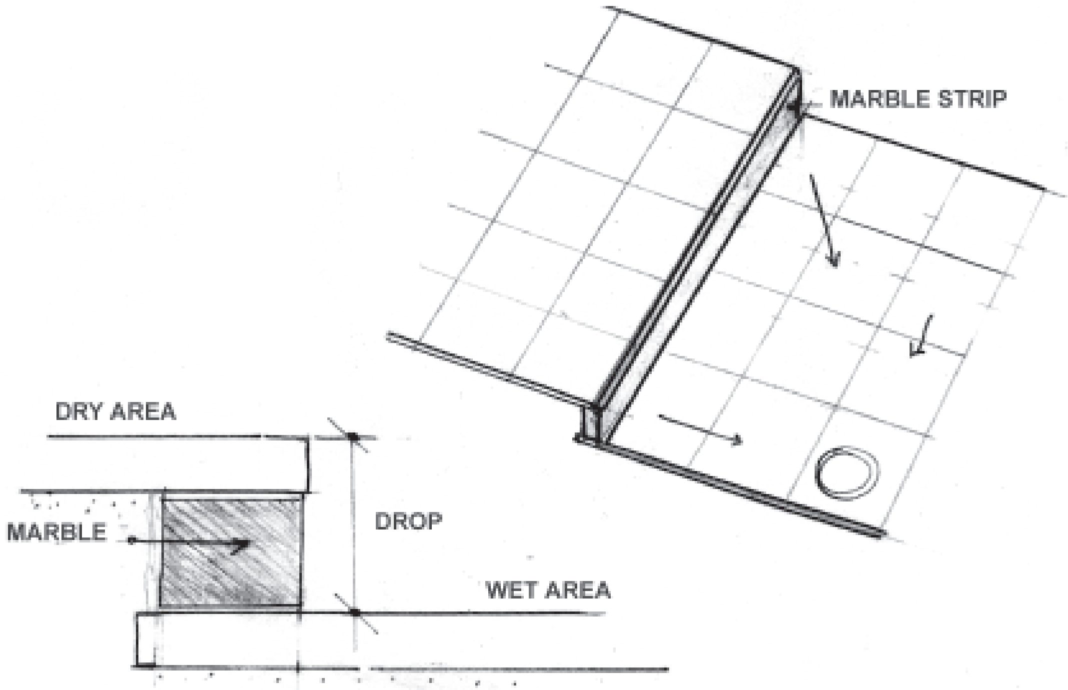
5) All openings for nahani trap and commode shall be made precisely on the same day, using cutter machine necessarily.



6) Tile joints should be racked at the end of the same day and joints shall be filled with joint filer on the next day.

7) Curing shall be done atleast for 7 days.





DETAILS AT DROP

WINDOW SILLS AND THRESHOLDS:

A] Fixing Of Window Sills: -

1) Window sills shall be fixed after completion of window work.

2) Before fixing the sills, Adhesive and fine sand shall be applied at the bottom of window sill material for proper bonding.

3) The portion, where sill is to be fixed, shall be cleaned and wetted with water. The window frame surface shall be masked.

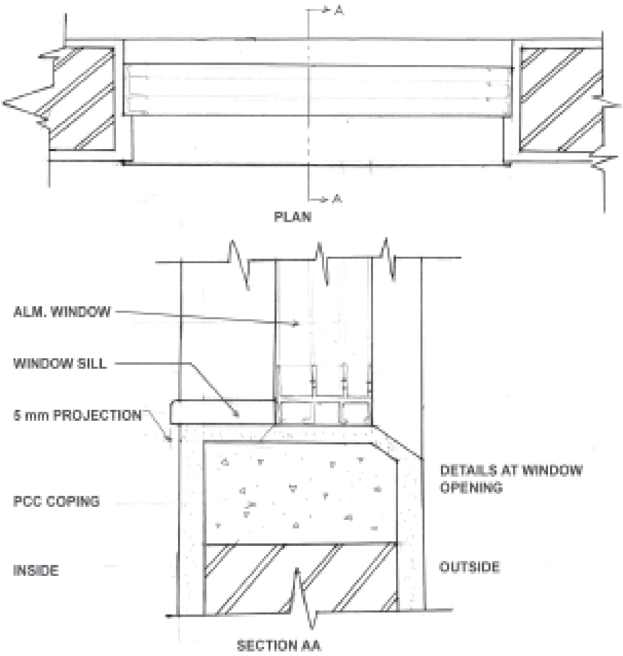
4) Sand mortar shall be prepared in the C.M.1:4.

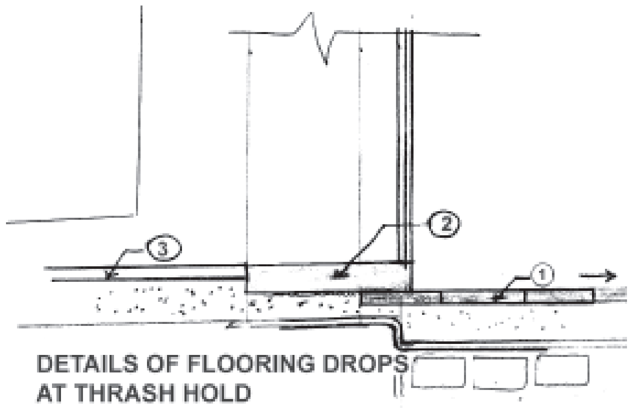
5) Window sill shall be fixed in line and level. Keep 12 mm bearing in the walls on both the sides and projecting out up to 5 mm from the finished surface of wall.

6) The adjoining plaster surface and window frame shall be cleaned properly.

7) The window sill shall be finished with C.M. 1:4. The plaster shall be matched with old plaster in line and plumb.

8) Curing shall be done atleast for 7 days.





DETAILS OF FLOORING DROPS AT THRASH HOLD

1 FLOORING OF TOILET
2 THRASH HOLD
3 FLOORING OF ROOM

B] FIXING OF THRESHOLDS (UMBRA PATTI) :-

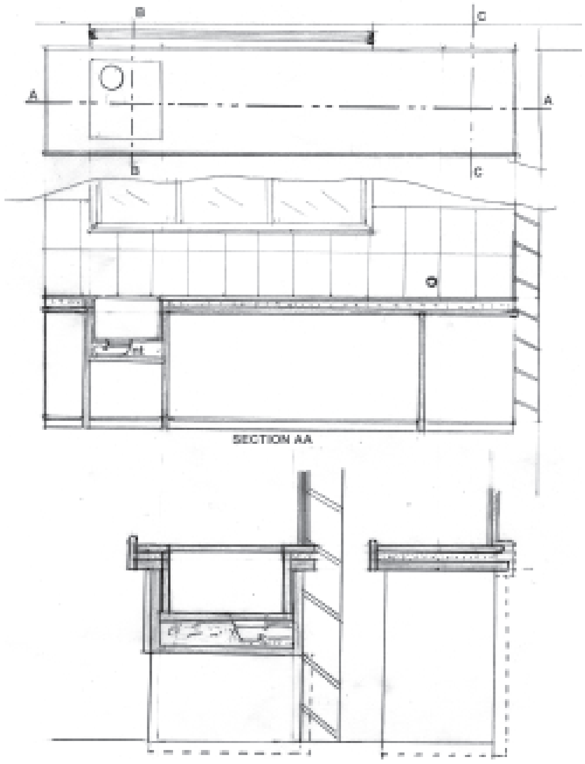
1) Thresholds (umbra Patti) are usually provided for main doors, toilet doors, terraces & balconies.
2) Umbra Patti shall be fixed in C.M. 1:4 and in cement slurry in proper line and level.
3) The umbra Patti for toilet and terrace/ balcony shall overlap the floor tile of toilet, terrace/ balconies.
4) Curing shall be done atleast for 7 days.

KITCHEN PLATFORM :-

Kitchen platform work shall be started after flooring work is completed. Changes shall be confirmed before starting the work. Usually height of the kitchen platform shall be kept 800 mm from the F.F.L.

PROCEDURE: -

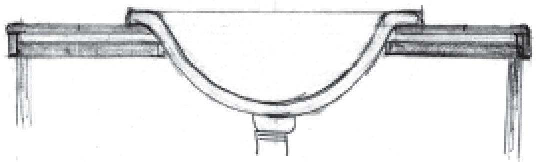
1) The position of vertical and horizontal supports shall be marked on the wall.
2) The marked portion shall be chiseled for sufficient bearings in the wall, using cutter machine necessarily.
3) The verticals shall be fixed in line, level and plumb.
4) Place the sub base of the bottom of the sink, sub base of the kitchen platform shall be fixed on the vertical supports in line and level.
5) The nahani trap shall be fixed at the sink bottom & seal the hole of the outlet in wall, in rich cement mortar.



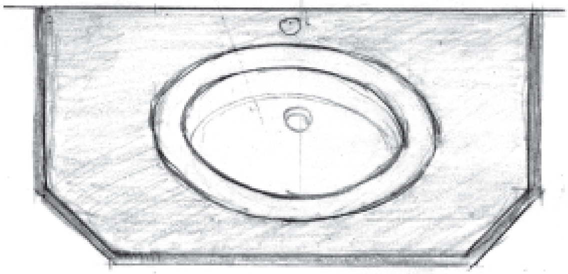
6) The bottom and sides of the sink shall be fixed with the slope of the bottom, towards nahani trap.
7) The sink bottom shall be finished with waterproofing & with proper slope towards nahani trap.
8) Cement mortar of 1:6 shall be laid on sub base with proper slope towards sink.
9) The top stone shall be fixed with cement slurry.
10) Facia shall be fixed, 6 mm above top of platform, on the higher end and in level. Clits (washer) shall be used for anchoring between facia & Kitchen otta.
11) A slot shall be kept at decided position for gas pipe outlet.
12) Proper care shall be taken while fixing the sink.
13) All the joints shall be filed with joint filler.
14) The kitchen platform shall be cleaned properly.
15) All edges of the top shall be rounded off and polished.
16) Curing shall be done atleast for 7 days.
17) Top of kitchen platform shall be masked before fixing kitchen dado.

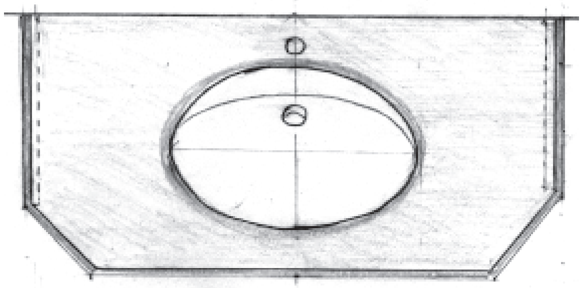
COUNTER BASIN: -

1) Procedure for fixing counter basin (i.e. under counter / over counter) is similar to the procedure of fixing of kitchen platform.
2) Precautions shall be taken for cutting holes in sub base and top and for pillar cock/basin mixer.

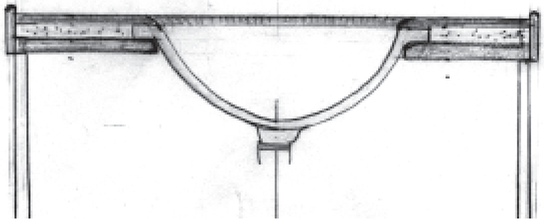


RIM ON TOP COUNTER





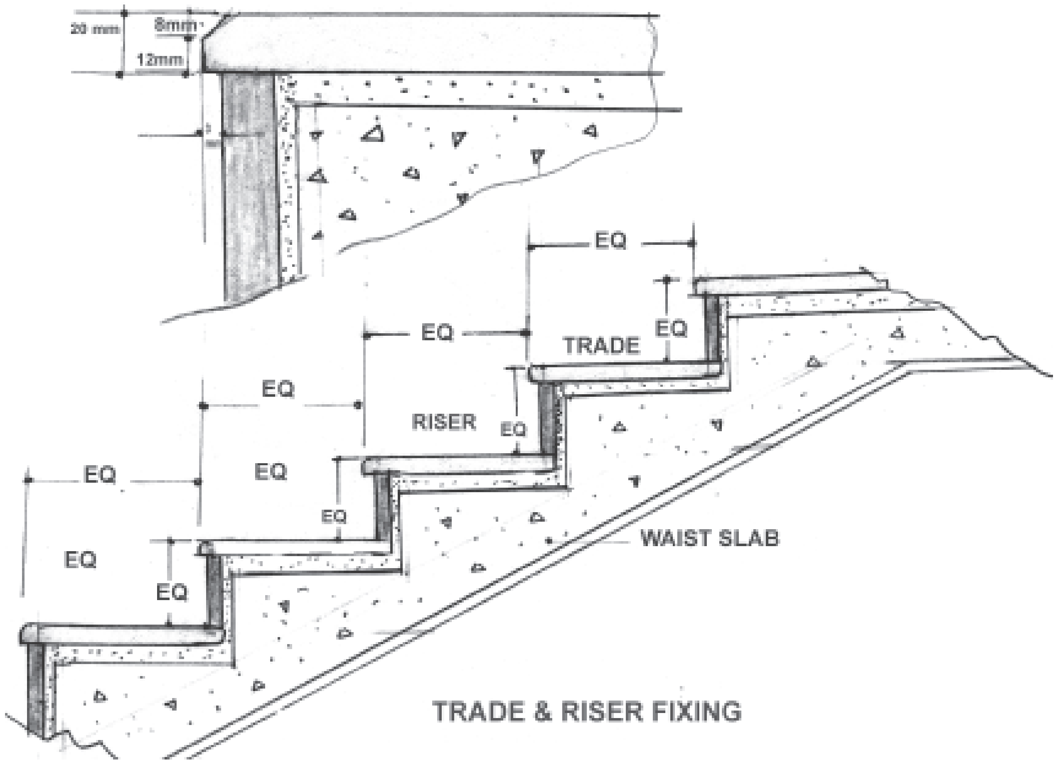
RIM BELOW COUNTER



3) Edge of top is to be polished & rounded up matching to the shape & edge of under counter basin.

TREADS & RISERS: -

TRADE WITH NOSING



TRADE & RISER FIXING

Treads and risers shall be fixed only after all plaster work in the staircase is completed.

1) All the RCC treads and risers shall be properly cleaned for excessive mortar.

2) The height of risers shall be calculated considering the finalized flooring level of successive floor landings

& the thickness of the tread stock.

3) Height of each riser between successive floors shall be equal.

4) Treads shall be dressed for uniform thickness.

5) Nosing of 5mm shall be provided for treads. Sharp edges of the tread shall be chamfered & polished.

6) The first riser shall be fixed using C.M. 1:4, Follow the same procedure for all above steps in staircase.

7) The use of staircase shall be avoided atleast for 24 hours after fixing the tiles.

8) All the joints shall be cleaned and filled with the joint filler.

9) Curing shall be done atleast for 7 days.

DOORS AND WINDOWS

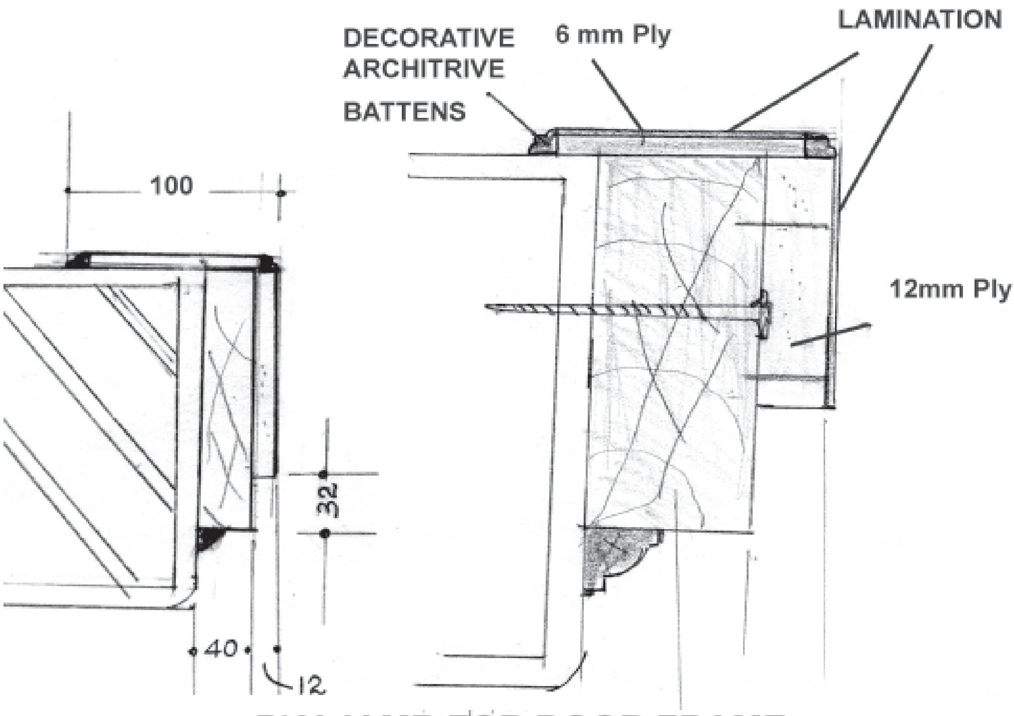
INTRODUCTION :

Doors are necessary for access, safety and privacy whereas windows are provided for light and ventilation and add to aesthetic view of the building.

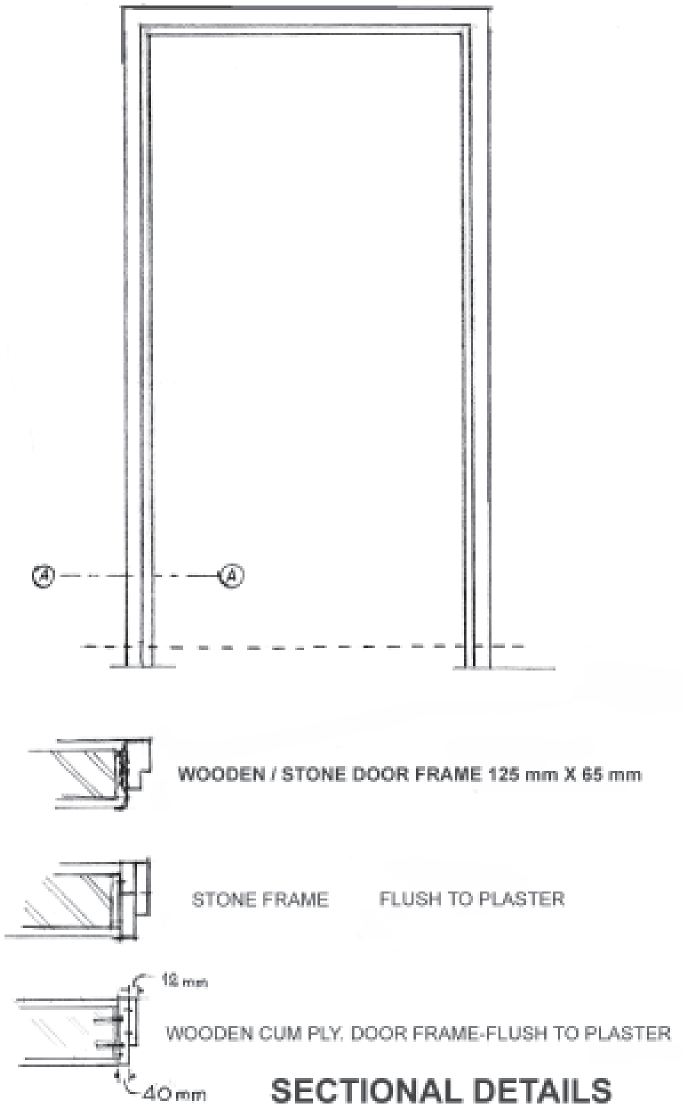
DOOR FRAMES

Door frames are required for the proper fixity and hinge action of the shutter. Door frames contribute sturdiness and safety to the door opening. The frame also helps in making the locking arrangement.
Since the serviceability of the shutter depends on the straightness & verticality of the frame, maximum care shall be taken while selecting the material for the frame. Usually seasoned teakwood frames are preferred because of versatile properties of wood. But to safeguard the environmental interest & cost, other material like mild steel or natural stones are preferred in this era.
While selecting the material for doorframe; following qualities shall be governed: -

1. The sturdiness of the frame through selecting proper cross-section and thickness (in case of sheet metal).
2. The serviceability of the shutter is satisfactory if the member of the frame is straight & free from faults.
3. The dead load of the frame shall not be excessive so as to hamper the verticality (plumb) and right angle of the frame.
4. Overall durability, ease in painting and maintenance shall also be considered.



PLY JAMB FOR DOOR FRAME
165 mm X 40 mm FRAME



TYPES OF DOOR SHUTTERS: -

1) Wooden panel shutter.
2) Wooden flush shutter
3) PVC flush shutter
4) M.S. shutter

1) Wooden Panelled door shutters:

These are generally used for entrance doors. These are moulded and decorative door shutters. Various types of designs can be made in panels.

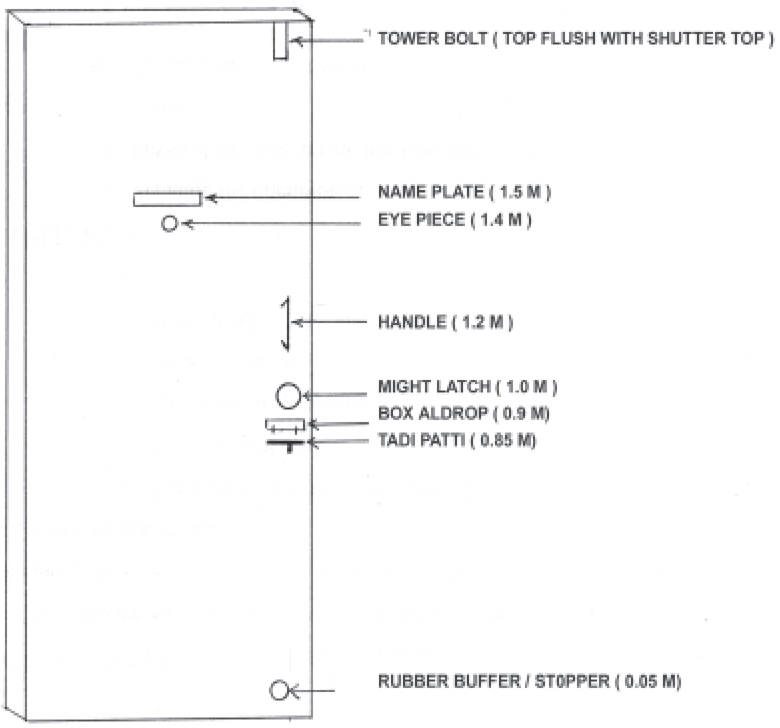
2) Wooden Flush Doors:

These are most commonly used in building construction. These are available in various standard sizes.

FIXING OF DOOR SHUTTER:

1) Check the opening of doorframe for size, plumb and direction of shutter opening.
2) Fix the lipping patti / bidding Patti, 12mm thick on all four sides of shutter using fevicol and panel pins to protect the shutter.
3) Make the slots for hinges at pre-designed location.
4) Fix the door shutter using screw with appropriate hinges. Maintain a uniform tolerance of 3 mm between the shutter & door frame on all sides.
5) Fix all the fixtures as per the standard height given below.

Sr.No.	Name Of Fitting	Standard Height From FFL
1.	Night Latch/Mortice lock	1.0 M
2.	Aldrop	0.9 M
3.	Handle	1.2 M
4.	Door Stopper	As per the height of the leg of stopper
5.	Eye piece	1.4 M
6.	Tadi Patti	0.85 M
7.	Tower Bolt	Top flush to top of shutter
8.	Name Plate	1.5 M
9.	Rubber Gattu	0.05 M



PRESCRIBED HEIGHTS OF FIXTURES ON A DOOR SHUTTER FROM F.F.L.

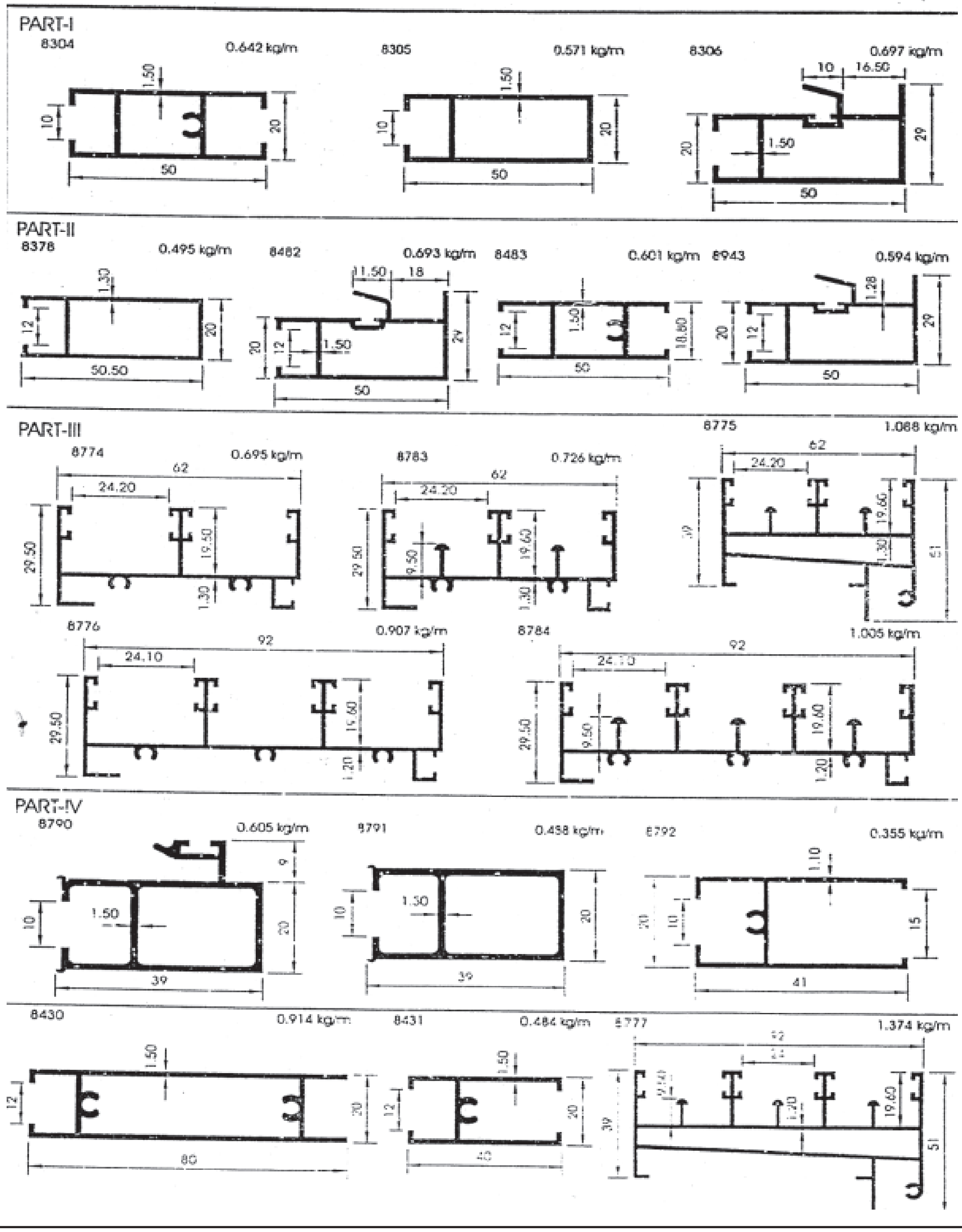
ALUMINIMUM SLIDDING WINDOWS AND DOORS:

Now a days, use of aluminum window is a standard practice. These windows are durable, light in weight, easy to handle and easy to maintain. These windows give elegant appearance to the building and a non-obstructive view.

MATERIAL SPECIFICATION CHART :

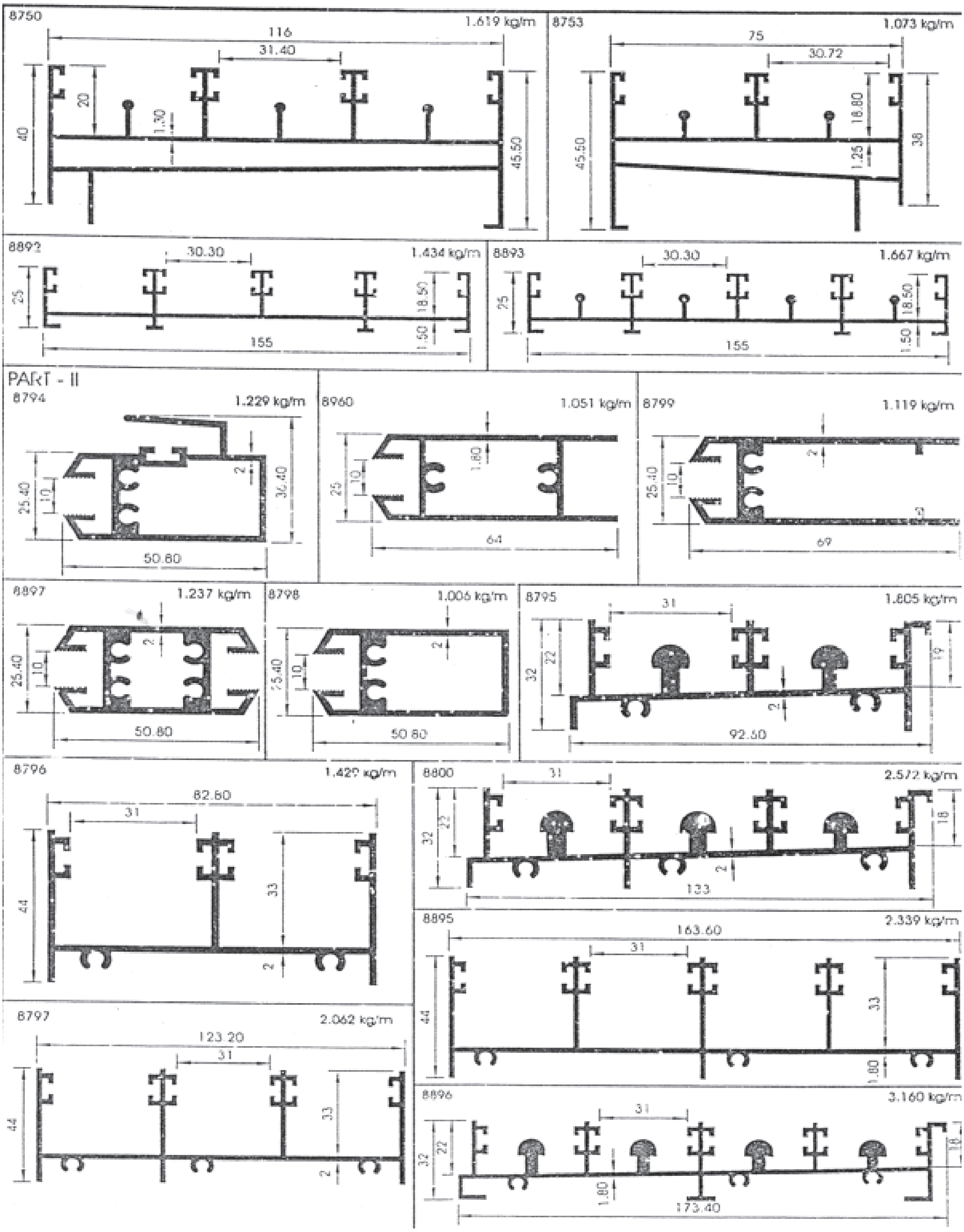
DETAILS OF SLIDING WINDOW SECTIONS

SHUTTER SECTION-20 mm.



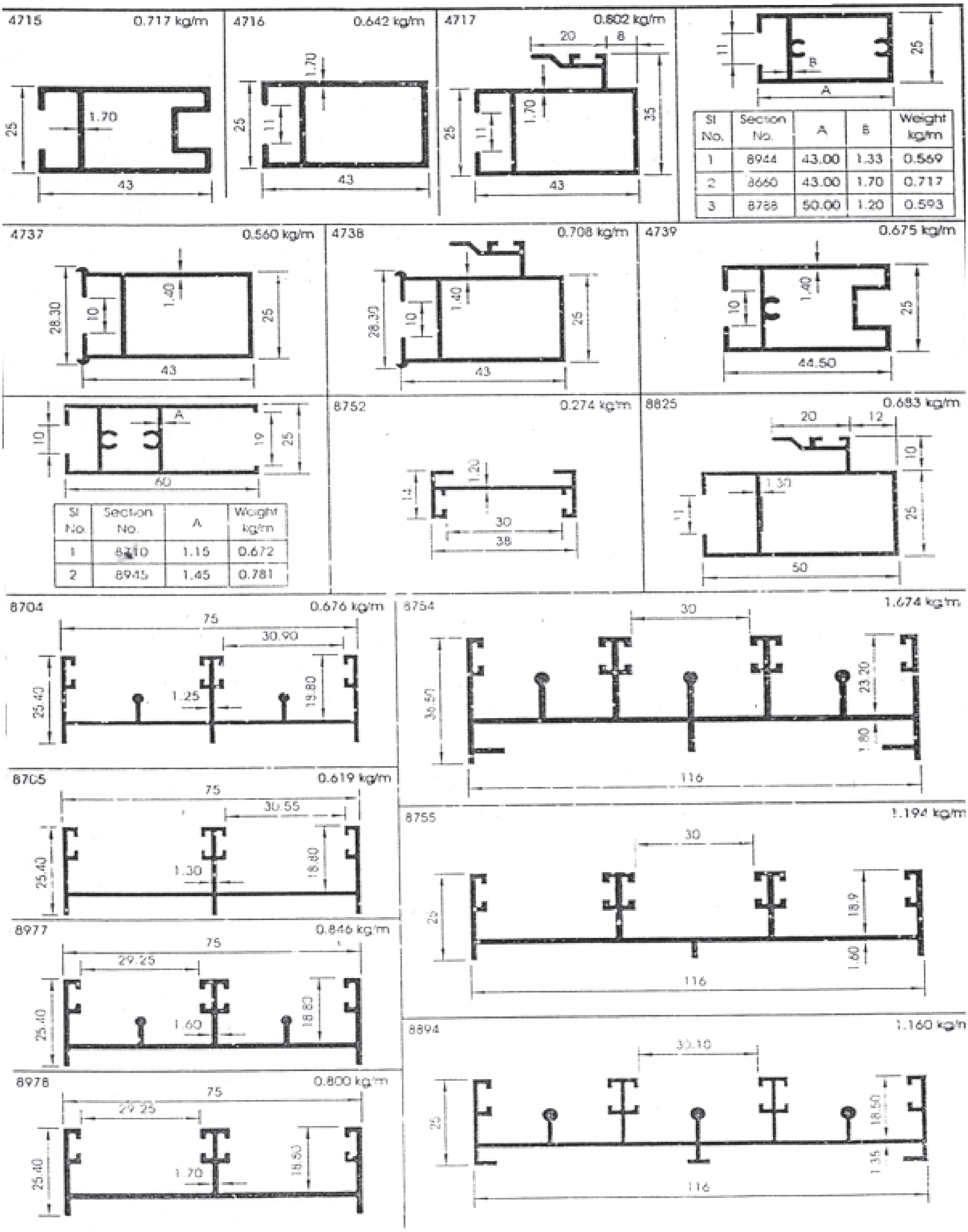
DETAILS OF SLIDING WINDOW SECTIONS

SHUTTER SECTION-25 mm



DETAILS OF SLIDING WINDOW SECTIONS

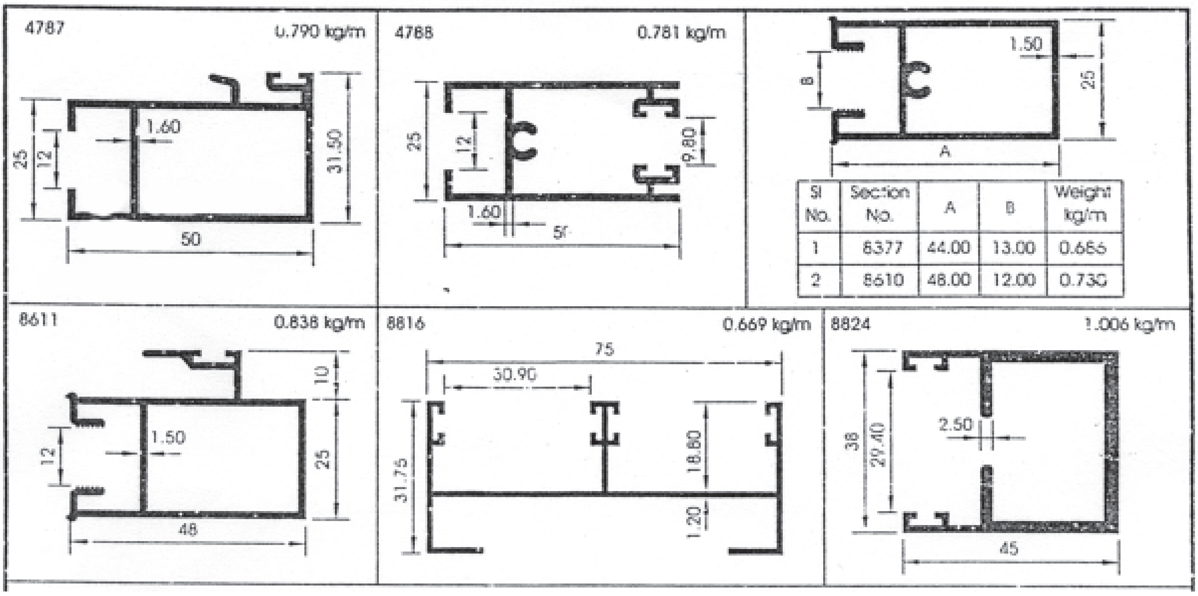
SHUTTER SECTION-25 mm.



Sl No.	Section No.	A	B	Weight kg/m
1	8944	43.00	1.33	0.569
2	8660	43.00	1.70	0.717
3	8788	50.00	1.20	0.593

Sl No.	Section No.	A	Weight kg/m
1	8710	1.15	0.672
2	8945	1.45	0.781

DETAILS OF SLIDING WINDOW SECTIONS
SHUTTER SECTION-25 mm.



Sl No.	Section No.	A	B	Weight kg/m
1	8377	44.00	13.00	0.686
2	8610	48.00	12.00	0.730

WORK PROCEDURE:

1) Check the measurements, right angle & Diagonals of the window opening. Rectify the opening to the desired dimensions if required
2) Check the specifications and weight range of aluminum sections.
3) All aluminum sections should be in right angle and plumb
4) Fix the aluminum frames along with shutters with anodized/power-coated screws at every 30cm in staggered pattern.
5) Fix the locks on the shutters.
6) Check weather wool piles and rubber gaskets are properly fixed for full length of frames & shutters respectively.
7) Check for proper locking arrangement.
8) Check weather drain holes are flush with bottom rail.
9) Check weather the glasses are bubble free.
10) Check weather rubber bushes are provided to sides of shutters.
11) Check for swift sliding movement of the shutters.
12) Gap between plaster and aluminum frames should be filled with silicon sealant.
13) Clean the track with blowers.

PRECAUTIONS:

1) Use rubber/wooden malate for fixing frames and shutters.
2) Periodical cleaning of tracks is necessary to avoid damage to roller bearing.
3) Do not clean the aluminum section with any hard material having sharp edges.

FABRICATION WORK

INTRODUCTION:

Fabrication is an activity involved in construction work to facilitate safety, security, convenience and it adds to beauty. Most of the times, M.S. fabrication is done at a later stage of the work, but the required supportive structures in RCC work, is done earlier. Therefore variety of inserts, provision for hinges etc is required to be done during RCC work.

Fabrication work includes: -

- Staircase Railings.
- Balcony railings.
- Safety grills and doors.
- Miscellaneous works
- Entrance gates, etc.

Various types of M.S. materials used for fabrication works are: -

- Round bars
- Square bars
- Flats
- Tubes
- Z-sections
- T-sections
- Muliums
- Angles
- H-beams
- I-sections
- Channels
- Weld mesh
- Chain link
- Many other composite materials.

The temporary electrical connections given at site should be proper and not hanging. All the machinery and the job should be earthed properly before starting the work to avoid accidents.

PROCEDURE FOR FIXING WINDOW GRILLS/RAILINGS

i) It should be as per drawings and specification.

ii) Material should be as per standard quantity and weight range.

iii) Correct measurement for grills/railings should be taken at site.

iv) Check all diagonals and dimensions of the window grills. In case of railings, the vertical legs of M.S.

railing should be welded to inserts provided in the R.C.C. pardi.

v) Check that the joints are welded properly.

vi) Check that all the joints are smoothly grinded.

vii) Check for proper anchoring/fixing arrangement.

viii) Scrap the entire surface of the grill/railing for rusting, skull etc if any.

ix) A protective coat of red lead oil paint and a coat of oil paint of approved shade should be applied before fixing grill/railing.

x) Fabricated jobs should be handled carefully while transporting and erecting at places for avoiding the damages to the other completed works.

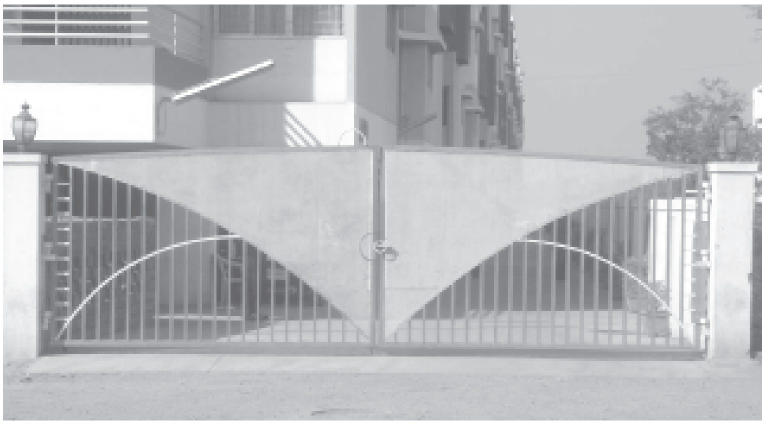
xi) Grills/railings should be fixed at places with proper anchoring bolts/screws using plastic rawal plugs.

xii) Check the line level and plumb.

xiii) Final coat of approved shape should be applied later on.

GENERAL POINTS :-

- The temporary electrical supply given for fabrication at site shall be given through proper fitting and fixtures.
- Hanging wires at various places shall be avoided.
- Earthing should be provided to the job during fabrication at site.
- Heavy structural members should be handled only by proper material handling equipment.



ELECTRICAL WORKS

INTRODUCTION:

In the modern civilization, houses without television, computer, radio or refrigerator are the exceptions. It is nonetheless true that the average consumer has at best; a very sketchy idea of what he is paying for each time his electricity bill falls due.

For a civil engineer, in building construction it is very important to have fundamental knowledge of electrical work involved.

ROLE OF ELECTRICAL CONSULTANT

Electricity plays a vital role in all the services provided to a house but it is also very dangerous if not handled properly. **Therefore all the electrical works should be carried out under the guidance of competent electrical consultant.**

Following are the duties and responsibilities of an electrical consultant.

1) To study the building layout, for electrical design prepared by Architect.
2) To prepare the layouts and preliminary estimates of the electrical work in co-ordination with architects and developers.
3) To obtain a temporary electrical supply.
4) To visit the site for confirming the available resources of electricity .
5) To calculate the electrical load required for the project and get it sanctioned.
6) To prepare the following layouts.

Development layouts :-

- i) Location of substation and transformer
- ii) Location of feeder pillar
- iii) Location of meter room
- iv) Underground ducting layouts
- v) Layouts of temporary service lines
- vi) Location of D.G. sets
- vii) Layouts of electricity supply and distribution for clubhouse & different amenities.

Internal layout :-

- i) Layout of cables for mains, T.V. & telephone.
- ii) Layout of electrical points.
- iii) Layout of slab conduiting.
- iv) Layout of drooping on walls.
- v) Layout of switchboard & light points.

7) To Finalize the specification & detailed estimates.

8) To make necessary planning for the actual work at the site.

9) To test & confirm the material received at site as per specification & norms

10) Supervision & periodic inspection of work as & when required.

OBTAINING ELECTRICAL CONNECTION (CONSTRUCTION METER)

Depending upon the nature of use of the electricity, the electricity companies levy different tariffs. The temporary connections given for a project during construction are charged at higher tariff rates.

The temporary electricity connection (construction meter) is obtained from the authority. The necessary documents and procedure is described later on.

Before commencing a project, availability of electricity at the site is a basic requirement. Therefore considering the minimum load of construction machineries supply of electricity shall be made available from proper authority

LAISONING WITH ELECTRICITY BOARD:

For every new electrical connection, electricity board has laid down certain norms and procedures. Depending upon the nature of use, various categories have been made by the electricity board. Initially, starting with new construction on vacant plot, following procedure is adopted.

OBTAINING CONSTRUCTION METER (TEMPORARY)

a) Documents required are :-

  1) 3 sets of sanctioned building drawings.

  2) Load calculations.

  3) Extract of the Property card of the land.

  4) 7/12 extract of the land.

  5) Demand letter from the developer.

  6) A1 form & undertaking on stamp paper by the Developer.

b) Submission of 3 sets of all above drawings and documents to electricity board's division office.

c) Arrange for site visit of A.E and J.E from subdivision office.

d) Preparation of lease deed for land, needed for substation with electricity board.

e) After getting approval from the division office, subdivision will issue the construction meter.

f) Finalize the location for fixing the construction meter and get the connection from subdivision office.

LOAD SANCTIONING PROCESS:

Subdivision office gives details of available load and rough estimate of transformer capacity. Division office will make necessary changes as per the rules of electricity board and prevailing site situations.

The division office further informs the zonal office about the demand of the load. Zonal office estimates the total expenditure for the desired load. The developer has to pay 15 % amount of the estimate as the supervision charge to the electricity board. The C.E then issues the sanction letter for the total load. After paying 15% supervision charges to electricity board; Developer will approach construction division of the electricity board with sanction letter & receipt of supervision charges.

Then construction division officers visit the site and order licensed contractor to start the work as per the estimates and specification of load sanctioned letter. Builder/ contractor will procure the transformer, H.T. cables, L.T. cables, main feeder pillars, sub feeder pillars, lugs, hardware etc.

All civil work construction of transformer room trenches inside the room, location of transformer, earthing pits, O.S.F, feeder pillars etc will be completed as per the contract and electricity board's instruction.
Project engineer should check all electrical equipment and material as per specifications.

After completion of all electrical and civil work, the transformer is ready for charging. Construction division will issue a call letter to electrical inspector (P.W.D.). He will inspect the site for the following compliances

a) Necessary permission for any structure, higher than 15 meter in height.
b) Provision made for warning alarms against fire etc.
c) Provision for lightning arrestor system wherever required.
d) Checking the electrical installations for proper connections and safety.

The electrical inspector issues the permission letter for charging the transformer / generator to construction division of electricity board, after confirming all above norms.
The executive engineer of the construction division issues the instruction to charge the transformer. Then the transformer is charged.

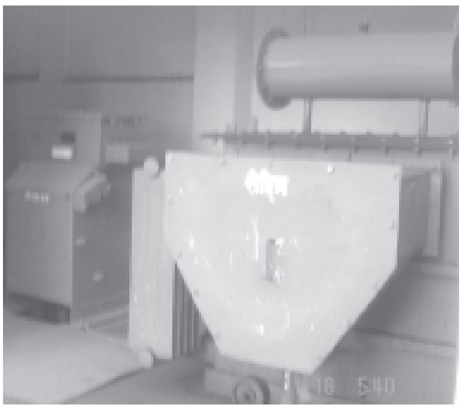
For getting the individual unit connections, the subdivision office prepares the quotations of the cost. After paying this quotation cost, the individual connections are sanctioned. Individual meters shall be fixed with proper earthing.

A) COVERED TRANSFORMER ROOM:

Transformer room is a place provided to accommodate transformer, O.S.F. and main feeder pillar to ensure its security and safety. Size of transformer room: -

1) For single transformer – 6m x 8m
2) For two transformer – 6m x 11m

The room should have clear and proper access, and proper ventilation. All trenches are provided with non-flammable covers. It should be well equipped with fire fighting equipment.



Transformer: - Transformer is a device which steps up/ steps down the voltages from the incoming source in a safe manner. There are two types of transformers dry & oil filled type. When transformer is provided in basement, Dry type transformer is mandatory.

Transformers are available in following ratings:

Sr No.	Capacity in KVA	Length in mm	Width in mm	Height in mm	Weight in Kg
1.	500	2050	2250	2350	2300
2.	630	2500	2350	2450	2750
3.	750	2500	2450	2450	3000
4.	1000	2550	2700	2550	3500
5.	1250	3000	2700	2650	4150
6.	1600	3050	2750	2650	4800
7.	2000	3200	3250	3050	5800

O.S.F. (oil switch fuse): - The function of O.S.F. or S.F.U. is to provide a cut off and protection for transformer. They are available in following ranges: -

1) 11 KVA
2) 22 KVA

Main Feeder Pillar With ACB: - M.F.P distributes the electrical load through the terminals. It has one incoming terminal and remaining are outgoing terminals, through H.R.C. fuse. Air circuit breaker cuts-off the supply, in case of failure of the other circuit breaker.

R.M.U. (Ring Main Unit): - R.M.U. works as a change over switch for two high-tension supply lines of which one is taken as a **standby.**

Meter Room: - Meter room is a place, which accommodates the electrical meters, with the necessary distributions made through bus bar. Meter room should be easily accessible and safe. It should have proper ventilation and lighting. It should be always locked to avoid mishaps. It should be planned for easy movement of atleast one person.

Earthing: - Earthing is a circuit, which provides the connection between leaking electrical current and mass of earth. It is a safety measure to avoid mishaps due to leakage of current. The types of earthing depend on the resistance of the soil and required safety level of the device to be earthed. The recommended earthing resistance values are as follows:-

1) Phase to earth – 25 ohms
2) Phase to neutral – 15 ohms
3) Phase to phase – 15 ohms
4) Earth – 0.5 ohms

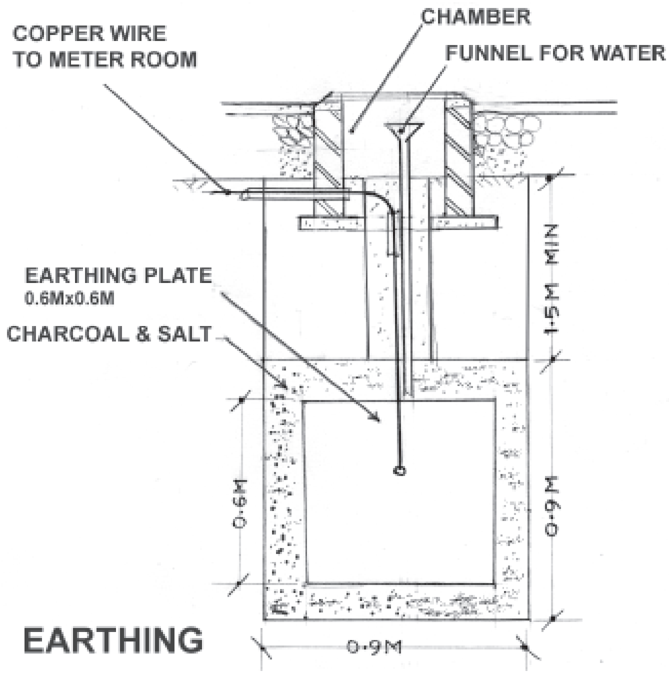
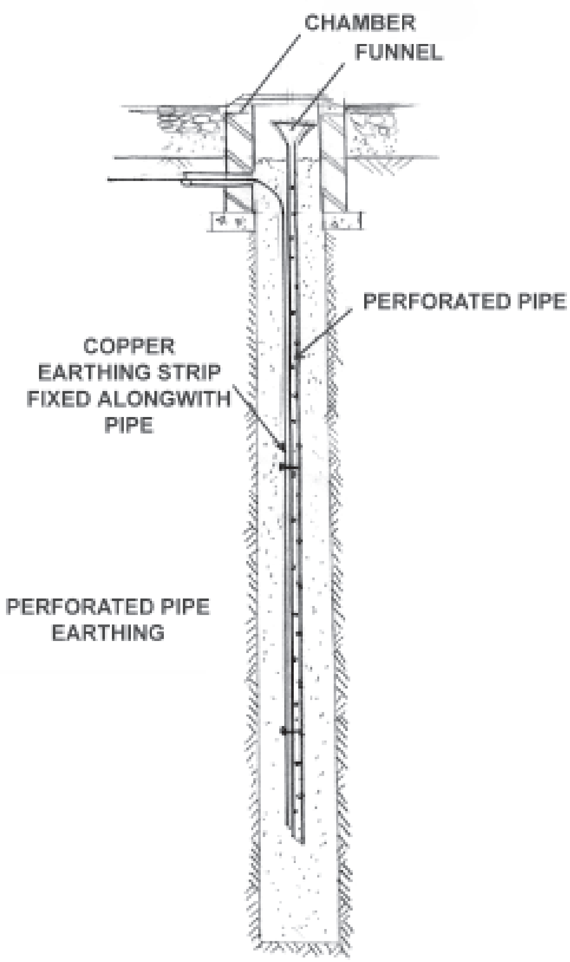


Plate type earthing



Pipe earthing

To get this safer limits of earthing, suitable type of earthing is chosen. A standard G.I. plate/ Cu plate type earthing is recommended for soil having good conductivity.

Minimum earthing points: -

Sr no.	Description	Minimum earth points
1	Transformer	8 Nos.
2	Meter room	3 Nos.
3	Lift	2 Nos.
4	Generator	4 Nos.

Bus Bar: - The Busbar is a distribution box with copper strips and H.R.C. fuse (High Rupture capacity fuse). From the feeder pillar, main supply is provided to bus bar. Required tapings are provided to electrical meters. Proper earthing is necessary for bus bar. Different capacities of busbar are 100 A, 200A & 400A.

Under ground Cable Network (Ducting): - After finalizing the locations of the substation, L.T. feeder pillar, meter rooms, generators, pump house, street lighting, the underground cabling network plan is to be finalized.

Following points should be considered while finalizing the underground cabling network layout.

1) Drainage layout.
2) Water supply layout.
3) Fire fighting layout
4) Telephone ducting
5) Generator cabling networks.
6) Storm water drains etc.

It is necessary to use well-laid and properly jointed RCC Hume pipe of specified diameter for cable ducting network. The RCC pipes should be laid atleast 1.2m below the finished road level. It is necessary to provide chambers of adequate size, to have proper space for cabling through RCC Hume pipes.

Location of chambers is decided as per : -

1) The change of directions.
2) At Junctions or at every 15 meter or as required in this straight lengths.

Internal Wiring:-

To safeguard the wires and to avoid any mishap, they are run through P.V.C. conduits,

Types of conduit wiring are: -

1) Open conduit wiring.
2) Concealed conduit wiring.

1) Open conduit wiring :-

I. ***Open Conduit wiring*: -** Generally this type of wiring is preferred for carrying the mains (wires from meter room to distribution box). Pipes and fittings of approved make confirming to IS specifications are to be used.

II. ***Casing Caping*: -** Rectangular P.V.C, channel shaped conduits, which are lockable to each other are widely known as casing caping. Casing caping is used in open conduit type wiring because it provides

a) Better appearance
b) Ease in maintenance
c) More flexibility for alterations and change in internal electrical layout.

Different Sizes of Pipes to be used as Conduits :-

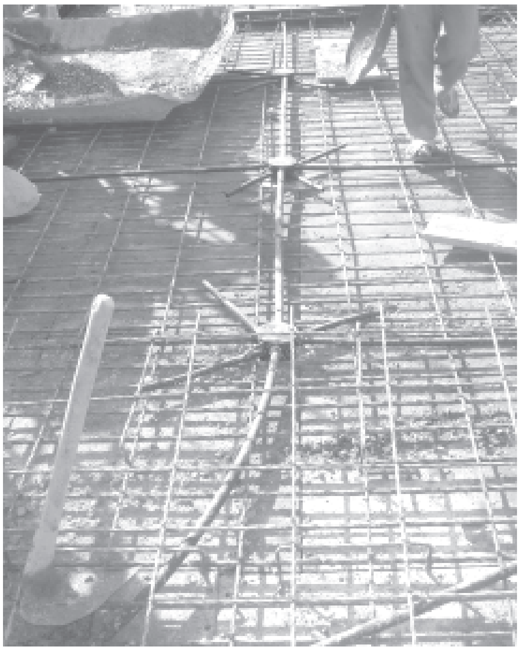
1) Mains – 32mm diameter.
2) Sub main – 25mm diameter
3) Earthing – 20mm diameter
4) Power point – 20mm/25mm diameter
5) Light point – 20mm/25mm diameter
6) T.V. and Phone – 20mm diameter

Concealed conduit wiring: - This type of wiring is preferred over open type conduiting because,

1) It is safer.
2) It is durable.
3) It gives better appearance to the ceilings & walls.

Work Procedure: -

Conduiting in Slabs: -



1) Study the electrical layout for position of points and distribution network.
2) Mark the position of distribution box, switchboards and height of points from F.F.L.
3) Lay the conduit for mains, sub mains, T.V points, phone points and fan boxes etc.
4) Finalize the location of fan box, considering the position and size of loft, elevational projections if any.
5) Lay the conduit after the reinforcement work is completed. Conduit should be firmly binded with the reinforcement.
6) All pipes and accessories should be fixed using adhesive.
7) Check the position & thickness of the wall while laying the wall dropping.
8) Joint at junction box and fan box should be sealed properly to prevent the entry of cement slurry in it.
9) Seal the hollow part of the fan box with paper.
10) While casting of slab, electrician should be present on the slab, to check that the pipes are not damaged during casting of slab.
11) Avoid sharp turnings and overlapping of conduits
12) Avoid running of a bunch of pipes to prevent weakening of concrete in that area.
13) After deshuttering of beams and slabs; clean all the pipes, and pass the G.I. wire through it to confirm the routing of pipes is not damaged during concrete.

Conduiting In Walls: -

1) The dropping at slab, beam and distribution boards should be checked.
2) After completion of brickwork and its curing, the layout of conduits and positions of switch board with reference to FFL should be marked.

3) Chiseling of grooves should be done by cutter machine only.

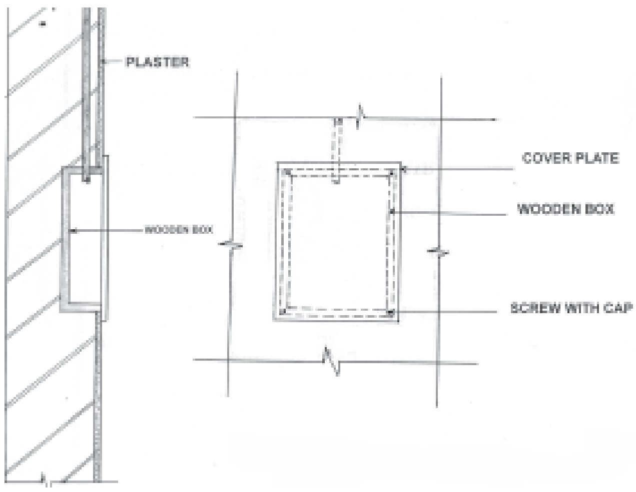
4) Fix the pipe firmly and ensure that pipes are be inside the surface of wall.

5) All concealed boxes shall be fixed with their face in line with the plaster level dots.

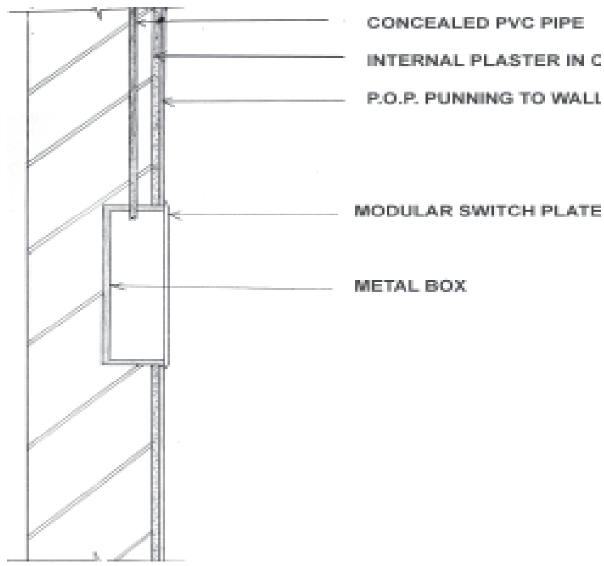
6) Chicken mesh shall be fixed on wall conduits and grooves shall be finished in cement mortar with scratch finish.

7) Curing should be done properly.

Electrical Switch Box using wooden board



Electrical Switch Box using metal box



Wiring And Fixtures Fitting: -

1) Wiring work should commence after doors and windows are fixed with proper locking arrangement.

2) Study the drawings and specifications of material to be used.

3) Complete the wiring as per colour code and size of the wires for various points.

4) Extra length of wires for looping should be considered while terminating the wires in accessories.

5) Ensure that, all the switch plates, angle holders, ceiling roses etc are in line and level.

6) All the wires connected to switches, fixtures & fittings are to be done firmly.

7) The testing of wiring should be carried by using meger only.

Protection of Electrical Work: -

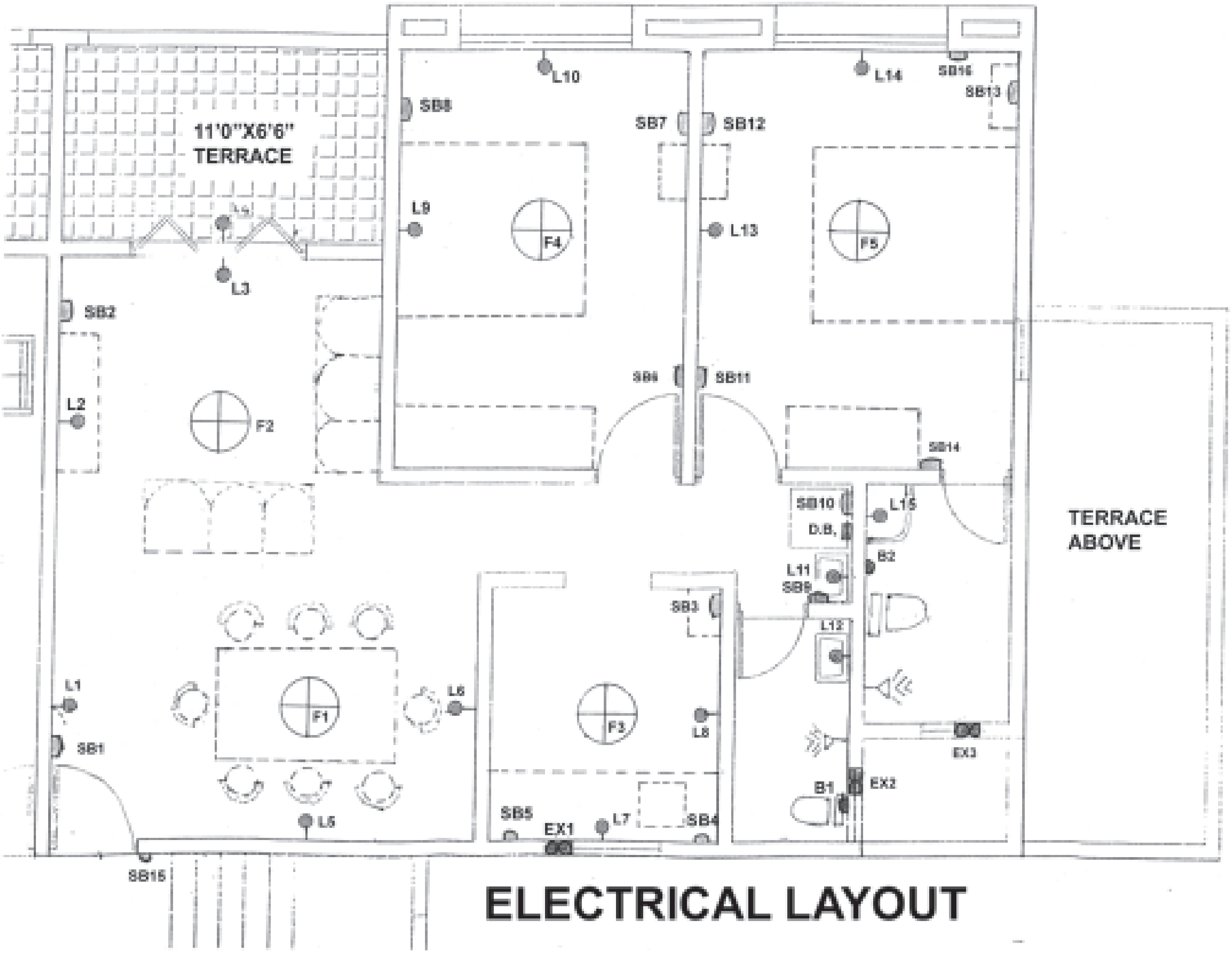
1) Protection against earth leakage: - To interrupt the current due to short circuit MCB/ELCB shall be used.

2) Protection against over load: - MCB/designed rating fuses shall be provided to avoid overload.

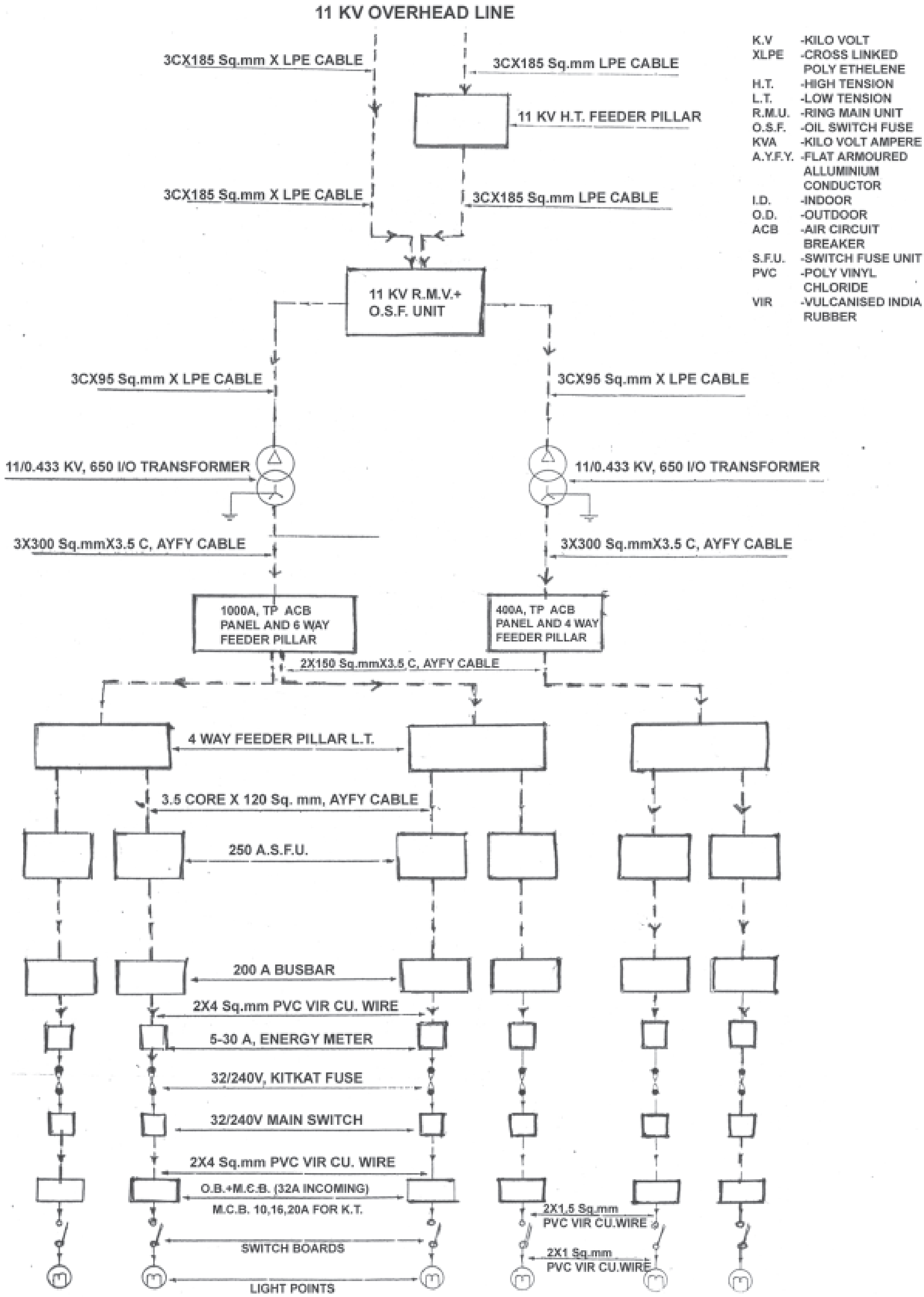
3) Protection against short circuit: - MCB/fuses/circuit breakers shall be provided to have protection against short circuit.

HEIGHT OF POINTS FROM FFL	
0.75 m	SB 2, SB7, SB8, SB 12, SB13
1.5 m	SB1,SB3, SB4, SB5 SB6, SB9, SB10, SB11 SB14, SB15, SB16
1.95 m	EX1, EX2, EX3, L11 L12, L15
2.4 m	L1,L2, L3, L4, L5, L6, L7, L8, L9, L10, L13, L14, B1, B2, D.B.

DESCRIPTION	
SB1	F1,F2,L1,L2,L3,L4,L5,L6 5A(1)
SB2	TV, TELE, 5A(1)
SB3	F3,L7,L8,15A(1)
SB4	5A(1)
SB5	5A(1), EX1
SB6	L9, L10, F4
SB7	T.V., 5A(1)
SB8	TELE
SB9	L12, B1(15A), EX2 L11
SB10	15A(1)
SB11	L13, F5, L14
SB12	T.V., 5A(1)
SB13	TELE
SB14	L15, B2(15A), EX3
SB15	BELL
SB16	A.C.

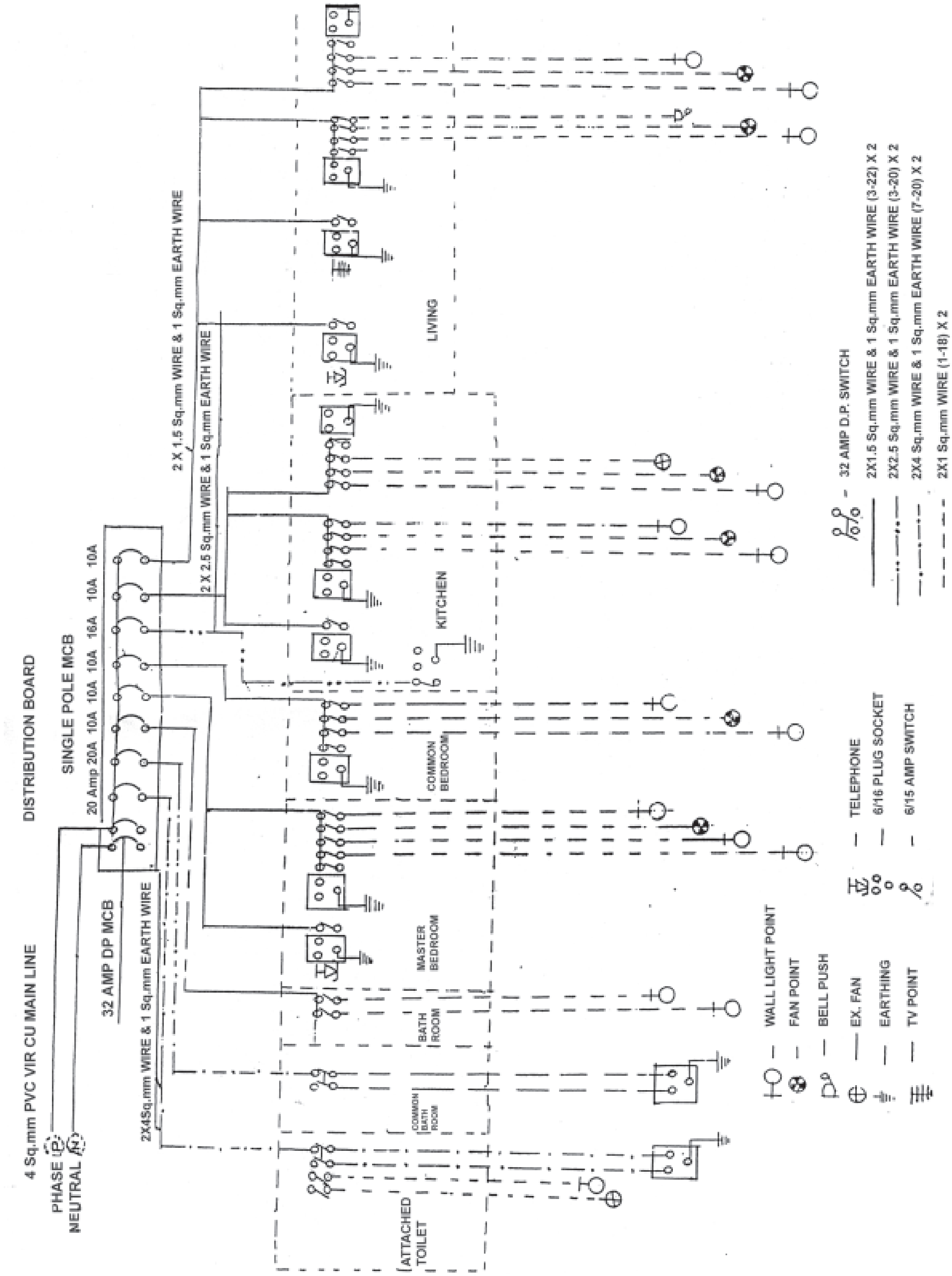


ELECTRICAL LAYOUT



SINGLE LINE DIAGRAM FROM MSEB CUT OUT POINT TO LIGHT POINT

TYPICAL ELECTRICAL LAYOUT FOR A TWO BEDROOM FLAT



Standard Height Of Electrical Fittings from the F.F.L.: -

Sr No.	Fittings	Height From FFL
1	Bell push	1.5 m
2	Switch board	1.5 m
3	Light point on wall	2.4 m
4	T.V./Phone/5A point	0.75 m
5	Exhaust fan point	2.1 m
6	Boiler point	2.4 m
7	Main D.B.	2.4 m
8	Fridge point	1.5 m
9	Window A/C point	1.5 m
10	Washing machine point	1.5 m

Minimum Electrical Points required : -

Sr No	Rooms	Approx Area	Light Point	Fan Point	Power Point	Plug on main board	Plug Point	Exhaust Point	T.V. Point	Phone Point
1	Living room	Upto 150 sft	2	1	__	1	2	1	1	1
2	Dinning	Upto 80 sft	1	1	__	1	__	__	__	__
3	Kitchen	Upto 80 sft	2	1	2	1	1	1	__	__
4	Master bed	Upto 140 sft	2	1	1	1	1	__	1	1
5	Common bed	Upto 130 sft	2	1	__	1	1	__	__	__
6	Balcony/Terrace	Upto 100 sft	1	__	__	__	__	__	__	__
7	Toilet	Upto 40 sft	1	__	1	__	1	1	__	__
8	Passage	_	_	__	1	__	1 (for washing m/c)	__	__	__

Power Requirement for Some of The Important Household Appliances: -

Sr.No.	Item	Power in watts
1	Electric iron	400 w – 1000 w
2	Immersion heater	500 w – 1000 w
3	Rapid action heater	700 w – 1200 w
4	Hair dryer	500 w
5	Heating pad	90 w
6	Vaccum cleaner	150 w – 300 w
7	Oven	700 w – 1500 w
8	Washing machine	300 w
9	Radio	50 w – 100 w
10	Refrigerator	100 w – 200 w
11	Mixer	40 w – 60 w
12	T.V.	80 w – 100 w
13	Fan	80 w

Sizes of Wires For Various Purposes :-

Supply (From - To)	Type of Supply	Size of wire used	colour of wire
Mains- (Meter room to D.B.)	Phase I	4 mm^2 (7/20)	Red
	Phase II	4 mm^2 (7/20)	Yellow
	Phase III	4 mm^2 (7/20)	Blue
	Neutral	4 mm^2 (7/20)	Black
Sub main (D.B. to Switch board)	Earth	1 mm^2 (1/18)	Green
	Phase	2.5 mm^2 (3/20)	Red
	Neutral	2.5 mm^2 (3/20)	Black
Points (Switch Board to Terminal)	Earth	1 mm^2 (1/18)	Green
	Phase	1 mm^2 (1/18)	Red
	Neutral	1 mm^2 (1/18)	Black

LOAD CALCULATIONS: - (Example)

Total Buildings – **3 nos. of P+7 storied**

All **2BHK flats** with **28-flats/ building.**

Standard Points per flat :-

Sr No	Rooms	Bell Point	Light Point	Fan Point	Power Point	Board Plug	Plug Point	Exhaust Point	T.V. Point	Phone Point
1	Living room	1	2	1	__	1	2	1	1	1
2	Dining	__	1	1	__	1	__	__	__	__
3	Kitchen	__	2	1	1	1	2	1	__	__
4	Master bed	__	2	1	1	1	1	__	1	1
5	Common bed	__	2	1	__	1	1	__	__	__
6	Balcony/Terrace	__	1	__	__	__	__	__	__	__
7	Toilet	__	2	__	2	__	2	2	__	__
8	Passage	__	1	__	__	__	1	__	__	__
	Total	1	13	5	4	5	9	3	2	2

Common lighting: -

Building landing: - 8 light points

Terrace: - 2 light points

M/C room: - 1 light point

Entrance foyer: - 3 light point

Parking: - 8 light points

Streetlight:	- 14 light point
Lift:	- 7.5 HP
Bulkhead:	- 8 nos.
Lift cabinet:	- 1 light point

Calculation of total loads

a) Load per flat

1) Light point – 13nos x 40W = 520W

2) Fan point – 8nos x 50W = 400W

3) Power point: -

b) A.C. point – 1 x 1500W = 1500W

c) Geyser point – 2 x 2000W = 4000W

d) Fridge point – 1 x 200W = 200W

4) 5A point – 14nos x 200W = 2800W

TOTAL LOAD = 9420watts

= 9.42 KW per Flat.

Apply diversity factor of 0.6 = 0.6 x 9.42KW

= 5.652KW per Flat.

Common Lighting Load: -

1) Staircase, passage and parking: - 22nos x 40watt = 880watt

2) External lighting: - 14nos x 40watt = 560watt

3) Lift and machine room: - 10nos x 40watt = 400watt

4) Lift electrical motor: - 7.5HP = 7.5 x 0.746 = 5.595KW

TOTAL = 7.435KW

Total Building load = (No. of flats x load/flat + common lighting load)

= (28 x 5.652 + 7.435) KW

= 165.69KW.

Total Load of 3 building = 3 x 165.69KW = 497.07KW

Applying overall diversity factor as 0.70 load will be;

Load = 497.07 x 0.7

= 347.94KW Say 348KW.

. : Transformer capacity $= \frac{348KW}{0.8}$

$= 435\ KVA = \frac{435}{0.9\ (efficiency)}$

= 483.33 KVA Say 483KVA

. : Transformer capacity = 500 KVA

Norms For Constructing a Building In The Vicinity Of High-Tension Lines: -

1) No building should be allowed to be erected or re-erected or any additions or alterations made to the existing building unless the following minimum clearance is provided from the overhead electric supply line. For every additional 33 KV voltage line add 0.3 meter clearance extra in the minimum clearance indicated.

Sr. No.	Description	Minimum clear vertical distance in meters	Minimum clear distance in meters
1	Low and medium voltage lines	2.50 m	1.20 m
2	High voltage lines 1) Up to 11KV. 2) Above 11KV & up to 33KV.	 3.70 m 1.20 m	 3.70 m 2.00 m

Recommended Symbols For Electrical Installation: -

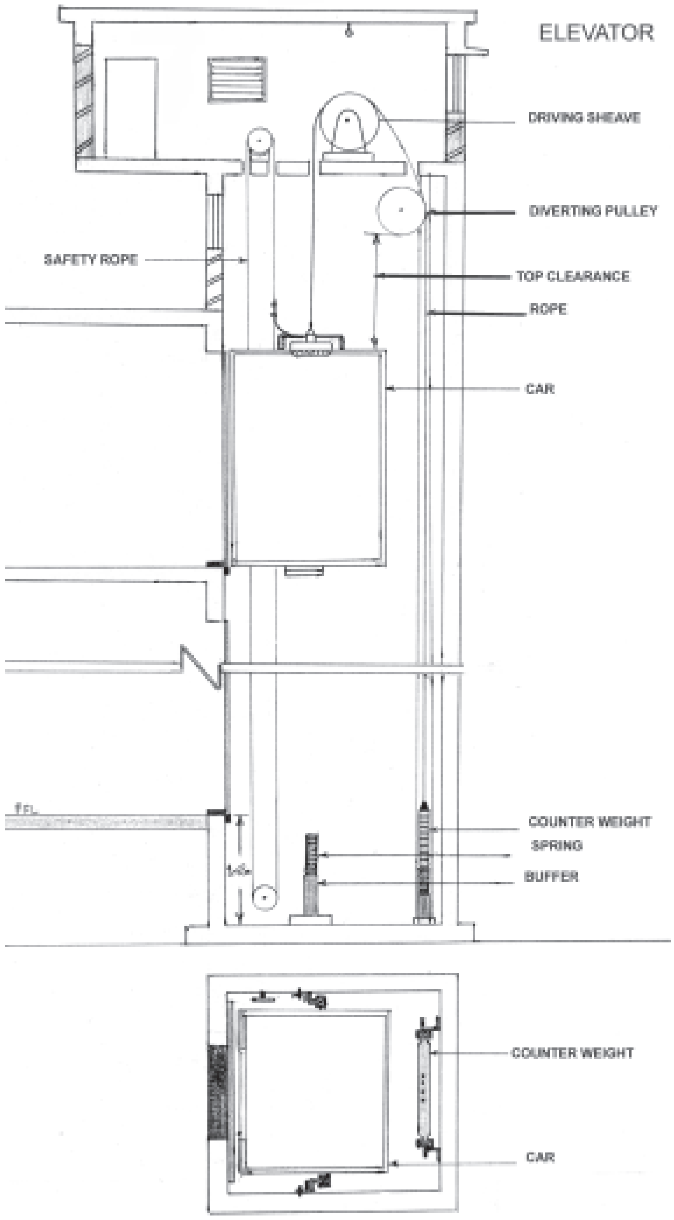
Sr. No.	Description	Symbol
1.	**WIRING**	
Ø	General wiring	
Ø	Wiring on the surface	
Ø	Wiring under the surface	
Ø	Wiring in surface conduit	
Ø	Wiring in concealed conduit	
Ø	Wiring going upwards	
Ø	Wiring going downwards	
Ø	Wiring passing vertically through room	
2.	**FUSE-BOARDS**	
Ø	Lighting fuse-board without switches	
Ø	Lightning fuse-boards with switches	
Ø	Distribution fuse-board without switches	
Ø	Distribution fuse-board with switches	
Ø	Power fuse-board without switches	
Ø	Power fuse-board with switches	
3.	**EARTHING**	
Ø	Earth point	
4.	**SWITCHES AND SWITCH-OUTLET**	
Ø	One-way single pole switch	
Ø	One-way two pole switch	
Ø	Two-way switch	
Ø	Pendant switch	
Ø	Push button	
5.	**SOCKET-OUTLET**	
Ø	Socket-outlet, 5A	
Ø	Socket-outlet, 15 A	
Ø	Combined switch and socket outlet, 5A	
Ø	Combined switch and socket outlet, 15A	
6.	**FANS**	
Ø	Ceiling fan	
Ø	Bracket fan	
Ø	Exhaust fan	
Ø	Fan regulator	

7.	**ELECTRICAL APPLIANCES**	
Ø	General	
Ø	Heater	
8.	**LAMPS AND LIGHTINING APPRATUS**	
Ø	Lamp or outlet for lamp	
Ø	Lamp mounted on wall	
Ø	Lamp mounted on ceiling	
Ø	Fixture with built in switch	
Ø	Emergency lamp	
Ø	Bulk head lamp	
Ø	Water tight lighting fitting	
Ø	Fluorescent lamp	
9.	**BELL, BUZZERS AND SIRENS**	
Ø	Bell	
Ø	Buzzer	
Ø	Siren	
Ø	Horn or hooter	
10.	**TELECOMMUNICATION APPARATUS**	
Ø	Socket for telecommunication apparatus	
Ø	Arial	
Ø	Loudspeaker	
Ø	Radio receiving set	
Ø	Amplifying equipment	
Ø	Television receiver	
Ø	Control board for public address	
11.	**FIRE ALARMS**	
Ø	Manually operated fire alarm	
Ø	Automatic fire detector switch	
Ø	Fire alarm indicator	

ELEVATORS

LIFT :-

Lift is an appliance by which persons and goods are moved vertically from one level to another. A passenger lift is designed to carry persons. Goods lift or hoist servers are primarily used to transport the material. A platform lift is used for transporting the materials. It has a platform or floor unlike a car. It has neither sides nor door.



1) Lift pits: - Minimum depth of lift pit required is 1.5 meter. The lift pit should be completely watertight. M.S. ladder to be provided for access to the lift pit.
2) Buffers: - Oil type or spring type buffers are fixed at the bottom of the pit . It should be in line with the center of the car and other in line with the counter weight, at the extreme lower limit of travel.
3) Lift car: - The unit, which carries the passengers. It has a steel frame which supported on the floor or platform in addition to side & top bodywork & to which the safety gear, guide shoes & suspension ropes are fixed.
4) Counter weight: - A unit consisting of steel weights which counter balances the self weight of the car and part of live load. The suspension ropes are attached to the counter weight.
5) Diverting pulley: - A wheel situated at the top of the shaft and below the driving sheave, which serve to bring the suspension ropes directly over the counter weight.
6) Driving sheave: - A wheel with V- shaped groove on its face the suspension ropes pass over & in the wheel the power from the lift machine is transferred to the wheel through the wire ropes.
7) Guide Rails: - These are fixed vertically in the shaft are of steel material and serve to guide the movement of both car and counter-weight.
8) Controller: - A group of device mounted on a panel, which governs the motion, direction, travel steep

and stopping of lift car.

9) <u>Door closer</u>: - A device, which closes the door automatically.

10) <u>Landing call push</u>: - A push button provided at landing for activating the call indicators.

11) <u>Top clearance</u>:- Adequate clearance shall be maintained between the top of the car (when it is on top floor) and the bottom of the diverting pully.

12) <u>Template</u>: - Template is a right angle frame of wood or M.S. angle, which is kept on two supports at the top of the lift shaft from which the plumb strings are suspended. For maintaining the verticality of the guide rails and body of the car. It also helps in deciding the position of the pockets.

<u>Types of elevators</u>: -

1) Passenger lifts: - For carrying passengers from the residential and commercial building.
2) Stretcher lift: - For hospital use.
3) Goods lift: - Use in factories to carry goods.
4) Hydraulic lifts: - Used for the buildings and bungalows with inadequate space for lift room.
5) Dumb waiters: - Used in hotels & Hospitals use.

<u>Civil work required for lift</u>:

1) Waterproofing to be done to the lift shaft below ground level from outside by fixing rough Shahabad tiles.
2) Minimum depth of 1.5m is to be kept below the F.F.L.of the bottommost stop.
3) Fix M.S. ladders for access to the pit
4) Make scaffolding as per the specification given by the erector & fix the template.
5) The surface walls of the lift shaft should be cleaned, free from any projections and finished smoothly.
6) Apply white wash to all internal faces of lift shaft.
7) Face walls of the lifts should be 230mm thick brickwork. The brickwork should be in plumb and right angle. Fix all the door frames except GF/basement levels frames in plumb and as positions given by the erector.
8) Plaster the above wall from both sides in line, plumb and right angle. The external face of the wall may be rough plaster for cladding work.
9) The ground floor/ basement level brickwork and frame fixing should be done after the lift car is installed.
10) Do the cladding work after completing the plaster.
11) Construct the machine room as per drawing, ensuring proper ventilation.
12 Finish the machine room floor with IPS after all the wiring and raceways are completed.
13) Do the painting of machine room.
14) Fix shutter of machine room and keep it locked.

Electrical work: -

A three-phase & single phase connection is required in the lift machine room for which armored cable are run on the back wall of the lift shaft. A light point & a 3 pin socket at each floor level & are provided in lift shaft. Provision of a lift point & 3 pin socket is made in lift pit also.

Safety gear: -

Every passenger & goods lift must be provided with an emergency stop switch, a press button alarm & automatic safety gear on the car, which in the event of rope failure will stop and sustain the pulley-loaded car in the guides. Such gear is fitted below the platform and between the car guide nails. For slow speed lifts the gear should be quick acting and for high-speed lifts it must be more gradual in action. Details differ but essentially guide rails are gripped by the mechanism sufficiently to stop the car during its decent.

Over speed Governors: -

This is a form of safety gear, which operates when a descending car exceeds the predetermined maximum speed. It must be fitted to every lift having a travel exceeding 6 meters and is situated near the top of the shafts. A steel or bronze rope connected to the safety gears described above is passed over the pulley of the governor, continued down the shaft and passed under a pulley fixed in the pit and up to the car to which it attached. If the car during it's decent exceeds the maximum speed, the governor comes into operation to lock the rope and thereby bring for operating the safety gear.

CHECKLIST: -

1) Check the depth of the lift pit as per standard dimensions given
2) Check the lift shaft for the right angles and plumb.
3) The interior specifications of car
4) The threshold of the lift door should be above the landing floor level. The slope of landing tiles should be away from the lift door.
5) Check the emergency light and bell are working.
6) Check whether all indicators are working or not.
7) Check whether Instruction sheets are fixed in the machine room and lift car.

FIRE FIGHTING SYSTEM

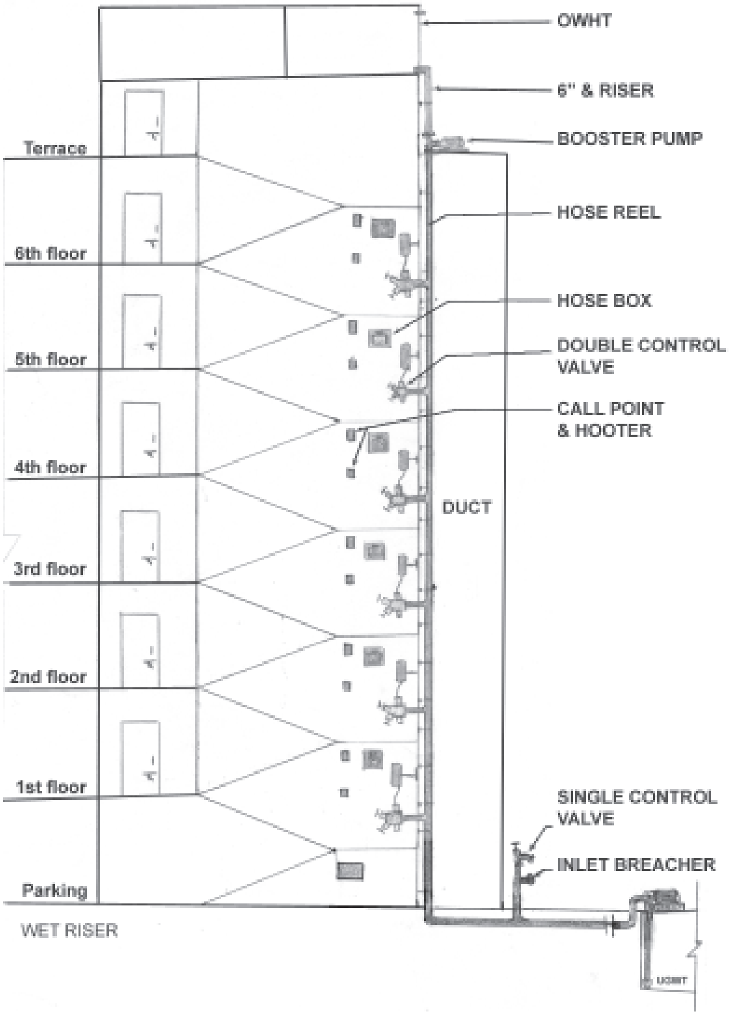
INTRODUCTION:

Carelessness is responsible for a large proportion of Fires, so the owners & occupant of the building should take greater care to avid the out bursts of fire. However the designer of the building should ensure that the premises complies with the rules and regulations formed by the municipal authorities. The rules & regulations may vary from place to place.

What is Fire Fighting System:

Provision of detecting warning and extinguishing equipment to dealing with fires is fire-fighting system.

Requirement: Required if the height of building exceeds 15m from ground level. This system is to be installed compulsorily.



Basic requirements for fire fighting system:

(i) Access to the building

(ii) Water supply for Fire fighting

(iii) Fire alarm System

(iv) Fire lift

(v) Refuge Area

(vi) Fire extinguishers

1) Access:

It is important to provide reasonable access to fire fighting tankers to all buildings. It should be possible to drive the fire appliances to the entrance of the building.

2) Water Supply for Fire Fighting

1) OHWT of the building should have a provision of minimum 10,000 liters of water for fire fighting with partition for domestics use

2) A 150mm diameter Rising main is installed from the staircase, which should be easily accessible from the landings at all floors. It is connected to the OHWT & UGWT.

3) This rising main is connected to the double controlled fire hydrant valve by 100 mm diameter GI pipe on each floor.

4) One control of the valve is connected to be wall mounted Hose reel with rubber pipe 20mm diameter & 15 meters length. The other end is kept free for fixing fire hosepipe 65mm diameter, 15 meters long with Gunmetal coupling.

5) **Fire hose box**: Is installed on each floor this box is fabricated MS Sheet box glass fronted & with lock & key. The Fire Hose Pipe is kept in this box. This box should be fixed in such a way that its easily visible & accessible.

6) **Single control valves**: Two single controlled walls are installed at the ground floor one at front side of building & the other on the backside. These are connected to the Rising main. The purpose of installing these valves is that the hose can be fixed to these valves and water can be sprayed from the outer side of the building.

7) One three way inlet breacher is installed on the ground floor at the entrance of the building. From this water can be pumped in to the main riser by the fire-fighting vehicle.

8) Pumps: One 5HP mono block is required to be installed at the terrace level and one pump of 20HP on the U.G.W.T. to which the Riser main is connected.

9) In buildings, where height of building is more than 15m & has basement parking, installation of sprinklers is compulsory. The sprinklers have a bulb of tough transparent material as a strut to support a valve assembly, which forms a watertight joint. This bulb contains a liquid, which expands when heated as the temperature rises. As the internal pressure increases the bulb eventually fractures and shatters into small pieces which allows immediate discharge of water from the valve on to the deflectors and water is sparkled over the area. The sprinklers are connected to the main Riser by 25mm GI pipe network all over the parking with sufficient nos. of sprinklers.

3) Alarm System

Automatic electric fire alarm system consist of detectors fixed in suitable positions on each floor which can be activated by heat, smoke detectors or by manual call points, which operate an electric circuit to give the alarm by the ringing of siren inside as well as outside the building.

The system installed at the ground floor indicates the floor on with the fire is detected. The system can also automatically. Summons the fire brigade if it is attached with telephone connection. In case of manual call point system, the glass of the call point switch is to be broken by hammer that activates the system and the siren blows.

4) Fire lift:

These are required for any building of height above 24m from the ground The lift have a platform area of not less than 1.44m^2 and capable of carrying of least 544 kgs. It has a fireman to switch at ground floor level from floor enabling fireman to summon it without the interference from landing call points The switch is placed in a glass fronted box marked Fire Switch at the entrance.

5) Refuge Area:

It is an area usually at 24m levels, which is kept as a open hall without internal walls, It should be at the exteriors face of the building. It is a place where in case of fire all the occupants of the building can assemble and can be evacuated by fire fighting personnel.

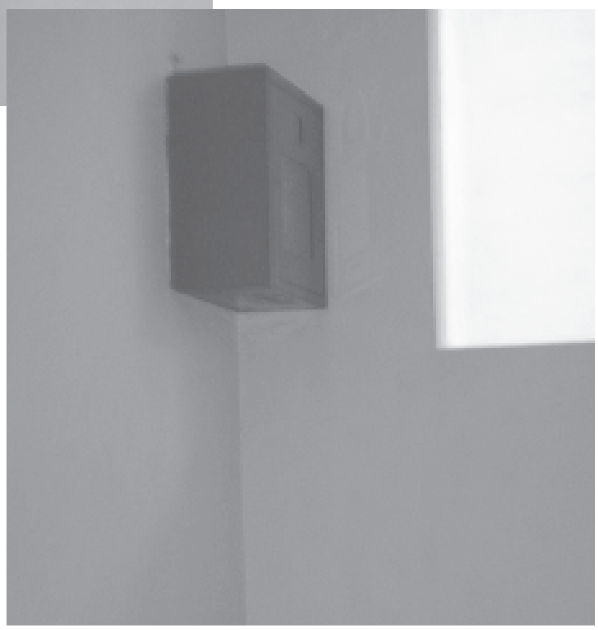
6) Portable fire extinguisher:

Portable fire extinguishing cylinders of 5kg of dry chemical powder should be installed at parking, meter room, lift room & transformer room.

Maintenance:

1) The system should be operated at least once a month and check if the entire hydrant valves and pumps are in working condition.

2) The dry powder of the fire extinguisher should be changed as per the expiry date.



EXTERNAL GLAZING

INTRODUCTION:

Panelling and glazing represents new trends of beautifying exteriors of the buildings. It also helps in providing safety, adding illumination and controlling sound. These are perfect replacement for conventional cladding materials such as marble, granite, decorative artificial stones, textures etc. It increases the expected value of commercial or residential projects.

ALUMINUM COMPOSITE PANELS

An aluminum composite panel is made by sandwiching two skins of aluminum sheets with a nontoxic polyethylene core having fluorocarbon coating. This coating is applied on the top, ensuring superior corrosion resistance and weatherability.

This material has following properties :-

- Excellent flatness
- Light weight
- High strength
- Durable
- Corrosion resistance
- Sound isolation
- Thermal isolation
- Impact resistance
- Easy for installation
- Quick installation
- Vivid colours
- Maintenance free
- Easily available
- Easily mouldable

Alongwith the versatile properties mentioned above, this material is available in attractive colours, finishes and thicknesses, therefore it is set to become a leading choice for building exteriors, foyers, ceilings, elevators, office interiors, shop fronts, signboard etc.

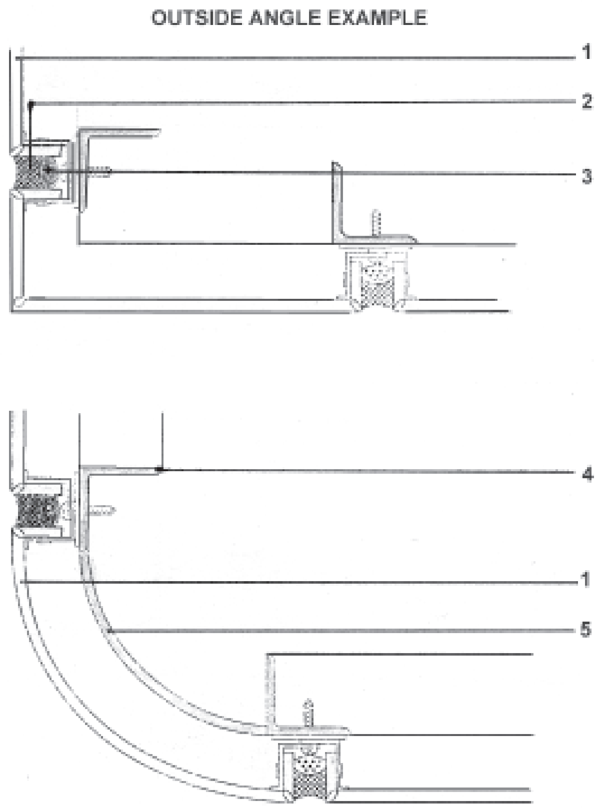
WORK PROCEDURE

1) Erect a firm and workable M.S. scaffolding to facilitate the panel fixing work.
2) Mark the grid lines as per decided panel sizes.
3) Fix M.S. angles with holes in line, level and plumb, to serve as the basic frame.
4) Fix aluminum composite panel with screws on grids as per designed grooves.

5) Fill the sealant in grooves, taking utmost care.

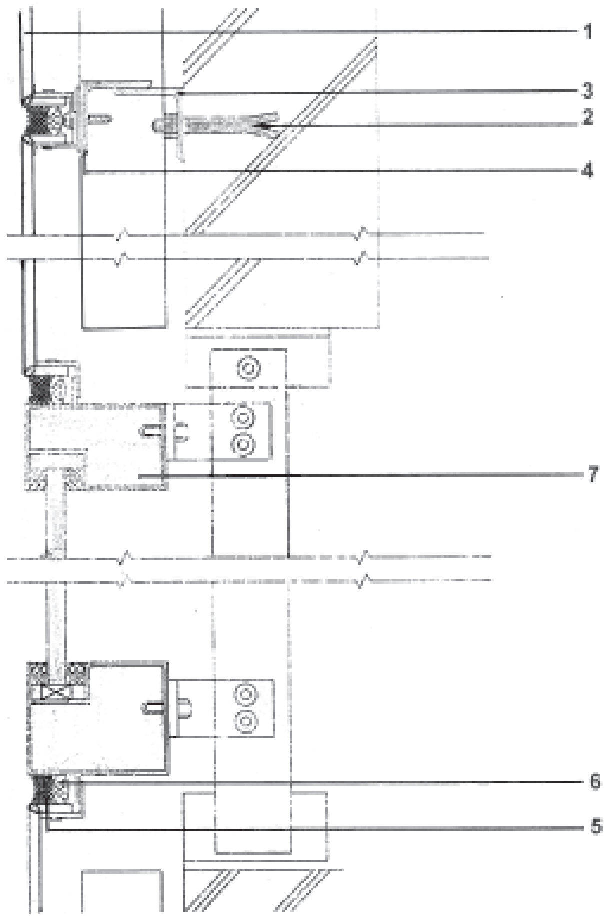
6) Remove the protection film and clean the panel with soft cloth.

EXAMPLE OF INSTALLATION

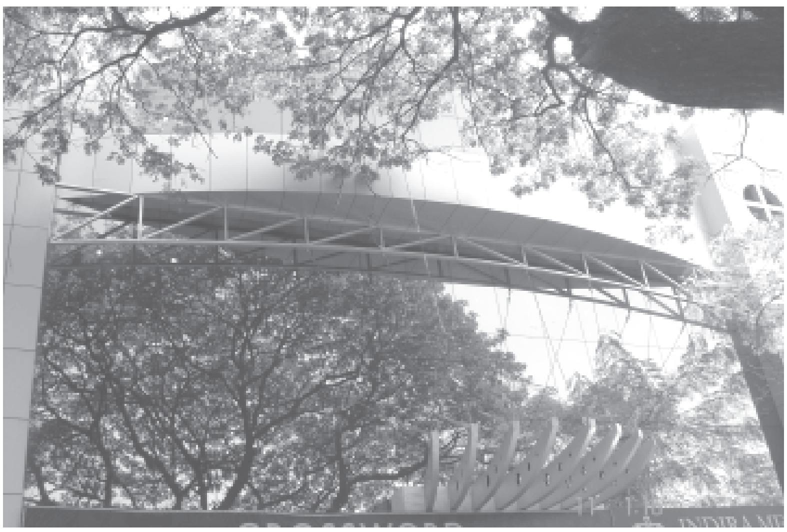


1 ACP
2 SEALING MATERIAL
3 BACKUP MATERIAL
4 STEEL ANGLE
5 STEEL FLAT BAR

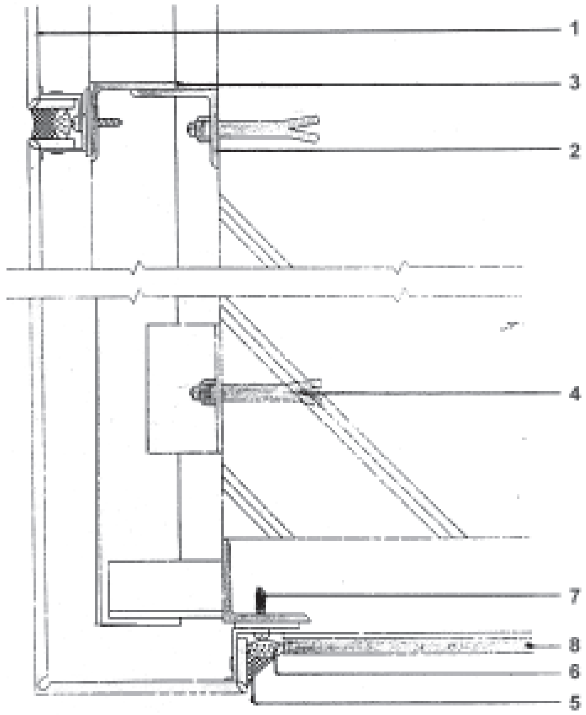
EXAMPLE AROUNED WINDOW FRAME



1 ACP
2 HOLE-IN ANCHOR OR BUILT IN BOLT
3 ANGLE PIECE-BRACKET
4 STEEL ANGLE
5 SEALING MATERIAL
6 BACKUP MATERIAL
7 OUTER FITTING WINDOW FRAME

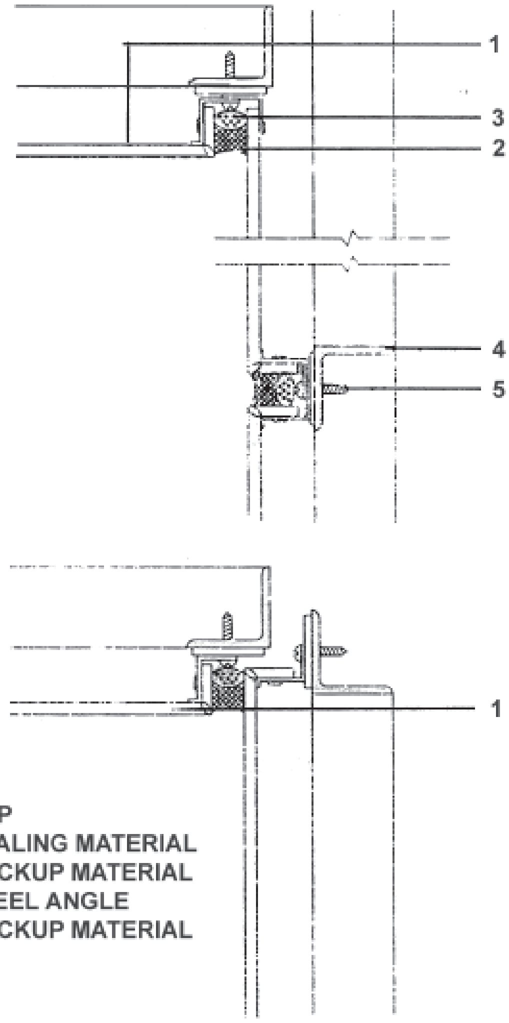


EXAMPLE AROUND DRIP



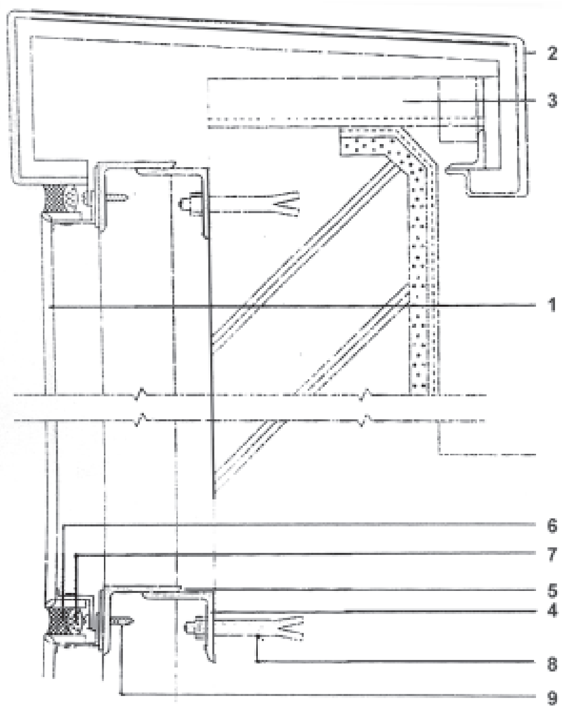
1 ACP
2 ANGLE PIECE-BRACKET
3 STEEL ANGLE
4 HOLE-IN ANCHOR OR BUILT-IN BOLT
5 SEALING MATERIAL
6 BACKUP MATERIAL
7 TAPPING SCREW
8 CEILING BOARD

INSIDE ANGLE EXAMPLE



1 ACP
2 SEALING MATERIAL
3 BACKUP MATERIAL
4 STEEL ANGLE
5 BACKUP MATERIAL

EXAMPLE AROUND COPING



1 ACP
2 COPING
3 ANGLE PIECE-BRACKET
4 ANGLE PIECE
5 STEEL ANGLE
6 SEALING MATERIAL
7 BACKUP MATERIAL
8 TAPPING SCREW
9 HOLE-IN ANCHOR OR BUILT-IN BOLT

PAINTING

INTRODUCTION:

Paints and varnishes are used to protect metal, timber or plastered surfaces from the corrosive effect of heat, moisture, gases and changing weather conditions. Paints are also used to improve the appearance of a structure.

Paints are classified as per their basic ingredient as follows: -

1) Oil Paint.
2) Distempers.
3) Enamel Paint.
4) Lacquer.
5) Fireproof Paint.
6) Cellulose Paint.
7) Aluminium Paint.
8) Varnishes.
9) Cement Paint.
10) Textured Paint.

The serviceability expected from a surface after painting and the purpose of painting shall be decided beforehand. According to the decided purpose, a specific paint, delivering required results, should be selected. The purpose for painting any surface is to make that surface impermeable, heat resistive, durable & elegant. Simultaneously the durability, maintainability of the paint in application & the cost of the paint also governs the selection process.

Considering all these properties of the paint as well as the desired purpose of painting; a proper painting material shall be selected.

The best quality of painting lies in the preparation of the surface. Therefore, utmost care shall be taken in 'Preparing' a surface.

PREPARATION OF SURFACE FOR INTERNAL PAINTING:

1) The surfaces should be completely dry
2) The surface should have no patch of efflorescence.
3) Surface should be cleaned with wire brush., for dust, loose scales etc.
4) The surface should not be rough. If the surface is rough, sand paper shall be used to smoothen the surface.
5) Cement plastered surface must be washed and allowed to dry.
6) All gaps, cracks and undulations in plaster works shall be filled and smoothened.
7) All activities involving cement shall be completed prior to painting.

8) All parallel & subsequent works creating probable damages to the painted surface,shall be planned and controlled so as to avoid the damage (for e.g. final floor polishing).

INTERNAL PAINTING:

1) After preparation of surface, apply thick coat of primer to walls and ceilings.
2) Apply filler (putty) on all the walls and ceiling in horizontal and vertical direction to cover all undulations and minor cracks, on the next day
3) After 24 hours, gently rub the surface with fine sand paper for proper bonding of the paint.
4) Clean the surface with cotton cloth.
5) Mask all the doorframes, window frames and all fixtures.
6) Apply first coat of paint in vertical and horizontal direction simultaneously.
7) On the next day, check for undulations if any, and rectify the same with putty.
8) Confirm the completion of the parallel activity (switches, plates) before the start of the subsequent coat of paint. An interval of minimum 24 hours shall be maintained between any two coats of paint. .
9) Clean all the doors, windows and fixtures and floor with proper care.

WOOD POLISH:

1) Mask all the fixtures and adjoining walls of the surface to be polished.
2) Scrap the surface to be polished by sand paper. No. 80 shall be used.
3) Apply a sealer coat by spray machine.
4) Fill the depressions, if any, with wax.
5) Scrap the surface with sand paper, gently to obtain smooth finish.
6) Apply the first coat of polish.
7) Scrap the surface as required.
8) Apply the final coat of polish uniformly.
9) Clean the surface with clean cotton cloth, gently.

EXTERNAL PAINTING:

External painting shall be started only when, all the plaster, waterproofing, plumbing lines, electrical works, rectifications and repair work are completed.

1) Prepare firm scaffolding for painting to walls.
2) Clean the surface to make free from dust, loose mortar and extra deposition if any.
3) Fill all the cracks with waterproof crack-fill compounds.
4) Mask the external surface of window and railing etc.
5) Water the surface to be painted atleast 12 hours before painting.
6) Mix the paint thoroughly, as per the manufacturers instruction.
7) Apply first thick coat of paint, uniformly in vertical and horizontal directions simultaneously.

8) Cure the cement paint atleast for two days.

9) Second coat of paint should be applied only after curing of first coat is completed.

PRECAUTIONS:

1) Application of paint is to be done only after checking the paint life and manufacturers' instructions.

2) All painters must wear safety belts and helmets while working on and around scaffolding area.

CHECKLISTS

A) EXCAVATION & P.C.C.

1) Final plinth levels of all buildings.
2) Strata as per consultant's specifications.
3) Size of pits is more than size of P.C.C., & depth as desired.
4) Shuttering provided, if required.
5) Uniformity & thickness of soling.
6) Compaction of concrete.
7) Thickness of P.C.C. as specified.
8) Curing for 7 days.

B) FOOTING & PLINTH BEAM

1) Final plinth level of building.
2) Footing number, size, column number & orientation.
3) Reinforcement of footing & plinth beams.
4) Cover for reinforcement.
5) Layout of plinth beams.
6) Shuttering of plinth beams.
7) Compaction of concrete.
8) Cubes taken with identification.
9) Test report of cubes. (7 days& 28 days)

C) BACKFILLING

1) Assorted material made available for backfilling.
2) Filling in layers & proper compaction.
3) Watering.

D) COLUMNS

1.1.1 General & reinforcement

1. Plotting of gridline for center of column above plinth / floor slab.
2. Locating & marking the centers of columns.
3. Binding & placing column reinforcement above upper floor slab as per required height, considering lap length of the bar.
4. Column reinforcement & its arrangement as per drawing.
5. Ring spacing & their arrangement as per R.C.C. drawings.

6. Proper binding of reinforcement with binding wire.
7. Fixing of concrete or P.V.C. cover blocks to reinforcement.

1.1.2 Checking of shuttering for columns

1. The quality of shuttering before placing.
2. Applying deshuttering oil to plywood shuttering.
3. Fixing M.S.clamps (shinkanjas) at every 0.6 m (2’0") internal.
4. Stiffness of side supports to have formwork in plumb.

1.1.3 Checking of column before concreting

1. Size as per drawing.
2. Diagonals as required.
3. Oiling of shuttering.
4. Plumb on both sides.
5. Line of columns as desired.
6. Sufficient Marking level up to which concreting to be done.
7. Supports.
8. Reinforcement cover provided.
9. Spacing of reinforcement above concrete level, maintained as required.
10. Proper filling of gaps from outside by soil paste.

1.1.4 Checking of column while concreting.

1. Quality of materials of concrete.
2. The proportion & mixing of material.
3. Six cube mould are kept ready to cast cubes from different batches.
4. Controlled water cement ratio.
5. Availability of vibrator or labour for tamping.
6. Proper cover after concreting on top level.
7. Casting of concrete cubes as required.
8. Proper numbering on cubes.
9. Fill joints if slurry flows from anywhere.
10. Maintain required concrete level.
11. Cleaning of mixing platform.

1.1.5 Checking of columns after concreting.

1. Deshuttering of columns after 24 hrs-48 hrs.
2. Submission of the deshuttering report to higher authority.
3. Finishing of honey combing, if any, with proper care.

4. Date of casting written on column.
5. Hacking of columns.
6. Cubes removed next day & kept for curing, with code numbers, cast code, site name on cubes.
7. Curing of columns done for minimum 15 days. Wet nesian cloth wrapped around it.
8. Testing of cubes on due dates i.e. after seventh & twenty eighth day.

E) SLAB & BEAMS

1.1.1 Checking of shuttering material

1. Height of slab from plinth / slab level.
2. Quality of shuttering material.
3. Proper fixing of cap on column to take load of beam & slab shuttering.
4. Width of beam bottom plank.
5. Proper fixing of beam bottom cap.
6. Line & level of beam bottoms.
7. Depth of beam as per R.C.C. drawings.
8. Proper fixing of props for bottom in line & plumb at every 0.6 m internal.
9. Packing below props only one or two wooden plank pieces is allowed. (No bricks or blocks are allowed).
10. Proper fixing of side beam in line, level & plumb.
11. Support to vertical joint of shuttering for 0.6 m beam or 0.75 m beam.
12. Gaps in beam sides to be filled.
13. Ensure fixing of steel plates over beam sides in flush position.
14. Slab plates should be supported by 3"x3" chavis at 2’0" (0.60 m).distance center to center.
15. ‘Side plank’ for slab panel periphery (Dhar falee).
16. Individual level of each bay of slab.
17. Marking thickness of slab.
18. Water tightening of plates joints & ghabadi work.
19. Oiling of slab shuttering.
20. Internal panel measurement, beam-to-beam & diagonal of panel.
21. Location & depth of sunken slab.
22. Outer line of beam sides.
23. Room sides & diagonals.
24. Water tightness near junctions of columns & beams.
25. Bamboo bracing for joining, prop to prop at 4’0" height from floor.

1.1.2 Checking of reinforcement for Beams.

1. Bottom bars, top bars, bentup bars, stirrups, distance of bentup bars from face of supports, spacing of the stirrups as per R.C.C. drawing, proper tying of stirrups.

2. Diameter of bars, binding of stirrups in plumb.
3. Length of bentup bars projecting in the adjacent beams.
4. L for bentup at discontinuous end.
5. Side covers & bottom covers for beams.
6. Pin is provided at required places between reinforcement.
7. Proper binding of laps in beam if provided with required length.
8. Extra stirrups at the junction of beams.

1.1.3 Steel for slab.

1. Spacing, diameter of bent up bars & main bars.
2. Distance of bent ups from face of beam.
3. Length of bent up bars projecting in adjacent bays.
4. Height of the bent up bars.
5. Chair below each & every bent up bar.
6. Covering for slab at bottom.
7. Proper binding of laps of required length.
8. Distribution steel diameters, spacing & ties.
9. Dowels of slab & beam.
10. Location, proper binding diameter & length of fan hook & quality of the hook box.
11. Stirrups in column for upper floor column size.

1.1.4 Care to be taken before / after casting of slab

1. To check the concealed electrical conduit work for slabs as per drawing; check I.S.I mark on P.V.C. pipes& note down the length of all pipes for billing purpose.
2. Check the junctions & all electrical layout, position of fan points, M,S, boxes, junction boxes.
3. Avoid breaking of pipes during concreting.
4. Certificate from Architect.
5. Certificate from R.C.C. consultants.

1.1.5 Management before / after casting of slab.

1. The stock of cement , sand & metal required for casting of slab.
2. Arrangement of water & standby arrangement of water in case of electrical failure.
3. Labour strength required & available for slab casting.
4. Inform contractor about starting time of slab & maximum allowable time for slab casting.
5. Decide the position of concrete joints in case of big slab after consulting & approval of R.C.C. Consultant.
6. Casting of slab with the help of mixer ,vibrator & measuring box.
7. Machine operator for mixer & vibrator is present on site.
8. Proportion of aggregate decided.

9. Casting of six cube moulds of various batches for testing.
10. Ensure cleaning of wooden pieces, papers etc. from slab, beam before casting.
11. Proper levelling of slab by mason.
12. Maintaining slab register.
13. Arrangement of planks over slab for labour movement along with the M.S. walk ways for avoiding the disturbance to top reinforcement.
14. Arrange petrol & diesel for vibrator & mixer.
15. Ensure the working of materials lift before commencement of work. Ensure for rigid scaffolding of lift.
16. Sufficient light arrangement in case of late night concreting.

1.1.6 Checklist after concreting

1. Deshuttering of outer beams after 24 hours.
2. Making small bonds in sand & cement mortar (1:10) for ponding method of curing for slab, with each bay having maximum size of 2.0 m x 2.0 m.
3. Removal of waste material like sand, metal & steel pieces?
4. Deshuttering of internal beam sides after 48 hours?
5. Curing of slab for 28 days.
6. Painting the date of casting of slab on front & side beam.
7. Register in head office, next day after casting.
8. Deshuttering of slab after 7 days, 10 days or 15 days depending on spans.
9. Hacking of beam sides, beam bottom, slab bottom.
10. Minor honey combing surfaces, finished with rich mortar.
11. Major honeycombing shall be brought to the notice of R.C.C.Consultant.

F) BRICK MASONRY

1. Cleaning the entire floor, before starting the line out of masonry.
2. Confirm dimensions & diagonals of room after first layer (line out).
3. First layer checked with beam top / bottom edge, offset & plumb.
4. Opening to be provided at first layer for doors & at sill level for windows & A.C. units.
5. Screening of sand,mortar proportion & soaking of bricks.
6. Erection of door & window frames with necessary number of holdfast.
7. Fixing of holdfasts to frames & to R.C.C. Columns if any.
8. Racking of joints & surface cleaning after completion of day-to-day work.
9. Verticality of walls & corners.
10. Thickness of joints not more than 12 mm.
11. 20 mm metal chips filling in R.C.C.& masonry junction.
12. Cleaning of room
13. Curing for 7 days.

G) PLASTERING

INTERNAL PLASTER

ITEMS TO BE CHECKED: -

1. Service line like electrical & plumbing line chasing & filling of voids (Ghabadi).
2. Sufficient hacking (tacha) to all R.C.C. work.
3. Checking leakage (Toilets, W.C., passage).
4. Height & location of electrical points, switch boards, T.V. & Telephone frames.
5. Verticality of all door & window frames.
6. Hold fasting, fixing of doorframes in concrete.
7. Cleaning of all R.C.C. & masonry surfaces.
8. 'Khadi maal' at beam bottom, column & masonry joints.
9. Chicken mesh fixing at joints of RCC & masonry work.
10. Watering of surface before one day of plastering.
11. Level dots (Thiyya) to be marked.
12. Sand measured by farma.
13. Silt content of sand (permissible limit).
14. Arrangement of M.S.chairs and planks.
15. Extra amenities, if any.
16. Covering of electrical boxes by dummy plates.
17. Soaking of sanala (* if not instant).

AFTER PLASTERING

1. Fan hook at its position.
2. Line, level, right angle of plastered area.
3. Sanala application after 2 hours.
4. Trowelling the surface on next day for smooth finish.
5. Sills, column beam edges in plumb.
6. Cleaning of plastered surface.
7. Curing for minimum 10 days.
8. 150 mm cutting of plaster in level for fixing skirting.
9. No sanala application at glazed or ceramic dado positions.
10. Edges to be made adding cement in sanala.
11. Cleaning of windows & door frames.
12. Cleaning floor exposed to slab top.
13. Finishing ghabadi work.
14. Provision for window sill fixing.
15. I.P.S. on loft top.

EXTERNAL PLASTER

1. Use of measuring farma according to the mix proportion.
2. Smoothness of concrete surface hacked with tacha.
3. Water the surface to be plastered one day in advance.
4. Verticality & stability of the provided scaffolding.
5. Mark dots (thiyya) before plastering, to ensure minimum specified thickness.
6. The cement sand mortar between junction of bottom beam & the last layer of masonry shall be filled well in advance before plastering.
7. Chicken mesh of minimum 23 cm in width on either side of junction of different surfaces (junction of masonry to R.C.C.).
8. 3 to 4 days gap between two successive coats for double coat plaster.
9. Finishing of scaffolding holes properly & immediately.
10. Verticality of window opening jamb as well as horizontality of its bottom sills and top to be checked during plastering work.
11. For parapet wall, leave a margin of 0.4m ht. in plaster at bottom level from terrace side.
12. Clean the terrace after plastering work.
13. Curing the plaster for minimum 15 days.
14. Plaster checked for its thickness, line , level & plumb.

H) WATERPROOFING

CHECKLIST FOR 'BOX TYPE' WATERPROOFING

1. Finalise required levels.
2. Decide grade of mortar.
3. Mixing of waterproof compound
4. Ensure thickness of mortar
5. Ensure thickness of shahabad stone.
6. Grouting of cement mortar.
7. Metal grouting in joints.
8. Check plumb of dado
9. Proper filling & finishing of joints
10. Proper curing

CHECKLIST BEFORE WATERPROOFING FOR TOILET

1. Internal plaster of walls, leaving margin of 450mm from the final floor level be completed.
2. Grooving / chasing for concealed G.I. piping / electrical conduit pipe be completed.
3. All concealed G.I. & Electrical work in bathroom / toilet be completed.
4. Removal of all debris from toilet/ bathroom & chiseling of extra mortar, if any, to expose the slab.

5. Completion of making holes in external walls for connecting nahani trap, p trap etc. to external drainage line.
6. Thorough cleaning of bathroom/ toilet with sufficient quantity of water is done.
7. Marking levels on walls with respect to floor level.

CHECKLIST FOR 'BASE COAT' FOR TOILET / BATHROOM WATERPROOFING

1. Any leakage in base slab.
2. Maintain slope of 1:100 from entrance door towards water escape pipe (drainage pipe) with cement mortar 1:4, thickness 25 mm to 40 mm.
3. Complete the base coat on walls up to height of 300 mm above toilet finish floor level covering all beam top junction etc. properly.
4. Flood the base coat with water, upto slab drop top, for minimum 4 days for curing & testing of leakage, if any.
5. Provide 25 mm G.I. / P.V.C. pipe for water escape outlet just above the base coat of W.C./Bath/Toilet.

CHECKLIST FOR 'BRICKBAT COBA' COAT FOR TOILET / BATHROOM WATERPROOFING

1. Lay well burnt brick bats, thoroughly soaked in water, on edge and fill the joint cement mortar in 1:6 proportion with slope of 1:100 ,with waterproofing.
2. Fill the holes in wall for P.V.C./G.I. pipe connection is filled with waterproofing coba.
3. Curing for 4 days & confirm that there is no leakages

CHECKLIST FOR TOPPING COAT FOR TOILET/ BATHROOM WATERPROOFING

1. Topping with 1:4 cement mortar with waterproofing compound and maintain proper slope from entrance to nahani trap & finish with neat cement slurry.
2. Provide curing for minimum 7 days with water. Minimum 7.5 cm depth of water to be maintained.

CHECKLIST FOR TERRACE WATERPROOFING

PREPARATION CHECKS

1. Remove extra mortar accumulated on terrace and clean the surface clean with water.
2. Mix and apply cement slurry on terrace.
3. Leave sufficient margin (approx. 150mm) w/p from terrace door bottom level.
4. Mark the levels on parapet wall all round.
5. Provide rain water pipe outlet bend in correct position.
6. Make available well burnt brick bats, properly soaked in water.

CHECKLIST FOR BRICKBAT COBA COAT FOR TERRACE WATERPROOFING

1. Check for levels & proper slope towards, rain water pipe outlet.
2. Fix the bricks & fill the joints of brick bats with C.M. 1:6 and maintain a slope of 1:150 with waterproofing

compound.

3. Proper round shape to the mortar near water pipe.
4. Curing of brickbat coba for 7 days.

CHECKLIST OF FINAL COAT OF TERRACE WATERPROOFING

1. Spread the cement mortar of 1:4 proportion along with waterproofing compound over brick bat coba.
2. Apply cement slurry over the surface along with waterproofing compound for smooth finish.
3. Mark lines on polished surface.
4. Construct projected edge between the parapet & the watta on the next day.
5. Clean & cure the final coat atleast 21 days by ponding 150mm high water, standing on it.

CHECKLIST FOR CHAJJA WATERPROOFING (before plastering work)

Ensure & confirm:

1. Cleaning the top of the chajja and chiselling out any extra mortar.
2. Top of chajja applying thick cement slurry.
3. Metal screen coat 1:1, 1:2,1:3 as specified.
4. Watta rounding at the junction of chajja & wall.
5. Curing for atleast 7 days.

CHECKLIST FOR SLOPPING TERRACE WATERPROOFING (before any other architectural treatment)

Ensure & confirm:

1. Cleaning sloping surface of slab properly.
2. Making metal screen coat 1:1,1:2 properly.
3. Applying finishing coat with C.M. 1:4 & water proofing method.
4. Making edge between parapet wall & sloping slab.
5. Curing the waterproofing for atleast 15 days.

CHECKLIST FOR PLUMBING

1. Ensure that all fixtures like bibcocks, mixers etc. are fixed properly.
2. Confirm that there is no leakage from cocks/ other C.P. fixtures.
3. Confirm that there is proper pressure to all the cocks / other C.P. fixtures.
4. Ensure that the half turn flush cock is operating properly.
5. Ensure that there is not any choke up in W.C. after continuous flow of water from half turn flush cock.
6. Confirm that there not any cement lump observed in P-trap of W.C.
7. Ensure that there is not any choke up of Nahani trap of bath room after continuous flow of water for five minutes.
8. Ensure that the hot & cold water mixer is operating properly.
9. Ensure that the boiler connections are properly plugged .

10. Ensure that the low level water tank of E.W.C. is operating properly.
11. Confirm that the seat cover of E.W.C. fixed properly.
12. Ensure that proper cleaning is done for all sanitary fixtures.
13. Confirm that the brackets of W.H.B. are painted with oil paint.
14. Confirm that open G.I. pipes fitting connected to E.W.C.are painted .
15. W.H.B. is fitted properly. (It should not shake).
16. Are there any cracks/ breakages for any of the sanitary fittings.
17. Confirm that there is no leakage from G.I. lines in duct after continuous water flow for fifteen minutes.
18. Confirm that the fixing of G.I. / C.I./ P.V.C. lines in plumb and with proper clamping.
19. Confirm that there is no leakage in the drainage chambers.
20. Confirm that there are no cracks on white cement filled between wash basin and wall.
21. Confirm that there is no leakage in the main inlet and outlet G.I. lines or water tanks.
22. Ensure that the P.V.C. outlet pipes for wash hand basin and kitchen sink are fixed properly.
23. Ensure that the escape spouts from W.C. and bath are provided.

CHECKLIST FOR DOORS & WINDOWS

DOORS

Ensure & confirm:

1. Customer changes if any.
2. Size & specification of shutter.
3. Side of opening.
4. Slots & spacing of hinges.
5. Frames for plumb & alignment
6. Lipping provided or not.
7. Fixtures as per specifications and standard position(heights) of fittings.
8. Painting or polishing done properly to shutters, lipping etc.
9. All screws are fitted with screw driver & not hammered.
10. Clearance from all sides of shutters.

ALUMINUM WINDOWS

Ensure & confirm:

1. Right angle for the window.
2. Diagonal of the window
3. Details of tracks as per drawings
4. Weight range of sections.
5. Gap between the window and the walls.
6. Holes in the tracks are inside or outside.
7. Operation of the shutters.

8. Provision of screws to all four sides of windows.
9. Cleanliness of the track
10. Covering paper
11. Sealout filing on gaps.
12. Thickness of glass.
13. Quality & defects of glass.
14. Quality and operation of rollers
15. Handles and locking system fitted properly.
16. Intactness of rubber packing all around.

CHECKLIST FOR PAINTING

Internal wall painting

Ensure & confirm:

1. Check that curing period is completed.
2. Wall has been scrapped for all unwanted material like excess cement, mortar, nails, dust etc.
3. The mix and application of donga is done properly.
4. Donga has been removed completely and wall surface is rubbed by fine grade paper 120 No.
5. Mix, preparation and application of primer.
6. Primer allowed to dry for atleast 24 hours before application of putty.
7. All the undulations of minor nature, dents, cracks, etc. are filled up with putty and surface is smooth to receive paint.
8. Surface has been rubbed with fine paper to get smooth finish after 24 hours of application of putty.
9. Mix, preparation and application of first coat of distemper.
10. The floor has been cleaned immediately and first coat is allowed to dry for atleast 24 hours, before application of successive coat.
11. Cleaning of the window glass, terrace, floor, pipes, doors, fixtures, electrical switches etc. has been done properly.

Oil paint

For M.S. Windows, doors, gates, grills & railings etc.

Ensure & confirm:

1. All cement mortar, unwanted welding burr etc. are removed before application of primer.
2. Free movement of hinges, working systems before application of primer.
3. Application of zinc cromite metal primer before application of first coat of oil paint.
4. Application of first coat of oil paint.
5. Application of second coat of oil paint after 24 hours drying of first coat.
6. Cleaning of the window glass, terrace, floor, pipes, doors, fixtures, electrical switches etc. has been done properly.

For wooden Doors

1. The door frames for its line, level, plumb, quality and door shutter for its free movement, bent, termite attack etc.
2. Wood primer is applied.
3. Putty has been filled in all the holes, gaps, depressions, etc. and the surface is ready to get first coat.
4. First coat for colour, mix and application.
5. Application of second coat after 24 hours drying of first coat and application of putty.
6. Cleaning of floor and fittings has been done properly.
7. Cleaning of the window glass, terrace, floor, pipes, doors, fixtures, electrical switches etc. has been done properly.

EXTERNAL WALL PAINTING (CEMENT PAINT)

Ensure & confirm:

1. External wall surface is cleaned properly.
2. All the electrical and plumbing holes are finished properly before the application of the first coat.
3. The surface is watered for 12 hours before application of the first coat
4. The first coat for proper mix, preparation, thickness & finishing of surface.
5. Curing for 7 days has been done.
6. Second coat for proper mix, preparation, thickness & finishing of surface.
7. Cleaning of the window glass, terrace, floor, pipes, doors, fixtures, electrical switches etc. has been done properly.

CHECKLIST FOR ELECTRICAL WORK

Ensure & confirm:

1. No. of points in each rooms as per drawing.
2. Location of the points.
3. Height of all boards and points as required.
4. Line, level and alignment of casing caping /switch boards/ light points.
5. All material is of approved quality and specifications.
6. Size of boards as per the fixtures on it.
7. Internal connections in board for phase and neutral distribution is proper.
8. Colour codes and size of wires used for various points are as specified.
9. Operation of all the switches for smooth working.
10. The quality and tightening of all the screws with required spacing and with proper gripes /rawal plugs.
11. The earthing connections for its proper working.
12. The supply of all the points by megger or test lamp and final testing report is prepared.
13. The wiring in meter cabinet for quality, colour codes of wires, gauge of wire, main switches, connections

in bus bar etc.

14. The name of the flat holder painted on concerned meter and main switch.
15. The size of cables for required capacity.
16. The main supply for sufficient voltage.
17. The parking, street lightening and all common supply.

CHECKLIST FOR ELEVATORS (LIFTS)

Ensure & confirm:

1. Lift pit & shaft size as per lift manufacturer's specification.
2. Waterproofing to the lift shaft & top of the machine room slab.
3. Size of the lift shaft, size of all door openings, floor levels & height of machine room as per manufacturer's requirement.
4. Cleaning of lift pit, shafts & ducts.
5. All material produced is as per the specification.
6. Angles and channels drooping in the lift shaft/ duct.
7. Scaffolding is made in the lift shafts is steady and approved by the lift erector.
8. Fixing of template.
9. All the door frames (Except ground floor) are kept in the plumb line fixed by the erector.
10. Rope hole in the bottom slab of machine room & pockets are made in the side walls for clamping of angles.
11. Grouting of brackets & its rigidity
12. Whitewash in the lift shaft.
13. For the machine room :- I.P.S.Flooring, Ventilation/ exhaust fan, shutter fixing & painting of machine room.
14. Angles (rails) fixing and roping.
15. Machine of the lift is fixed with proper bolting, grouting and anti vibration pads are fixed below it.
16. Flooring in the landing is done as per levels fixed previously and slope of the flooring is always away from the lift.
17. Button box holes are marked and made properly.
18. Three-phase meter exclusively for each lift.
19. All safety arrangement as a) ladder for pit b) weld mesh guard to the motor c) weld mesh guard to the window to avoid entry of the birds. d) all safety indicators working properly e) Effective key operations f) Emergency key operations g) Instruction plates for the passengers' guidance h) Earthing done properly.
20. While the trial run of the lift that, there are no jerks and sudden stops, floor level matching to the lift level at all floors.
21. Ensure about the guarantee period and certification from P.W.D.

CHECKLIST FOR FIREFIGHTING

Ensure & confirm:

1. The capacity of O.H.W.T. & a separate provision in that tank for fire fighting water storage.
2. Other requirements as per Municipal Authorities mentioned in the provisional N.O.C.
3. Authorised agency for fire fighting installation work.
4. Quality of material supplied by the contractor; refer work order.
5. Civil work like excavation, making holes to the bricks, wall, concrete and refinishing is done properly as per the requirement of working agency.
6. Scaffolding fixed in such a way that no work in fire fighting system erection is disturbed.
7. Testing done before inspection by Municipal Authorities.
8. All G.I. / M.S. pipelines for straightness, level, plumb etc. for perfectness.
9. G.I./M.S line painted in red colour.
10. All fire Extinguishers are working and are installed at proper locations.
11. Fire hydrants are easily accessible.

General

1. Demarcation of road on the layout plan and type of road to be provided. Distinguish roads, ramps, open parkings areas, pavings etc.
2. Longitudinal and cross section of the existing ground level with respect to T.B.M.
3. The layers in foundation (sub base) and base course and thickness of wearing surface.
4. The formation level with respect to plinth level of buildings and approach road.
5. Balancing of cutting and filling.
6. The longitudinal slope, camber, super elevation etc.
7. The cross Drains, Service line ducts.

Sub base

1. Initial ground level.
2. Excavated final ground level.
3. Murum filling in layers and rolling by 10 to 12 T roller.
4. Record final sub grade levels

Base coat

1. Record initial levels of sub base.
2. The pipes are laid for cross drain, electrical, drainage, water line and any other service line.
3. Soling with stone laid on their edges and chips filled in voids properly.
4. Width of soling 0.3m more than the width of the road.
5. Rolling of the road by 10 to 12 T roller.
6. Record final formation levels.

Bituminous Road (On base course)

1. Record initial levels.
2. Spreading the grit as per specification
3. Proper slope, gradient, camber.
4. Grouting pattern (semi grout/ full grout) & weight of bitumen per square meter area.
5. Spreading of grit when bitumen is hot. Ensure the compaction by rolling.
6. Final levels.

Tack coat, Carpet & Seal coat (On base course)

1. Record initial levels.
2. Weight of bitumen per Sq.meter area.
3. Mixing of 20 mm & 12 mm, metal with bitumen.
4. Spreading the mixture in uniform thickness.
5. Rolling when mix is hot

   Same procedure to be adopted for seal coat. (Metal size smaller).
6. Record final levels.
7. Provision of speed breakers.

Concrete Road (On base Course)

1. Initial level of the base course.
2. Drawing showing lay out of concrete panels, expansion joints, construction joints.
3. Proper cleaning.
4. Channel thickness to match concrete thickness.
5. Grade of concrete/ mix design.
6. Concreting in alternate bays.
7. Filler for expansion joints.
8. Needle vibrator and screed vibrator.
9. Mechanical trovelling and vacuum dewatering
10. Broom finish
11. Curing by ponding
12. Filling bitumen 25 mm thick and deep, in joints.
13. Provision for speed breakers.

Paving Blocks (On base Course)

1. Approved drawing
2. Levels
3. Pattern of fixing
4. Blocks fixed in proper line, level and pattern with compaction.

CHECKLIST FOR STORM WATER SYSTEM

Ensure & confirm:

1. Approved drawing
2. Ensure that the storm water drain is not connected to sewage line in any case.
3. Ensure that no turbulence is created at junctions.
4. Periodic cleaning/pre monsoon precautions.

CHECKLIST FOR FABRICATION

Ensure & confirm:

1. The approved drawings, customer changes with N.O.C.
2. The material for the approved specifications prior to placing the order.
3. The material as per specifications.
4. a) Diagonal/Angles b) plumb c) Design d) joints welding e) Grounding of joints
5. Painting a) primer coat b) paint as per specification
6. Any damages created during erection, to be rectified.
8. Final touch ups.

COMPLETION PROCESS

The physical completion of a residential or commercial building does not permit the occupation and use of the building legally. The legal formalities with various government departments and local competent authority are to be completed before starting use of the building.

The following ‘No objection certificates’ (N.O.C.’s) are required to be sanctioned from relevant authorities.

1) Structural stability certificate.
2) Tax clearance certificate.
3) Drainage completion certificate.
4) Water supply system completion certificate.
5) Fire fighting system completion certificate.
6) N.O.C. from garden department.
7) N.O.C. from Encroachment department.
8) N.O.C. for lift from P.W.D.
9) Road completion certificate.

After getting this N.O.C’s and getting any other certificates as required; the local authority issues the final completion certificate i.e. occupation certificate.

The individual flat or shop can be handed over in the possession of the customer only after getting the occupation certificate..

HANDING OVER POSSESION OF A FLAT/SHOP.

While handing over of a unit, **it is our responsibility to make the customer not only happy but also proud of his new asset**. It is the ultimate stage of work at which all the work is to be completed with each and every corner thoroughly checked. All minor details, finishes are to be taken care of. Check and rectify some minor and important works before intimating the customer about completion.

MINOR THINGS, WHICH NEEDS ATTENTION BEFORE POSSESION

1. Tiling /Dado:

a) Tile cracks at place.
b) Tiles making hollow sound.
c) Butt finish.
d) Joint filling.
e) Shade variation in skirting, flooring and dado tiles.
f) Window sill chamfer.
g) Cutting near floor trap and commode..
h) Proper slope in terraces, toilets & W.C. and Bath.

2. Door shutters / polishing:

a) Stopper fixed flush to the floor.

b) Alignment of tower bolt & tadipatti.

c) Screws to hinges .

d) Gap in doorframe and shutters.

e) Polishing to door shutter and frame.

f) Final finishing of shutters left out

g) Polished / painted Top of door shutter .

3. Painting:

a) Edges of walls and undulations at wall surface.

b) Painting finish above skirting.

c) Cutting edges for oil paint and distemper.

d) Brush mark appears at ceilings and walls.

e) Finishing below kitchen otta

f) Doors, windows & electrical fixtures cleaning.

g) Paint stains on tiles, windowsills & sanitary wares.

4. C.P.Fittings:

a) Leakage from bottle trap / waist coupling and taps.

b) Choke up in balcony spout, nahani traps.

c) Proper fixing of Wash hand basin/flush tanks.

5. Aluminum window & doors:

a) Cleaning of tracks.

b) Play to shutters operating.

c) Drain holes for gutters to bottom tracks

d) Standard locking Patti for louvers.

e) Rusting of screws.

6. Kitchen platform:

a) Proper slope towards sink.

b) Proper sealing of all joints.

c) Proper finishing at nahani traps.

d) Edge chamfering, polishing of fascia raised from top.

e) Proper cleaning & polishing of Kadappa verticals & bottom.

f) Properly finished gas holes.

g) Proper finishing of overall platform.

h) Proper joint filing of dado.

These are few points, which needs care to be taken during finalization of flat.

1) Complete all works like tiling, otta, dado, sanitary fixing, door shutters with its fittings and painting work

up to your full satisfaction.

2) Carry out acid wash of floor (if specified) and dado of the flat with its proper joint filling with filler materials.

3) Final coat of painting, if required touch ups etc., cleaning; mopping the floor is to be completed.

4) Check the flat for all the items.

5) Confirm and check the finalized unit personally.

6) If any point executed is improper, get the same done properly. Inform the customer accordingly before handing over the unit.

HANDING OVER THE FLAT / UNIT.

For a Customer, taking possession of his flat is a **'Dream comes true'** stage.

1) Ask the customer to visit his flat, accompany him; wait for his observations before taking possession. If any defects or incomplete work is pointed out by the customer and if you feel that it needs to be done, get the same done, at earliest.

2) As per the procedure, take the possession card/note from the customer. Satisfactory note is to be signed by the customer for taking possession in good condition.

3) After getting signatures of customer on possession card/note and acceptance letter, hand over all keys of flats.

4) Do not handover the keys

   a) To carry out furniture work before completing entire work within the flat

   b) Without the signature of client on satisfactory note.

5) Explain and assure the customer about After Sales Service and hand over a copy of maintenance manual.

WISH HIM / HER HAPPY PROSPEROUS AND PEACEFUL LIFE AT THE NEW PREMISES WITH A WARMTH.

SATISFACTORY NOTE (Specimen)

Date:

To,

……………………..

………………………

…………………………

Received possession of unit no. ……………. Of building /unit……………………….

At site …………………………………………

Observed following :

Sr. No.	Item	Satisfactory	Unsatisfactory
1.	All doors & windows with fixtures		
2.	All toilets including a) Glazed tiles b) Sanitary fittings c) C.P. Fittings		
3.	Electrical accessories		
4.	Painting & cleaning		
5.	Flooring		
6.	Kitchen otta		
7.	Extra work (if any)		

I Mr. / Mrs.……………………………………….. Found the total unit in acceptable condition and intend to take the possession as per our legal agreement.

Client signature   Engineer signature

FORMATION OF LEGALLY CONSTITUED BODY OF THE OCCUPANTS

Once the project of building or buildings is completed and units are handed over to the respective purchaser; it is necessary to transfer the total ownership of the land to a common body, constituted by the unit holders. Usually the promoter or a builder is supposed to execute the final conveyance of the land title in the name of the common body.

As per the Maharashtra state ownership flat act, a legally consolidated body of the members of that buildings is required to be formed.

Such a common body can be formed as apartment or as a co-operative society. Usually co-operative societies are preferred over apartments.

To form a co-operative society minimum 7 to 11 members are required.

A procedure to form a co-operative society of unit holders is as follows:-

1) The builder initiates the process as the chief promoter alongwith the proposed members of the society.
2) The chief promoter shall submit an application to the registrar of co-operative societies of the respective jurisdiction with following documents.
   a) Title search report of land
   b) N.A. order
   c) U.L.C. order
   d) 7/12 extract
   e) Power of attorney or land purchase agreement
   f) Y form and Z form
   g) Commencement certificate
   h) Completion certificate
   i) Approved Drawings set
   j) List of members
   k) Bye- laws book duly signed by proposed members
   l) Four alternative suggestive names for the societies.
3) After scrutinizing the application and the documents the Registrar of the co-operatives issue the Registration certificate mentioning the Registration number and the name of the society.
4) Alongwith this registration certificate the Registrar issues the permission to open a bank account in district center co-operative bank for depositing the share amount collected from members.
5) After collecting the share certificate amount in the bank, share certificates are issued in the proportion of five numbers per members.
6) At this stage, the First Annual General Body Meeting is organized for electing the Managing Committee members; chairman, secretary and treasurer are elected from this Managing committee.
7) In case, if a builder is chief promoter of society; he can withdraw from the society after completing the above formalities.
8) The final conveyance of the land title is now executed between the builder and the legally formed co-operative society.

MAINTENANCE

Every product or service, needs periodic maintenance for its efficient performance. The maintenance carried out in a scheduled time avoids the total failure of a service. This helps to create discipline, peacefulness and harmony in the people, related to that product or service.

Generally maintenance can be classified as:-

a) Preventive maintenance.

b) Creative maintenance.

If the preventive maintenance is carried out efficiently then the corrective maintenance is rarely required. Therefore the maintenance manager shall concentrate more on the Preventive maintenance.

Many times it happens that, on failure of a specific service, people create chaos, till the corrective measures are taken**. Public memory being weak;** the necessary suggestions for the **preventive measures are forgotten till the next failure**.. During a crisis, the affected people are expecting some **'Immediate Relief'** and also a **long-term solution** to a problem. Therefore it is a very critical duty of a maintenance manager to achieve the Golden-mean during crisis.

To achieve this, Golden mean between Preventive and Corrective maintenance some suggestions are given herewith.

1. Maintain a log-book of all the services pertaining to a project. The log-book of each machine, equipment, service shall be maintained separately. The log-book contains the following information, in the following format.

Name of the Project:……………………………………………….

Name of the Machine / service:……………………………………

Name of the supplier/ contractor/ erector with address:…………..

Telephone No……………………………………………………

Contact person…………………………………………………..

Date of commissioning of the machine:……………………………

Recommended special Precautions, if any:………………………..

Recommended frequency of maintenance: Daily/Weekly / fortnightly / Monthly / Quarterly / Half-yearly / Yearly.

LOG-BOOK

Sr. No.	Date of commissioning	Due date of maintenance & Date of subsequent maintenance	Actual date of maintenance	Description of maintenance done	Sign	Remark

These due dates of maintenance shall be displayed near the machine prominently. This helps to remind the servicemen to carry out the maintenance in scheduled time.

The description of maintenance will help to decide about the 'Actual Health' of the concerned machine and its probable life. This helps to arrange the standby machine to avoid the total failure and its consequences. Inspite of, carrying out the preventive maintenance carefully: some failures in the machine may occur, but the severity of the failure will be restricted.

In case of failures on some occasions, the corrective maintenance shall be carried out immediately. A simple Log-book shall be maintained to record the description of the failure and the measures taken for rectification.

This record helps to learn about the ' Continual Improvement' in the 'Preventive Maintenance' in the future. Accordingly the focus of 'Preventive maintenance' shall be widened in the future.

So far as, the Construction Industry is concerned and especially the 'Housing construction Industry' is concerned; the same point-of-view shall be adopted as discussed above, for the maintenance of a flat, bunglow, shop, the related services and the project as a whole.

Considering the smallest unit, a flat, as the starting point, let us try to resolve the problems related to maintenance, as follows:

POSSIBLE PROBLEMS THAT MAY ARISE IN A UNIT(FLAT) AND THE SOLUTIONS THEREOF :

1) WALL CRACKS: - These may appear in the internal and external plaster in initial years of occupation due to following reasons as per I.S. codes.

a) Moisture changes.

b) Thermal variations.

c) Elastic deformation

d) Creep

e) Chemical reaction.

f) Foundation movement and settlement of soil.

g) Vegetation.

h) Earthquake.

A study report indicates very high percentage of cracks in Pune region, due to temperature variation in day and night time.

Do not panic. The process of cracks may continue for couple of years. After that you can simply fill cracks with primer putty and repaint the walls and see them without cracks for at least of 2-3 years.

2) DOORS: Hinges of doors should be oiled regularly, at least once in three months.

DOOR AND LATCHES: - After a period of time you may find the doors in your unit do not shut properly and the latches no longer seem to work perfectly.

This happens because self-weight of the door combined with temperature fluctuations and expansion and contraction of wood causes a shift in the original position of the doors. Just wait till the season changes and see things fall back into place. Or of required you can call a carpenter, who will rectify the problem.

3) FLOORING:

a) Marble tiles flooring: - The white marble floor should be cleaned with a little kerosene in warm water, twice a month.

b) Ceramic tiles flooring: - The ceramic tile flooring should be cleaned with detergent diluted liquid. In no case, should concentrate acids be used. Corners and skirting should be cleaned daily to keep them looking as good as new. Corners and skirting should be cleaned daily to keep them looking as good as new. If any further furniture work is done later on, remove the wood shaving and sawdust on the same day. No water should be allowed to mix with shaving, as it will leave permanent stains on the floor. No tea, coffee or cigarette butts should be dropped on the floor tiles, as they will leave permanent stains on the floor. Do not allow any workman to drag ladders or drop heavy tools like hammer etc on the floor. This will damage the tiles. Covering the bottom of the ladder with a piece of cloth or rubber gattus will prevent this damage.

4) ELECTRICAL BILLS: The electric bills for common electricity should be paid by the apartment condominium in time. The first bill is generally sent by Electricity Board after six months of installation of meter. Subsequently the bill is received regularly after every two months. In case the bill is not received, it is the duty of members to follow up with the Electricity Board directly and get it prepared from then to avoid disconnection. As far as the individual bill is concerned, each unit owner has to pay it within the prescribed date on it to avoid problems.

5) PREMONSOON PRECAUTIONS:

Monsoon season can be made safer for your new building, if little care is taken prior to monsoon, as explained below: -

1) Keep the terrace fully clean.
2) Clean the top slabs of all overhead water tanks, ensure the covers are properly closed.
3) Check all the rainwater lines. Remove the chokeup if any.
4) Keep the rainwater gutter along the road fully clean.
5) Do not allow any stagnant water in premises for longer period as it may cause danger to compound wall.
6) Clean the weep holes of compound wall/garden/retaining wall.
7) Check the loose antennas, lamp mounting, hoardings etc, for their stability.

   Check this once in 7 days in monsoon season and every fortnightly in other seasons and then the problem of leakage can be minimized.

6) DAMP PATCHES:

In the first 2 to 3 monsoons, damp patches and resulting cracks may appear in the walls due to seepage. But this is not a construction fault. Just wait for 2 to 3 summer and then do the patching of damp spots, filling the cracks and repainting the walls, and you should not see the problem again.

7) LEAKY TAPS:-

After a period of time due to regular usages; leading to leaky taps washers in the taps may get worn out, leading to leaky taps. You can solve it by replacing the washers, even by yourselves.

8) ELECTRICAL FAULTS:

In case of any electrical faults or problems, please call Electricity Board complaint center. If the problem does not involve the Electricity Board then please call licensed electrical contractor to set the things right.

9) TERMITE ATTACK:

Think of anti termite treatment as an insurance against termites. No home whatever old or new, concrete, wood, brick, slab type is safe from termite as thereis no such thing available as termite proof constructions. Though we have taken precaution to avoid termite attack, but costly furniture, clothes, books, documents, plastic insulation provide a convenient substitute for natural food of termite. Hence, it is advisable to have anti termite treatment (Pest control) to your furniture may be new or old after every couple of years. Hence instead of hoping, Termites do not attack, make sure that they can't attack and be protected.

GENERAL INSTRUCTIONS:

Following are the few tips to be kept in mind by the society members for proper and smooth running of the common services.

SECURITY:

1) Please park your vehicles in your allotted parking & ask your visitors not to park their vehicles in reserved parkings. This will help the security to identify the unauthorized person.
2) If you find any unauthorized person lingering in & around your building, please inform the security guards on duty, at the earliest.
3) Inform & furnish the details of maidservants & tenants with two copies of photographs to the security.
4) For any security problem, you may contact the head of the security services on his phone number.
5) Before leaving your residence, please get assure that you have closed all the water taps, put off gas connection, electrical switches & all the doors windows are locked properly.
6) If you have called any visitor, sales representative to your home, then please inform the security in advance.
7) Apart from security, the guards are also responsible for controlling the water supply & generator system.

WATER SUPPLY:

- o Please do not wash your floors & balconies daily. Just mop it by wet cloth.
- o Please do not wash your vehicles in scarcity of water.
- o Please see that water does not spill from your plantation pots. Proper arrangement of trays below the flower pots should be made.
- o Water never gets stale, hence, do not throw it.
- o Please ensure that water taps are closed while you are leaving your flat.

LIFT:

1) Do not overload the lift beyond its capacity
2) Carrying of construction & furniture material, heavy household objects such as refrigerator, cupboards, drums, grain bags etc. are **strictly prohibited.**
3) Open & close lift doors slowly & firmly. **Do not bang the doors or do not keep the doors open.**
4) Do not play with doors & switch panel. Do not put hands through collapsible doors while the lift is moving.
5) Do not try to open the lift doors, when the lift is in motion. Always wait for the lift to stop at floor.
6) **Children's below 10 yrs. Age should not operate the lift alone.** Parents are requested to take care of their children.
7) If lift is stuck in between the floors, make sure that, main T.P. SWITCH is put OFF, before trying any rescue operation.
8) For any problem contact immediately the person concerned.
9) In case of electricity failure, please have some patience till the generator is put ON.

Important telephone numbers shall be maintained at easily visible place.

1. Society or site office.
2. Lift maintenance Agency.
3. D.G.Set maintenance Agency.
4. Security supervisor / Head office.
5. Electrical complaint Centre.
6. Municipal Ward office.
7. Police station.

Telephone numbers of Emergency services shall also be maintained:

1. Police (city) .
2. Police control room.
3. Ambulance services.
4. Hospitals.
5. Blood Banks.
6. Heart Brigade.

7. 24 hour Chemists.
8. Railway Enquiry.
9. Railway Reservation Enquiry.
10. Airport general enquiry.
11. Airport reservation Enquiry.
12. State Transport Bus stands.
13. Taxi stands.
14. Municipal Corporation.
15. Municipal Complaint Service.

LEGAL ASPECTS

The housing construction projects are mainly governed by the state government Laws. E.g.

1) Ownership of Flats Act
2) Town Planning Act - MRTP
3) Land Ceilings Act
4) Land Acquisition Laws
5) Revenue Acts and Laws
6) MSEB Act

The Central Government also governs the housing construction industry through various laws e.g.

7) Income Tax Act
8. Contracts Act
9. Labour Laws
10. Atrocities Act
11. Human rights Act.

Apart from these laws and acts the housing construction industry is required to follow the rules & regulations laid down by the local authorities like municipalities and municipal corporations.

All the laws, acts, rules and regulations are revised from time to time, as per the social need & public demand. But a civil engineer should be aware of these laws so as to avoid complications during the work.

A civil engineer shall also be aware of the jurisdictions of various government departments. This helps to meet the needs during emergencies.

THE IMPORTANCE OF MACHINERY IN CONSTRUCTUION INDUSTRY

The variety of machinery plays an important role in the construction industry. Though the construction industry is more labour- intensive, the modern time demands a rapid speed in construction. The construction industry; being the 'Mother Industry' of all other industries, has to shoulder the responsibility of constructing the basic infrastructure for other industries. The construction of roads, water supply schemes, electrical substations and residential colonies; creates the infrastructure. The financial feasibility of other industries depends on the faster completion of the construction projects. Therefore a variety of machines are required to cope-with the required speed, gigantic quantities of items, precision and efficiency.

All the above modern demands can be met with, by using various machines, tools in a construction project. But let us not forget that the efficiency of the various machines depend on their 'Regular Periodic Maintenance' (R.P.M.). The otherwise efficient machines can become a devil if not maintained properly. Some of the machines used in the construction industry are tabled overleaf:

Sr.No.	Item of work	Machinery needed	Remark
1.	Excavation	Excavator	
		Earthmover	
		Transportation fleet-	
		dumpers, trucks, tractors with hydraulic trolleys.	
		Pneumatic compressors with breakers and jack hammers etc.	
		Dewatering diesel or electrical pumps	
		Sewage	
2.	R.C.C. work	Concrete mixer	
		Weigh batcher	
		Vibrators with different diameters needles.	
		Surface vibrators	
		Lift with guide rails and scaffoldings	
		Wood cutting hand machines	
3.	Masonry and plaster	Material lifting hoist /lift	
		Dubbing (spray) plaster machine	
4.	Waterproofing	Material lifting hoist	
5.	Tiling	Tile cutting machine	
		Grinder machine	
		Buffing machine	
		Polishing machine	
		Ceramic tile hand cutter	
6.	Plumbing	Drill machine	
		Cutting machine	
		Pressure testing machine	
7.	Joinery work	Drill machine	
		Cutter machine	
		Lock hole cutting/ drill machine	
8.	Alumonium windows	Section cutting machine	
		Drill machine	
		Glass cutter	
9.	Painting	Compressor with gun for spray painting	
10.	Fabrication	Section cutting machine	
		Bending machine	
		Table type drill machine	
		Hand drill machine	
		Grinding machine	
		Welding transformer with holders	
		Spray-painting compressor with gun.	
11.	Electrical work	Cutter machine	
		Drill machine	
		Crimping machine	

SECTION

IV

DEVELOPMENTAL WORKS

1) DEVELOPMENT - INTRODUCTION
2) ROADS
3) COMPOUND WALLS
4) WATER SUPPLY
5) RAIN WATER HARVESTING SYSTEM
7) GENERATORS
8) LANDSCAPED GARDEN
9) SWIMMING POOL
10) CLUB HOUSE
11) INTERCOM SYSTEM
12) LIGHTENING ARRESTOR

DEVELOPMENT

INTRODUCTION :

Development of a project involves the establishment of the necessary services supportive to the main structure.

Therefore some of the development activities are required to be carried out before the main project starts. In the same fashion, some development activities are carried out simultaneously as per the progress of the project. Some activities are such that, those can be executed only after the completion of the project. These development works not only give the service but also add to the beauty, security, value & saleability of the main project.

As per the necessity of the main project, the sequence and the interdependence of the works shall be decided before hand. This helps to avoid the failure of various services to maintain their serviceability The planned sequence of the development works helps to reduce the cost of the works as well as the cost of repetitive works and saves time.

The pre-decided sequence of development works as per the necessity of the project is usually as given below.

1) Access road
    - Access to the project
    - Access for the individual units & buildings.
2) Confirming & demarcating the boundaries of the land.
3) Contour & plane table survey.
4) Constructing boundary walls / fencing.
5) Cleaning & leveling of the land, for deciding the location for site office, cement godown, steel yard, water storage tank & network of streetlight, labour camp, water supply arrangement & security cabin etc.
6) Water supply arrangement
    - Temporary water supply for the construction & labour camp.
    - Permanent water supply arrangement.
7) Electricity supply arrangement
    - Temporary arrangement for the construction purpose.
    - Permanent arrangement.
8) Drainage arrangement
    - Temporary arrangement for labour camp & for the staff & visitors.
    - Permanent arrangement.
9) Services for communication (i.e. telephone ducting).
10) Clubhouse consisting of following (If planned and specified)
    - Gymnasium

- Jacuzzi bath
- Steam & sauna bath
- Billiards room
- T.T.Room
- Squash court
- Cards room
- Carom room
- Balling alley
- Skating rings
- Cafeteria
- Recreation hall
- Dancing floor
- Tennis court,
- Badminton court
- Basketball court.
- Golf putting
- Jogging Track
- Children's play park
- Amphi Theater

  Swimming pool

11) Landscaped Garden
12) Intercom system
13) Solar water heating system
14) Rain water harvesting system
15) Garbage disposal system
16) Internet connections
17) Sewage treatment plant
18) Parking
19) Vermiculture system
20) Local transport
21) Fire fighting system
22) Lifts & Elevators
23) Generator
24) Reticulated gas supply system
25) Overall security system
26) Schools, Temples, Dispensary, etc.
27) Essential commodities shopping.
28) Any other amenities.

After going through the list of development works, everybody will understand that the serviceability of all the amenities, depends on the foresight in the project planning, monitoring of the planning during the execution of the works. The engineer at site shoulders the prime responsibility during all this development at site.

Development works require efficient co-ordination of the management, consultants, local authorities, contractors & many other parameters. The time duration for development works is sometimes more than, that of the main project.

Therefore it is very essential to decide, maintain & document the total flow of technical information till the end of the project.

The well-documented technical information helps the successive changed staff to maintain the continuity of the progress of work as planned. These documents also help in maintaining all the services in the desired conditions.

The timely maintenance of all these services lead to the ultimate aim of customer satisfaction. The feed back from the users of these amenities & the information collected during the execution of the works, adds more to experience & foresight of the engineers. This helps them to take on the further works in the spirit of continual improvement.

The detailed procedures of executing some peculiar development works are highlighted hereafter.

ROADS

Roads: - Roads are constructed for making way for easy and uninterrupted access to various destinations. Area covered by roads is larger than area covered by structures, and hence it demands more supervision. Utmost care shall be taken while executing the road construction to have an **' IDEAL ROAD'**.

The life & serviceability of a road depends mainly on its foundation. The final finish of the road surface can be bituminous or concrete type, as per the need, but the foundation shall be constructed very carefully.

FOUNDATION OF ROAD: -

A] Excavation: -

- Finalize the finished road levels and make pillars of road level at various points.
- Excavate the ground for a minimum depth of 0.6m for good strata & to a minimum depth of 1.5 meter in black cotton soil.

B] Murrum Filling: -

- Fill the murrum in 150mm thick layers and compact it for the desired density by simultaneously watering it. This process of filling the murum in layers with watering shall be carried out till the desired reduced level is obtained. Every layer of murum shall be watered and compacted at optimum moisture content (O.M.C.)

C] Metalling: -

- Carry out the first layer of metalling with 65 to 75mm size hand broken metal to a depth of 150mm, compacted to 110mm with 10-T to 12-T roller. Every layer shall be watered & then compacted. Desired cambers shall be maintained from these layers for the early runoff of the rain water.
- Carry out the second layer of 100mm thickness, compacted to 75mm with 10-T roller.
- Spread the blindage layer of stone grit over the metelled surface.

This process of construction was invented by one Mr.Macadam & hence is called water bound macadam road (W.B.M.). W.B.M. road serves as the foundation for the final surface finish of the road. The final finishes of roads could be in asphalt, concrete, paving blocks etc. The roadside gutters are recommended to collect & drain off the rain water. The life of any road, depends mainly on the early runoff of rain water.

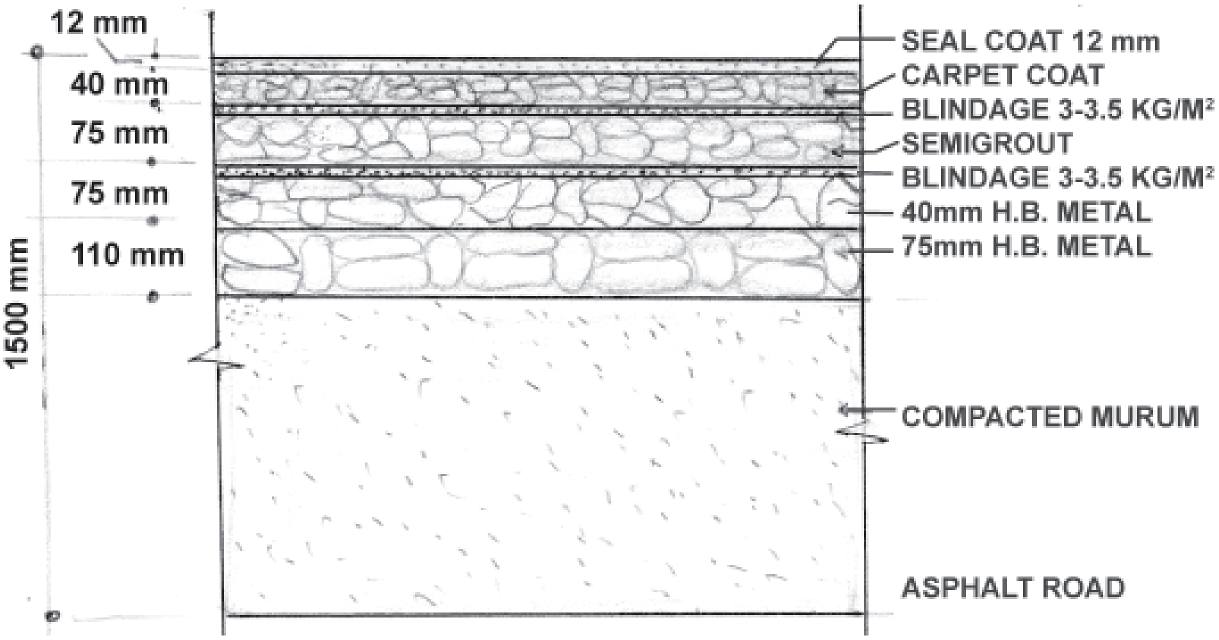
ASPHALT ROAD

Grouting by using Bitumin: -

- Hand broken metal of 40 mm size is spread and compacted in layers till the total thickness of 75 mm is achieved. Bitumen should be grouted at a minimum consumption rate of 3 to 3.5 Kg/m2 of road area.
- Spread a blindage layer of 12mm grit and dust. Compact this layer by a roller of 10 T capacity.

Tack coat & carpet : -

- Clean the surface properly with wire brush to remove the loose grit.



- Apply a coat of bitumen with minimum consumption of bitumen between 1.5 to 2 Kg/m^2.
- Spread a layer of 12 to 20mm metal of thickness 40 mm, compacted to 25 mm mixed with the bitumen content of atleast 1.5 Kg/m^2 .

Seal coat: -

- Spread a layer of 10 to 12 mm thick seal coat with a mix of 100 Kg grit & 5% of bitumen. During all these coats, proper cambare, super elevations shall be maintained to drain off the rain water as fast as possible.

VACCUM DEWATERED CONCRETE ROAD:

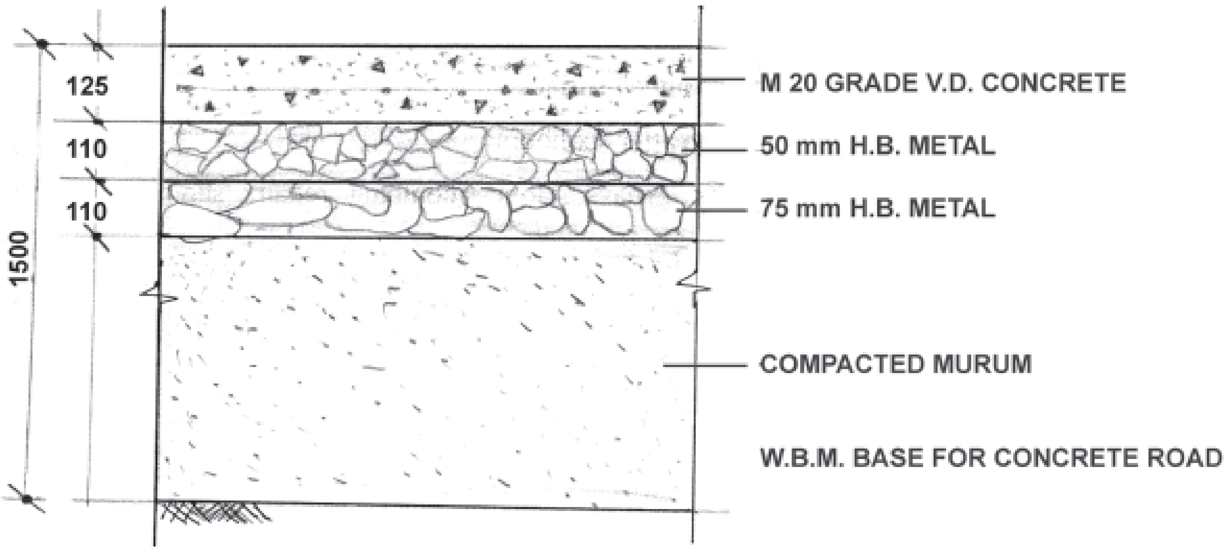
Work Procedure: -

The foundation for this type of road should be constructed by W.B.M. method.

1. The area to be concreted shall be covered with plastic sheet of 100 microns thickness.
2. M.S. Channels shall be fixed maintaining 3.5-meter maximum bay width and according to the slope and level dots.
3. The reinforcement shall be provided as per design and specifications.
4. Concreting shall be done in alternate bays.
5. Concreting shall be started from one end and completed in 2 layers, each layer being vibrated by plate vibrator.
6. The concrete shall be levelled with beam vibrator. This operation is to be done twice to get proper level.
7. After completing the concrete of the bay, filter pad shall be placed above it and then the suction pad shall be placed. Care shall be taken to place the filter pad in such a way that the suction pad goes 6" beyond the filter pad.
8. Dewater the concrete with pressure of 80 kg/cm^2 with dewatering time of 5 minutes for every one inch

depth of concrete.

9. After dewatering is completed, use disc float to get proper finish to the surface.
10. Broom finish the surface.
11. Cure the concrete for 7 days by ponding method and for 28 days by spraying water.
12. After 7 days, make grooves 6mm wide and 50mm deep with grooves cutting machine in an appropriate pattern.
13. Fill bituminous filler in groves.
14. Allow the road for vehicular traffic after 28 days, from casting.



Precautions to be taken while Vacuum Dewatered Concreting work : -

1) Extra corner reinforcement is necessary for each bay.
2) Cut the grooves in concrete to a depth of 1/3rd thickness of concrete.
3) Provide expansion joints at every 30 meters.
4) Provide dowel bars of 16mm diameter M.S. round, 600 mm long. at expansion joints.
5) One end of dowel is embedded in concrete and the other should be greased before concreting of next panel to have free movement in concrete for absorbing shocks.
6) Apply deshuttering agent to the construction joints before casting of adjacent bay.

COMPOUND WALL

Compound walls are constructed to define and secure the plot boundaries. For commencement of compound wall, get the boundaries of the plot marked by city survey department. Foundation of compound wall depends upon foundation stratum.

Types Of Compound Wall: -

1) Stone masonry walls.
2) Brick masonry walls.
3) Barbed wire fencing etc.

***1) Stone Masonry Walls*: -**

In this type of compound wall, foundation and super structure both are in stone masonry.

Following procedure shall be adopted.

a) Excavate up to hard strata.
b) Place 150 mm thick PCC.
c) Start the UCR masonry on 150 mm thick PCC.
d) Keeping the outer face fixed, reduction in width is done from inner sides as per the design depending on the depth of foundation.
e) All the engineering norms shall be practiced for the stone masonry work.

***2) Brick Masonry Work*: -**

In this type of compound wall, foundation may be of stone masonry, RCC or brick masonry depending on foundation strata available. This masonry above ground level is to be carried out as per the design up to the required height. Provide expansion joints at an interval of 15 meter. All the procedural norms for the brickwork shall be followed.

3) Barbed Wire / Chain Link Fencing: -

These types of fencing are mostly used for securing the boundaries of open plots as well as on other types of compound walls, to give additional security.

WATER SUPPLY ARRANGEMENTS

Water is a basic need of all human beings. Inadequate & contaminated water can create social problems. The cleanliness and hygiene of people, depends on the adequate and timely supply of good quality water.

The local municipalities arrange and maintain the water supply of a city. These municipalities lay their rules and regulation for ensuring the adequacy and the quality of waters in all the localities.

A construction project needs large quantity of water. Initially water is required for the construction work and the workers. After completion of the project, water is required for the residents, occupants of the project. Therefore a systematic water supply arrangement shall be designed to avoid wastage and to ensure the continuity of supply.

The water supply system is designed on the following lines.

I. Estimating exact demand of water.

II. Designing the underground & overhead water tanks for their capacity, size and locations.

III. Designing the pumping arrangements with pump capacities.

IV. Designing the locations for various valves such as air release valves, non- return valves etc.

V. Designing all the measures required to avoid leakage, bursting of lines, contamination of water etc.

A simple example will help to understand the method of design.

Consider a residential project having 3 buildings with 28 flats each. Assuming 5 occupants in each flat;

The total water demand per day is

=3no.(buildings)x28 no.(flats) x 5no.(occupants/flat)x135 lit./day/capita

= 56700 liter /day

+5670 liter / day (Added 10 % for common uses like firefighting reserves, evaporation & handling losses)

= 62370 liter / Day

= Say 62000 liters / Day

A suitable water connection is taken from the common water supply of the municipal Authority. Water supply is taken into an underground water storage tank located suitably.

The underground water tank (U.G.tank) is designed for a minimum capacity of 1.5 days demand.

Therefore the capacity of U.G. tank = 1.5 x 62000 liter

= 93000 liters

= 93 cubic meter

A tank of size 8 m x 5 m x 2.4 m (clear height) posses the capacity of 96 cubic meters. Therefore provide a water tank of size 8m long x 5m wide x 2.4 m height (including freeboard)will serve the purpose.

Actual capacity = 96000 liter (96cu. Meter).

The required size can be changed as per the site conditions without changing the capacity. The U.G.

Tank is built as per suitability of design, either in B.B.M. or in R.C.C. work. The tank is covered by R.C.C. slab. Manhole chambers with covers, ladder for entering inside for cleaning, air vent at suitable place and a sump at bottom corner for foot valve of pump etc. are the basic requirements of a U.G.W.T.

The water collected & stored in the U.G.W.T. is then lifted by pumps and rising main line to the O.H.W.T. The selection of pumps is based on, suction & discharge head as required. The O.H.W.T.'s are designed for a capacity of 1 day's domestic demand plus the minimum firefighting reserve stock as per the rules.

In the example discussed above for one building having 28 flats, the water demand & hence the capacity of the O.H.W.T. is worked out as follows.

Domestic Demand for one day = 28 No. X 5 No. x 135 liter / day
= 18900 liters
+10000 (for firefighting purpose)
= 28900 liters
Say 29000 liters
= 29 cu.m

Usually the O.H.W.T. constructed in R.C.C. work, is provided on the top of the staircase block so as also to work as a roof slab of staircase. The staircase block is usually of the size 5 m x 2.5 m. Therefore a O.H.W.T. of size 5 m x 2.5 m x 2.5 m having a capacity of 31.25 cu.m (Including freeboard) will suffice the purpose.

The water supply lines from the O.H.W.T. are provided, as per the designed pressure and diameter, to individual unit (flat, shop etc)

RAINWATER HARVESTING SYSTEMS

Water is the basic need of all living beings. The quality of life of human beings depends not only on the water available to them but also on how much water is made available for vegetation, for agriculture, for cleaning & maintaining hygienic conditions of the surrenderings. this indicates the importance of water & its scientific distribution.

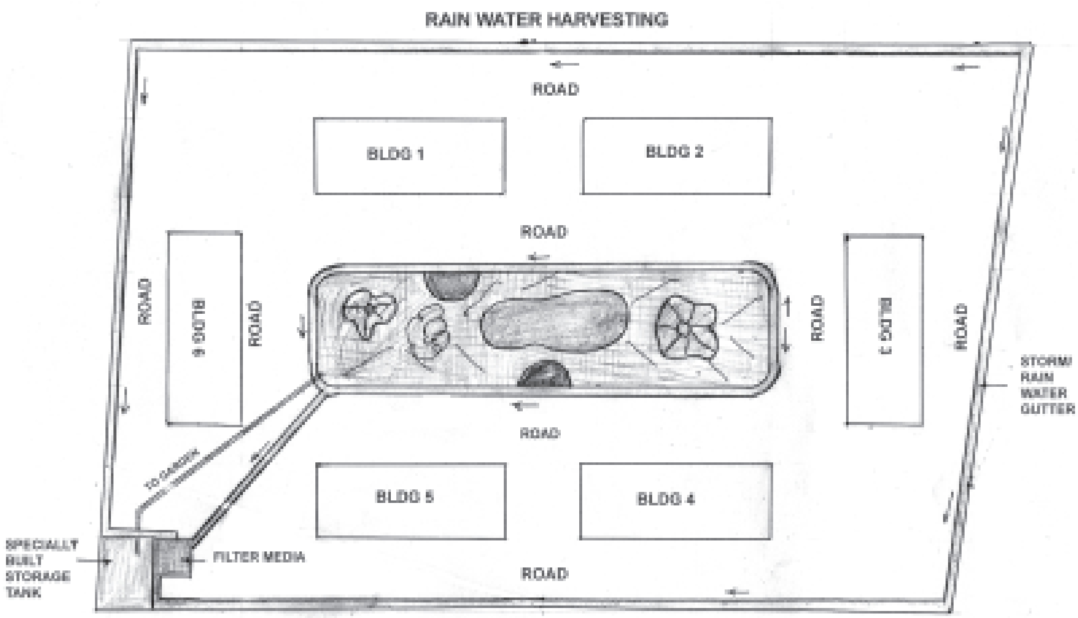
The growing urbanization, changing lifestyles, increasing literacy & awareness are some of the other factors contributing to the increasing demand of water.

The only source of water being rain, the modern civilization is facing a trememdous pressure due to decreasing volumn of rainfall & its unpredictibility. the water is becoming scarce everyday. the ground water table is also going below the desirable levels.

To overcome this grave situation, we are forced to store as much water from rain as possible in a scientific way.

The method of collecting the rain water through a proper system & utilizing it properly till the next rainy season is called as a rainwater harvesting system.

1. ‘Area drains’ are developed to collect and drain off the rainwater from roof terrace, flat terraces and roads.
2. Rainwater gutters are built to the desired slopes.
3. Gutters covered with proper grating.
4. All the network of rainwater derain is terminated at the desired points.
5. All collected water is passed through filter media to bore well/open well, separately constructed water tanks.
6. The stored water helps to overcome the scarcity.



GENERATOR

INTRODUCTION:

Generator is a composite unit, which generates electricity. In case of electricity failure, generator provides backup electricity.

Important Components Of Diesel operated Generating Sets are : -

1) Diesel engine.
2) Alternator
3) Control panel
4) Radiator
5) Battery
6) Diesel tank
7) Canopy
8) Silencer
9) Rain cap
10) Exhaust piping
11) Acoustic enclosure with doors
12) Base frame

Load Calculations for deciding the capacity of a Generating set: -

Consider three buildings, of seven storeys each and every building having 2 bedroom apartments on each floor. The generator backup is given to the following appliances.

1) Lift lighting
2) Staircase lighting
3) Parking lighting
4) Street lighting
5) Water pumps
6) Pumps for the Fire fighting system.

Calculations for the required load for each building are as follows: -

Sr No.	Electrical Points at	Numbers	Wattages	Total load
1	Staircase	8	40 W	320 W
2	Common Terrace	2	40 W	80 W
3	Parking	10	40 W	400 W
4	Lift & machine room	10	40 W	400 W
5	Lift motor	1	7.5 HP	7500 W
6	Pumps for Fire fighting	1	5 HP	5000 W
		TOTAL LOAD		13700 W
				i.e.13.7 KW

Load for Common lighting: -

1) Water pumps – 2nos x 2.0 HP = 4 HP = 4 kw
2) Street lighting – 14nos x 40 w = 560 W =0.56 kw

Total common load = 4.56 KW

. : Total load = 3 buildings x load/building + load for common lighting

= 3 x 13.7 KW + 4.56 KW

= 45.66 KW

Applying diversity factor = as 0.70, designed capacity load

= 0.7 x 45.60 KW

= 31.962 KW

The capacity of the Generator required for the above load is = 35 KVA.

Civil works involved in the installation of D.G. set : -

1) *Foundation:* - The details and sizes for the foundations given by the manufacturer,shall be followed..
2) *Installation of D.G. sets:* - Install the D.G. set on the foundation in specified orientation by keeping workable space on all sides.
3) *Conduiting and cabling:* - Cables shall be laid through RCC hume pipes or in trenches from D.G. set to meter room of each building. Provide feeder pillars of required capacity, at specified locations for the distribution of backup supply.
4) *Earthing:* - Provide earthing to body of the D.G. set, phase and feeder pillars as per the specified norms. Usually 6 nos. of earthings are provided.
5) *Change over switch:* - Provide specified change-over switch.

Commissioning of generator: -

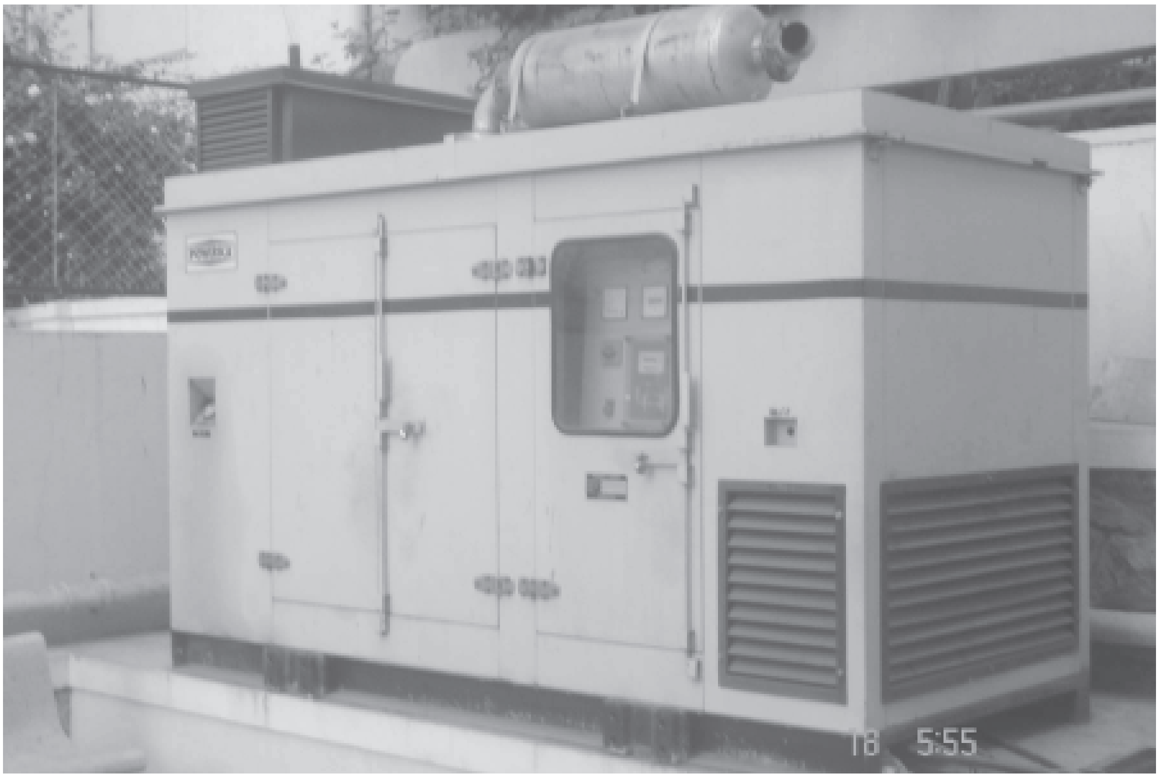
Commissioning of D.G. set should be done in the presence of the representative of the manufacturer and the electrical contractor. Commissioning should be done as per the check list provided by the manufacturer.

Each and every instruction from this checklist should be followed.

The system should be run for a period specified by the consultant before the final inspection. After the final inspection, all the necessary rectifications should be done and recorded.

Periodic checks of D.G. set: -

1) Check level of engine oil, and top up required quantity of oil, if necessary.
2) Check fuel level in fuel tank and protect the top of the tank.
3) Check level of coolant in radiator and top up if necessary.
4) Check for leakage of coolant, fuel and lube oil and rectify.
5) Check if all instruments are functioning.



LANDSCAPED GARDEN

Landscape garden is a common place for the people, who are otherwise living in isolated flats, to gather and develop social relations. A place where people can relax & relieve their stress. This is a place where people can exercise, can organize recreational functions, meet different people & exchange views. A place where children can play safely & develop new friendship ties, participate in healthy competition to realize their overall limitations, realize their physical & mental abilities adding to their overall development. A well developed garden gives a clean & pollution free environment for a healthy living.

To achieve these benefits, the landscaped garden should be located prominently in a township. The trees, lawns & the flowering trees shall be selected so as to provide evergreen, colourful and a pleasant view. The trees, plants & shrubs shall be selected for variety of developed heights, shape & shades, this breaks the monotony in the view & adds to the harmony. A part of the garden can also be reserved for plants having medicinal properties or as reserved sanctuaries for varieties of spacies.

Taking into account, so many benefits of a service, the words, price, cost & maintainability get secondary place.

It is always advisable to appoint a consultant for developing the landscaped garden. All civil work shall be carried over prior to starting the work of plantation.

WORK PROCEDURE FOR LANDSCAPING GARDEN

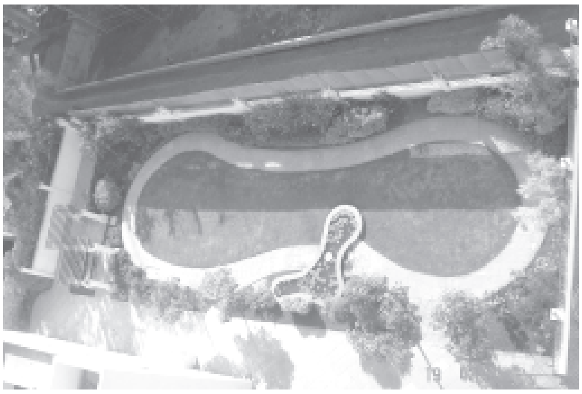
Instructions and specifications of the consultant shall be followed, however normal procedure of work is:

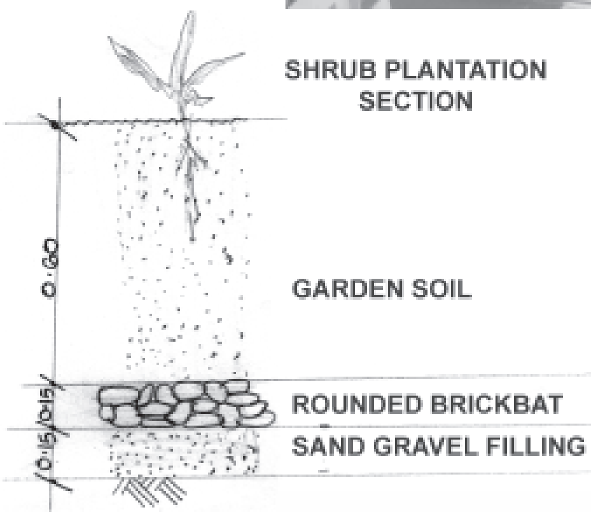
1. Mark the layout as per the approved plan.
2. The soil is to be excavated for a depth of 0.6 m from the final finished level for the plantation of lawn.
3. Spread a layer of sand as bedding.
4. Spread rounded brickbats in a layer of 0.15 m thick uniformly.
5. Spread a layer of 0.23 m thick garden soil, as per the required levels.
6. Mix fertilizers in the garden soil in the desired proportion.
7. The lawn shall be planted over the levelled surface.

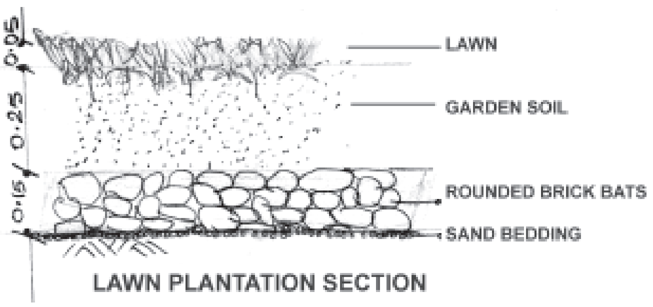
8. Protect the lawn area for minimum two months initially.

For plantation of shrubs

1. Excavate a pit of size 0.6 m x 0.6 m upto a depth of 0.9 m.
2. Lay the sand as a bed, of 0.15 m at the bottom of the pit.
3. A layer of 0.15 m thick, rounded brickbats shall be laid over the sand bed.
4. Fill the remaining 0.6 m depth of the pit with garden soil & appropriate proportion of fertilizers. Water the pit. Thus the pit is ready for plantation.
5. Protect this plantation area for minimum six to nine months.







SWIMMING POOL

A swimming pool serves as a recreational center and as a body-exercising medium for the community. The possibility of physical accidents & health hazards occurring while swimming in a natural source reservoir, are avoided in a **Well-built swimming pool**. Therefore the prime importance shall be given to the following requirements while designing a swimming pool.

- Safety of human life by providing proper size & shape of the pool.
- Proper filtration & circulation system to avoid health hazards.
- Additional safety measures for avoiding trace passing of children and unlearnt swimmers.
- Ease in maintenance.

Quality of water in a pool:

The swimming pool being a public place and water being the best medium for spreading various deceases; utmost care should be taken for, maintaining the Quality of water in the pool

The essential requirements of swimming pool waters are: -

1) The water should be clear, so as to make the bottom of the pool visible, to avoid accidents during diving.
2) The water should be safe to bath in it.
3) The water should have approved quantities of disinfectants, dissolved in it, to immediately remove the bacteria & pollution being added by the bathers from their body.
4) It should have a comfortable temperature of about 27^0 to 30^0 c.
5) Water should be chemically balanced to avoid adverse effect on swimmers' body.
6) The swimming pool & its surroundings shall be maintained clean & hygienic to maintain the quality of the water.

TYPES OF SWIMMING POOL

1) Overflow type
2) Skimmer type
3) Invert gully type

PROCEDURE FOR CONSTRUCTION OF SWIMMING POOL

The construction of swimming pool involves more civil engineering items; but because of the complexity of plumbing & electrical works related to the hydraulics, it is essential to construct a pool under the supervision of an experienced consultant.

It is equally important for the site engineer to deliver keen & timely supervision to avoid repetitive repairs.

Following are the key areas which demand keen supervision from the site Engineer.

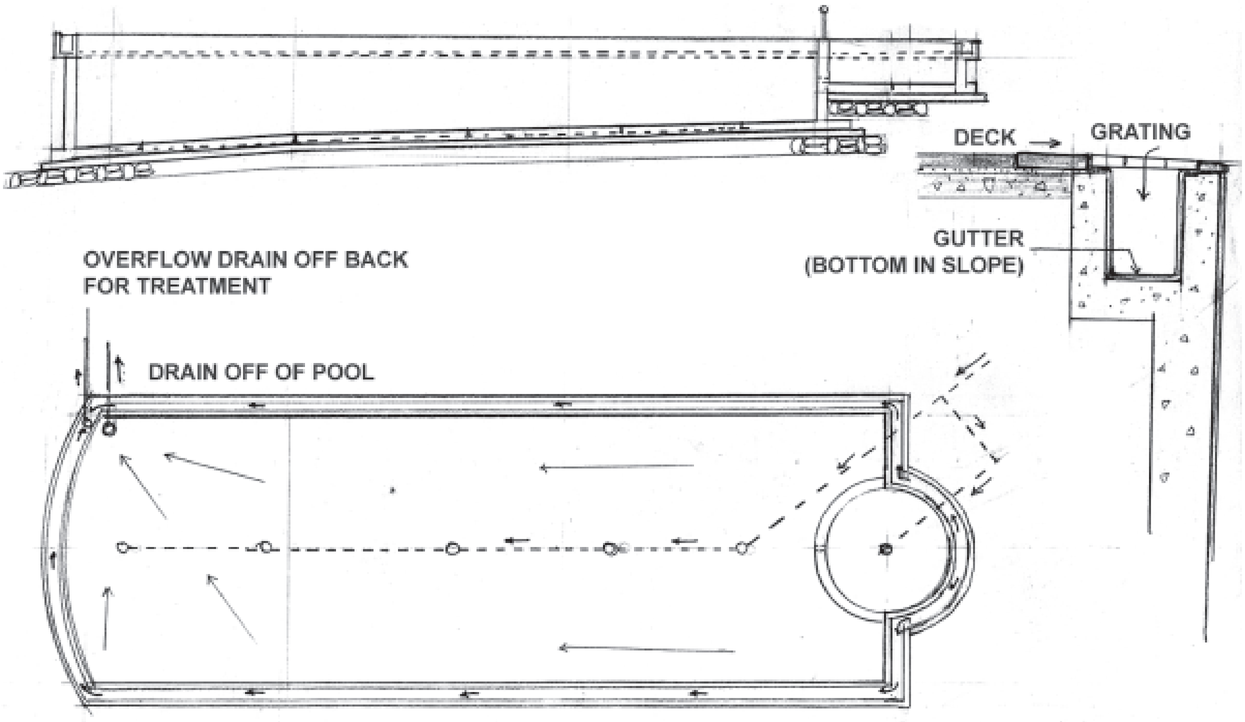
Approved architectural & structural design of swimming pool & surrounding landscaping will lead to the sequence of activities as follows.

Finalization of following reduced levels w.r.t. Deck top as the T.B.M..

1) F.F.L.of the road.
2) F.F.L.of the Deck.
3) Full reservoir level.
4) Plinth levels of adjoining structures like changing room etc.
5) Reduced levels of the following items by forming a grid of 2 m x2 m.to define the exact slope.

- Top of excavation.
- Top of soling.
- Top of P.C.C. below raft..
- Top of R.C.C. raft.
- Top of finished flooring level (bottom of swimming pool).
- Top of main drain jali.
- Top of water inlets.
- Top and bottom of Overflow gutters.
- Top of Vacuum point (for skimmer type pool)
- Top of Pool light points.

SWIMMING POOL DETAILS



PROCEDURE FOR CONSTRUCTION :

Mark permanently DECK LEVEL as T.B.M. and then start the setting out. Accordingly execute the works in the following sequence.

1. Excavation till required depth.
2. Murrum filling, watering & compaction.
3. Rubble soling & compaction
4. Mark & lay concealed G.I. plumbing lines for main drain & water inlet pipe. This activity is to be carried out along with the binding of steel.
5. P.C.C. (with waterproofing if specified)
6. R.C.C. raft (Take care to check the top of main drain jali & water inlet jali if to be provided at bottom)
7. Tying of reinforcement up to the bottom of overflow gutter (for overflow type of pool).
8. Necessary conduiting & provision of nitches for concealed waterproof light points at the time of shuttering.
9. Casting of R.C.C. pardi upto the bottom of overflow gutter
10. Shuttering & reinforcement of overflow gutter
11. Fixing of gutter outlet at specified location & level.
12. Concreting the bottom of the overflow gutter and then of the side pardies (Maintain desired slope of gutter & top of side pardies).
13. Cleaning of all the R.C.C. surface, opening /finishing and plugging the pockets/points.
14. Water proofing of R.C.C. raft , pardi from inside and outside including overflow gutter as specified. All curvatures and levels are to be precisely observed while water proofing.
15. Filling the pool with water.
16. Pressure testing of plumbing work.
17. Backfilling and compaction for deck area to be carried only after testing of water proofing and plumbing work.
18. Laying of necessary electrical and other service lines at deck area before P.C.C. of deck.
19. P.C.C. of deck with specified slopes etc.
20. Tiling of pool.

- Confirm the designed patterns with different tiles etc.
- Mark the patterns on bottom & sidewalls.
- Mark the guideline dots as required.
- Mark the floor level dots at bottom with required slope & levels.
- Start fixing the tiles as per patterned set, by using tile adhesives as specified by the swimming pool consultant.
- Follow & observe the same procedure for wall & floor tiling work.

Ensure the following things during tiling work strictly

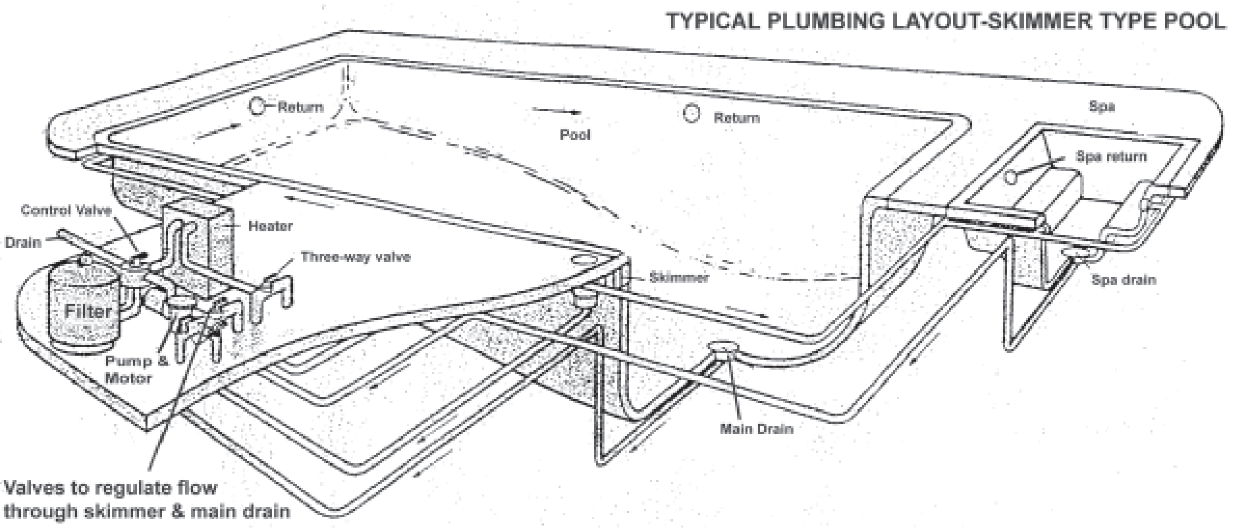
- Undulations must be avoided

- Sharp edges & corners must be avoided.
- Fill the tile joints using specified joint fillers only.
- Finishing must be done carefully at all openings for fittings
- Maintain the slope towards the gutter outlet during tiling.
- Top levels of two side walls of gutter are to be maintained as specified.
- Deck tiling work is to be carried out with specified line, levels & patterns.

Recycling of the pool water is widely practiced in swimming pools. Reuse of water is achieved by providing a filtration system. This system comprises of a pressure filter, chlorinator, chemical doser and a pumping system to recirculate the entire pool water in designed hours (Usually not more than eight hours a day). Water is sometimes areated to eliminate dissolved gases. Areation also gives a sparkling effect to the pool water.

In spite of the reuse of old water, certain fresh water will be required to be added in the pool to compensate the water lost, in evaporation, back washing of filter, surface skimming and vacuum cleaning of the pool floor. This lost water will have to be compensated almost daily by adding fresh quantity of water in the pool.

The typical plumbing layout details of swimming pool using recycling of pool water are shown in the figure.



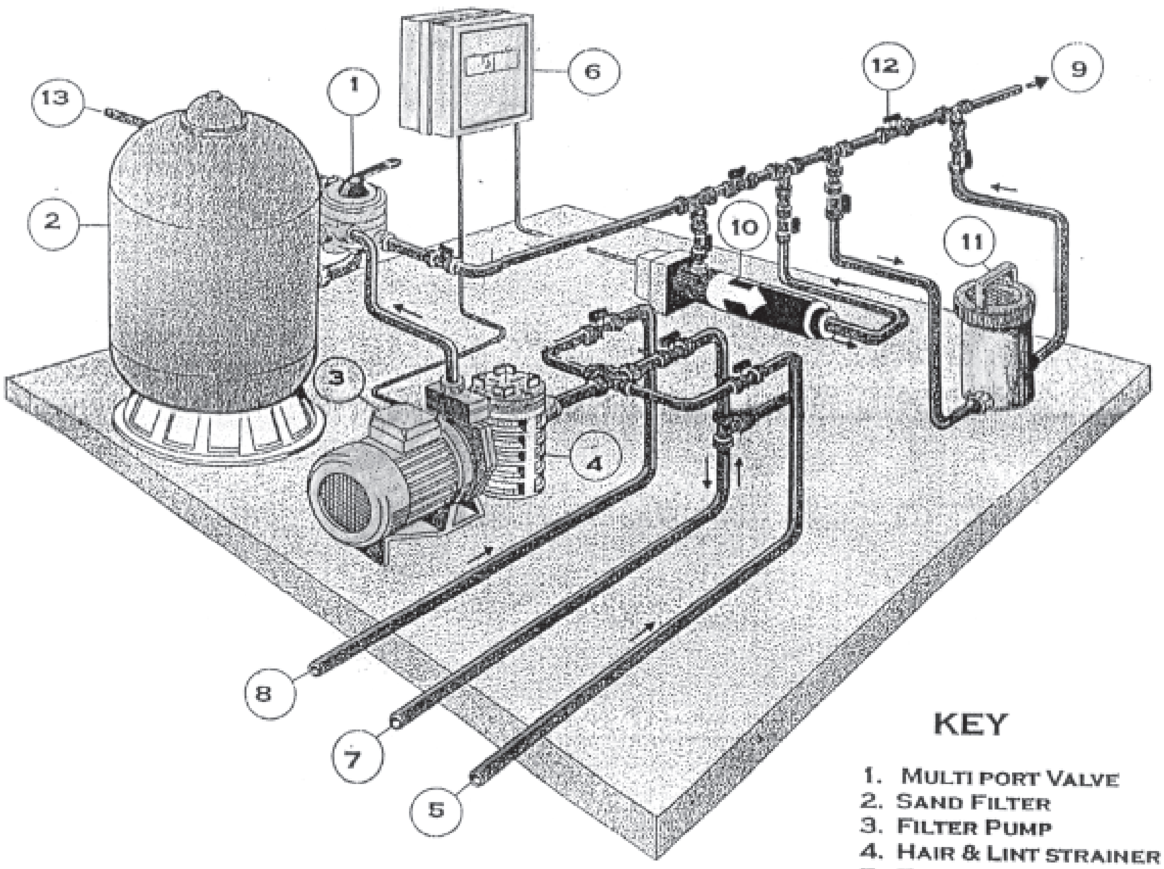
Acceptable values of water quality parameters to be tested in swimming pool.

Sr.No.	Parameter	Acceptable values
1.	Free chlorine	1 to 2 mg / L
2.	Combined chlorine	Not more than 1/3 chlorine
3.	pH	7.4 to 7.6
4.	Alkalinity using Hypo chloride	100 mg/ L
5.	Calcium	100 mg/ L

Filtration plant & room

This room is designed to accommodate the filteration plant. The room shall have proper access and ventilation. Floor level of this room is generally maintained below the bottommost level of the pool to facilitate the gravity flow of water from the pool to the filtration plant.

TYPICAL FILTER ROOM LAY-OUT



KEY

1. Multi port Valve
2. Sand Filter
3. Filter Pump
4. Hair & Lint strainer
5. From Skimmer
6. Control Panel
7. From Drain
8. From Vacuum Point
9. Return to Pool
10. Heater
11. Chlorine Dozer
12. Valve
13. To Waste

An Instructions Board shall be fixed at a prominent location to display the following rules and regulations.

1. Diving & jumping into pool is dangerous & strictly prohibited.
2. Enter the pool only after taking a shower bath.
3. Proper swimming suit is necessary to enter the pool.
4. Ladies should wear hair cap.
5. Use of goggles is recommended to avoid irritation of eyes .
6. Do not spit in & around pool.

7. Do not throw stones in the pool.
8. Children under 12 years of age, are allowed to swim only if accompanied by an adult.
9. Learners should not enter the pool without the trainer & lifeguard.
10. Timings are to be followed strictly.
11. Medical fitness certificate is to be furnished before using pool.
12. Eatables are not permitted in the pool area.
13. Any person using the pool should swim on his / her own risk.Management of the pool will not be responsible for any accident, loss of belongings, death of pool users. Management will not entertain any claim in this regard.
14. In case of any emergency, contact the club house attendant or call the security personnel.
15. Do not misbehave inside the pool area.
16. Kindly help to maintain the cleanliness of water & premises.
17. Management reserves the right to deny the use of the pool to anyone at any time.
18. No animal or pets are allowed in the pool or on the deck.
19. No person with communicable disease is allowed in the pool.
20. No person with skin, eye, ear or nosal infections is allowed in the pool.
21. No person under the influence of alcohol or drugs is allowed to use the pool.

CLUB HOUSE

It becomes necessary to provide recreational facilities in modern townships. A well equipped clubhouse is a facility where:

- People can exercise.
- People can organize recreational functions.
- People gather together and develop social relations.
- People can relax and relieve their stresses.

A well designed Clubhouse highlightens and adds to the value of a residential project.

The following facilities are provided in a Clubhouse:

- Gymnasium,
- T.T.Room,
- Swimming pool
- Squash court,
- Cards room,
- Carom room,
- Balling alley,
- Jacuzzi bath,
- Steam and sauna bath,
- Skating rings,
- Recreational hall,
- Dancing floor,
- Library,
- Yoga and meditation room etc.

Every facility listed above has its own peculiarity and requirement as per the specific use. Therefore a clubhouse shall be planned and constructed as per the details & specifications given by the Consultants. Consultants play a vital role in planning the Clubhouse for every minute detail.

The information for some of the facilities is briefed herewith.

JACUZZI BATH

Jacuzzi is an arrangement of water jets, which helps to provide Massage to human body. Since the body is almost weightless when immersed in the water, even a light water jet provides a blissful Massage to the body.

Salient features of Jacuzzi machine

1) Air nozzles give maximum pressure along with quality discharge. Air nozzles are of two types i.e. rotary and fixed type.
2) Mud pump can also be used for increasing the pressure.
3) Use of scheduled 80 CPVC pipes, reduces the frictional losses and salt formation.
4) A properly designed control panel consisting, robust control fuses, cabling, earthing terminal is used and it is painted by a weatherproof paint.

Technical specifications

a)	Nozzles	4 fixed and 4 Rotary Astral.
b)	Pump	1 hp / 2 hp Kirloskar make.
c)	Control panel	Consisting of starter L&T make with all controls.
d)	Air volume controller	3 or 4 nos. as required.
e)	Plumbing	The pipes and required fittings confirming to IS.
f)	Heater	Provided only if required
g)	Filter	Astral or equivalent make

The installation of Jacuzzi machines is done alonwith the following construction work.

a) Construction of tub.
b) Waterproofing of tub.
c) Tiling of tub.
d) Electricity supply to the main switch..
e) Water inlet of 50 mm diameter with gate valve.
f) Drain line from filter to drainage.
g) Drainage chamber near filter room.
h) When the Jacuzzi is connected to the pool, plumbing of overflow line shall be done from the Jacuzzi to the pool through a gate valve.

STEAM BATH

Technical specifications

Boiler:

Steam boiler is built in S.S. 304, argon welded and is tested for a pressure of 5 Kg/ sq.cm, with necessary insulation. The heater used is industrial immersion heater of S.S. and connected with Teflon coated probes. The heater is fitted inlet and drain valves, solenoid valve, level control probes etc.

Boiler Enclosure:

The boiler enclosure is made in 16 SWG mild steel with proper louvers for free air circulation and is duly powder coated with chosen shades.

Control panel :

The control panel consist of thermostat controller, on -off indicators, necessary printed circuit board, L&T make contactor, MCB, timer controller, display unit, relays etc.

Plumbing details:

Main water supply up to the steam boiler is to be provided Steam delivery line is made in G.I.pipes from steam boiler to the steam room. These lines are insulated properly. Nahani trap is provided with the drainage in the steam room.

Electrical details :

Total Power requirement = 9 KW.

Main cable having 4 cores and cross-section of 4 sq.mm.

Main switch through ELCB and MCB with proper earthing.

Operating cables from steam unit to operating panel.

One ceiling rose for fixing of light, above the false ceiling.

General details:

Steam bath is recommended for a time of not more than 10 to 20 minutes. Three persons can be accommodated in the cabin at a time. Ceiling and door of the cabin shall be made in Aluminium and wired glass.Door of the cabin shall be kept open to avoid odour. Locking arrangement shall not be provided to the door. Only hydraulic door closer shall be provided.

The required civil works includes:

1) Three phase Power supply with 4-core wire.
2) Water connection up to steam boiler
3) Construction of steam room
4) Tiling of steam room
5) Fixing of marble bench
6) AL & wired glass roof & door

7) Plumbing from steam boiler to steam room

8) Drainage outlet

9) One light point in steam room

SAUNA BATH

Introduction :

The sauna bath is nothing but a hot air bath. The hot air bath helps to sweat the body and indirectly helps to maintain the metabolism of the body.

The sauna unit consists of air heaters and with necessary control panel fitted with all safety devices. The necessary heatproof cabin is constructed in woodwork. The planks of Deodar or Canadian hemlock knotless wood are fitted on a suitable frame. The walls shall be protected from high temperature by using glass wool insulation & asbestos sheet behind the unit.

Technical Details

Heater : Aesthetically designed main body of the heater is manufactured in 14 gauge M.S. sheet and is powder coated. The electrical cables are thermally insulated and are totally outside the heater stove. The heating elements are of standard companies which have a unique heat distribution system. The pebbles are kept on the heater, which help to store the heat efficiently.

Control panel consists of :

- Thermostatic temperature controller.
- Digital temperature indicator.
- Necessary safety devices consisting higher limit controller.
- Standard switchgears.
- Two sensors fitted with thermostat to read temperature.

DETAILS OF WOOD WORK :

Wall ceiling & flooring

Wooden frame is constructed by using deodar wood of the section size 40 mm x 50 mm, on all six sides of the cabin. The cabin is provided with Resin boded mineral glass wool insulation on ceiling and four vertical walls.

Door

A Door frame made up of C.P.teakwood of section 100 mm x 25 mm is provided and the shutter is provided with toughened glass and wooden planks as designed. Locking arrangement shall not be provided to the door. Only hydraulic door closer shall be provided.

Requirement at site

1) 3 phase Power supply with 4 core wire.

2) All civil work to be done as specified.

3) Nerru plaster with water proofing on all walls up to 1.5 m height.

HEAT THERAPY

The steam and sauna bath help to benefit in some of the conditions of health by the use of heat. It helps in following conditions:

- Rheumatism, Arthritis and a wide variety of complaints involving the musculo-skeletal system.
- Sciatica and many other conditions affecting the nervous system.
- Some skin conditioning treatments those mimic the radiation contained in sunlight are helpful in treating the problems such as Acne.
- Respiratory problems including Asthma and Bronchitis.
- Heat therapy can also help in reducing the inflammation of the Kidneys and gallbladder.

WARNINGS

- Avoid heat treatments during heat conditions and high blood pressure.
- The heart-bit rate almost doubles just after seven minutes in a sauna, causing a dangerous strain on a weak heart.
- Heat therapy is not recommended for young babies.
- Elderly people shall use the comparatively cooler sauna benches and limit the exposure to extreme heat to five minutes.
- Overheating puts a strain on the heart and subsequent cooling may result in a chill and respiratory problems.
- Never drink alcohol before heat treatment to avoid the risk of dehydration.
- Expectant mothers, Diabetics, people suffering from heavy cold, flu, a heavy menstrual period, grandular obesity varicose veins, low blood pressure or under any medical treatments: can face a high risk in the heat therapy

INTERCOM SYSTEM

Intercom system is a service, which facilitates proper communication within small townships amongst the members of that townships. Though the Intercom system is provided alongwith landline phones & mobile phones, the calls made from this facility are not metered. In this system, all units (flats), security gates, lifts, parkings, clubhouse areas can be interconnected with each other.

To install an intercom system in a building, following things are required:

1. Under ground cable duct.
2. Safe and secured location for installing intercom system.
3. Concealed conduiting upto consumer end.
4. Two-pair telephone cables for one connection.
5. Electrical connection of a capacity of 5 Amp for the system.
6. Telephone instruments, sockets etc.

ADVANTAGES OF AN INTERCOM SYSTEM:-

1. Ease in communication
2. Safe way of communication between flat holders and visitors.
3. It helps to locate the security personnel in time.
4. It helps to mobilize the rescue operations, in case of an emergency, e.g. the rescue of people entrapped inside a lift cabin.
5. It helps to avoid direct entry of unauthorized persons, entering in the building premises.

LIGHTNING ARRESTER

Lightning arrester : -

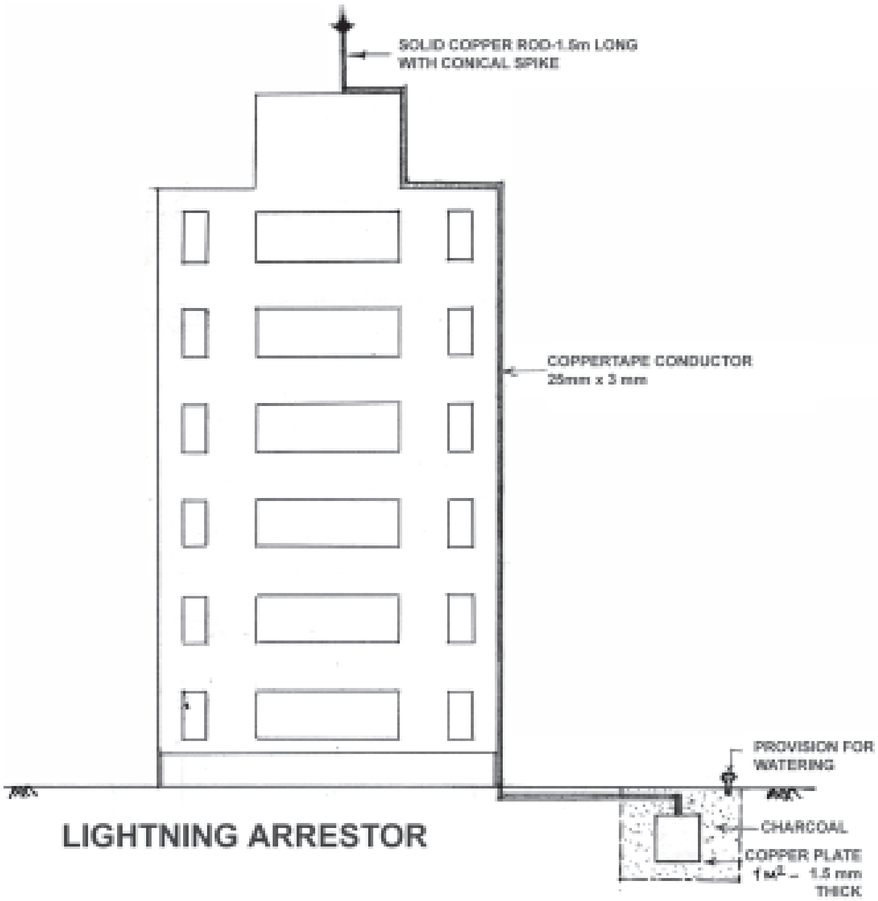
A system provided at the highest point of a structure to protect it from lightening is known as 'lightening arrester'. The lightening arrester shall be necessarily provided for the buildings situated at remote and hilly areas.

Material Required: -

1) Copper tape conductor, 25mm x 3mm.
2) Solid copper rod having upper terminal of 90mm diameter and of length 1.5m, with a knob at the end with a conical spike on top.
3) Suitable clamps to fix the conductor to wall.
4) Copper earth plate 1.5mm thick and 1m^2 in area.
5) Charcoal and sand for filling the earth pit.
6) C.I. pipe of 60mm diameter including fittings confirming to I.S.1230-1968.

Work Procedure: -

1) The upper terminal shall be fixed vertically at the highest point on the building. The terminating cone on the knob shall have a height equal to the radius of its base.
2) The conductor tape shall be attached to the upper terminal at the lower end by double riveting and soldering. It shall be fixed along the building face from outside, exposed to rain.
3) The conductor shall preferably be in one piece and shall be straight as far as possible.
4) If required to be bent, the straight length between the ends of bends shall not be less than half the curved length.
5) The conductor shall be enclosed in a 60mm diameter cast iron pipe fixed on the wall, for a height of 3m from ground to protect the conductor from injury/theft.
6) All metal surfaces, ridges, grooves gutters, etc shall be connected to the conductor with metal connections. After thorough cleaning and roughening by sand paper the copper rod and tape shall be fixed with screw or rivet and in addition it shall be soldered.
7) The lower end of the conductor shall be carried to a depth of 1.0 m below the ground.
8) Necessary trenches and pits shall be excavated for laying of the conductor and the copper plate.
9) The trenches shall be 10 to 13m long and 1m deep and shall be 5 to 6m away from the building.
10) A copper tape of 25mm x 3mm shall be riveted and saddled to the lower end of the conductor and carried along the trench up to the spot where the copper plate is to be buried.
11) The other end of the tape shall be connected to the copper earth plate by riveting and soldering.
12) All the joints from the upper end of the top terminal to the earth plate shall be perfect, mechanically and electrically.



13) The copper plate shall be ensured to be at a 0.60 m to 1.0 m below the substrata water level in the driest season of the year.

14) Where the permanent subsoil water level is deep, it is necessary to provide shallow earth in trenches laid away from the building. The thickness of the layer of the earth to be spread shall be 30 cm in dry soil and 60 cm in sandy soil. This layer helps to percolate the rain water easily.

15) The length of the trench shall be between 10m to 13m in dry soil. Alternatively conductor tape may be attached to a copper plug suitably riveted and soldered.

16) This plug shall then be inserted into a water supply pipe by coupling or tee joint.

17) The earth plate shall be surrounded with charcoal.

18) The copper conductor shall be laid in charcoal and the trench filled with sand.

19) The surface water shall be directed towards the trench.

20) Copper tape and rod should not be painted.

Testing Of Lightening Conductor: -

1) The lightening conductor shall be tested for the resistance by suitable apparatus. The overall resistance of the complete conductor system from the arrestor to the earth should be about 1 to 2 ohms.

2) The overall resistence should not exceed 10 ohms.

3) If the results are beyond the above limit, the defects shall be rectified so as to get satisfactory results.

SECTION

V

ADDITIONAL SERVICES

1) NON-CONVENTIONAL ENERGY SOURCES-SOLAR SYSTEM

2) RETICULATED COOKING GAS SYSTEM

3) HYDRO-PNEUMATIC SYSTEM

4) DISPOSAL OF WASTES

  1) SEWERAGE TREATMENT PLANT

  2A) GARBAGE DISPOSAL CHUTE SYSTEM

  2B) VERMICULTURE SYSTEM

  2C) WET GARBAGE TREATMENT

5) LOCAL TRANSPORT SYSTEM

6) FUTURISTIC SERVICES

NON-CONVENTIONAL ENERGY SOURCES

INTRODUCTION:

The energy generated by the SUN, WATER, & WIND is abundant. These energy sources are called as renewable energy sources. The energy from these sources is not used widely as the conventional sources are used (for petrol & gases). So these energy sources are called as " NON-CONVENTIONAL ENERGY SOURCES". The energy from these sources is available at, one time cost, rather than recurring costs. Sun delivers three types of energies such as light, heat & rays.

Now, utilization of these energies is the basic need of the modern days to get freedom from power cut, loadshading & shutdowns of conventional energy sources. The main purpose of using non-conventional energy sources is to make the Nature, **pollution free.**

Solar water heating system :

Any black coloured, non-shining, non-transparant & rough surface absorbs more heat. Solar water heating system works on the basis of 'BLACK BODY RADIATION and ABSORPTION'

1) SOLAR COLLECTORS

Flat plate collector- absorber plate

Collector glazing/ cover

Collector insulation

Casing collector box

Tubes

Flat plate collector- absorber plate:-

Absorber plate absorbs the solar power & transmits the solar power into heat. The transmitted heat is absorbed by water in tubes connected to absorber plate. The quantity of preheated water from solar system depends on the solar radiation, temperature of atmosphere, temperature of circulating water, & quality of insulation.

A collector of an approximate size 1m x 2 m, i.e. 2 Sq.m area can give 100 to 125 liters of preheated water of about 60^0 to 80^0c temperature.

Absorber plates are painted with specified black colour & special coating, which withstands against temperature variations. This helps in utilizing the solar power to the maximum limit.

Collector glazing / glass cover: -

A thick transparant toughened glass is used over absorber to restrict the transmission of the heat outside the box, generated by absorbers. The other purpose of fixing glass cover on the absorber plate is to safeguard the plates also.

Collector insulation: -

The purpose of collector insulation is to restrict the transmission losses of the generated heat from the sides, except the collector glazing.

Casing collector box:-

The purpose of casing collector box is to protect insulation & absorber plate, against atmosphere & heat losses.

Tubes :-

These insulation tubes are provided to circulate the cold & heated water to & from the collector.

2) WATER STORAGE TANK

The preheated water storage tank is made from such a material, which has good resistivety against the atmospheric changes & which will not affect the quality of water stored inside the tank. The type of insulation, for the water tank, depends on the desired temperature of heated water, lowest temperature of atmosphere & quality of insulation. Insulation is covered by a thin aluminum sheet to protect it from rains & atmosphere.

3) PIPELINES

Pipelines are required to carry the heated water up to the user. These pipelines are insulated with glass wool & aluminium sheet. (Mica 50 mm thick insulation) to avoid heat losses. Double insulated P.V.C. pipes (special Kytech) can be used.

Process of heating: -

When sunrays fall on the collector glazing, the energy from the sunrays is absorbed by the collector and is transmitted in the form of heat.

This transmitted heat is absorbed by the water in rising tubes.

Thus water is heated due to absorption and It becomes light in weight & goes in the storage tank.

Water is continuously circulated on the basis of thermosyphon in tubes.

One cycle of circulation of water through tubes up to tank, gives a minimum rise of 5^0c. Temperature.

The temperature of water can be achieved upto 25^0c to 65^0c.

Maintenance:-

If solar systems are made from first quality material, it can last long upto 20 to 25 years. Weekly cleaning of collector glazing is necessary for efficient working of the system. Thus the total system requires very less maintenance.

RETICULATED “L P G” SYSTEM

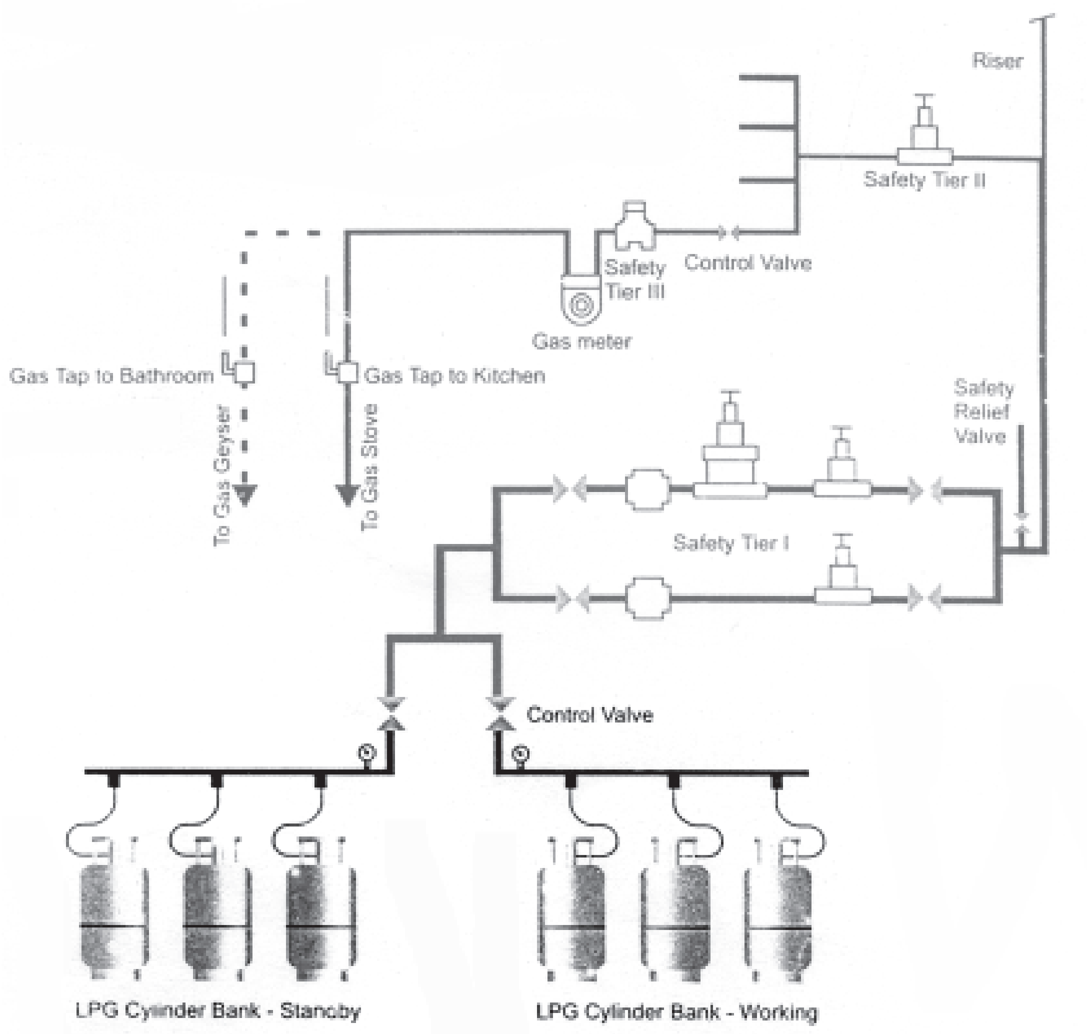
INTRODUCTION:

In this world of competition, every builder & developer tries to include something new and unique in housing projects. Providing even the best of amenities & facilities doesn’t ensure the success, because, today’s customers look for something really tangible & useful. They are looking for something that will make their day-to-day life easy. RETICULATED LPG SYSTEM fulfills the basic need of the customer.

PROCESS:

Reticulated system is supplying LPG (liquified petroleum gas) to the customer’s kitchen through a pipeline network, from a centralized cylinder bank or bulk installation. This system has multiple pressure regulation stage so as to facilitate LPG to users at low pressure & to ensure safety of the system.

TECHNICAL NETWORK DIAGRAM OF RETICULATED LPG SYSTEM:



SAFETY:

"RETICULATED LPG SYSTEM" is completely safe. It has been fitted with a three-tier safety system, comprising LPG pressure regulators, auto cut off valves & a safety relief valve. Non-return valves are fitted to every cylinder to prevent back flow. Isolation at every point & stage makes the system fully safe.

MAINTAINANCE:

There are many agencies to take care of the maintenance of the system through comprehensive & non-comprehensive contracts. The periodic inspection of the total system to locate and rectify the leakages & pressure losses helps to reduce the maintainance cost.

SUPPLY:

Regular supply of LPG from HPCL OR BPCL on the residential tariff can be arranged.

ADVANTAGES OF RETICULATED LPG SYSTEM:

1) Continuous supply of gas at the turn of a tap.
2) Freedom from cylinder refill hassles.
3) Freedom from cylinder transport to each house & possible damage to the floor or lift.
4) Increased convenience and easy & effortless operation
5) Increased safety in kitchen.
6) More space in the kitchen.
7) Value for money i.e. payment as per actual consumption of gas through meters.

HYDRO-PNEUMATIC SYSTEM

Water is an important necessity & commodity in all segments of life. In the changing scenario of the increasing cost of water, It has become the utmost important issue.

The conventional system for water supply & distribution is designed just to fulfill the requirement with minimum atomization & pressures.

The increasing cost of the pumps, electricity & manpower to operate any water supply system is compelling us to choose a totally automatic water supply & distribution system. The satisfactory solution, fulfilling the need, is the 'Hydro-Pneumatic System'. The hydro-pneumatic system provides water automatically at defined pressure & quantities at many locations from single pumping system. This system operates on variety of differential pressures. It operates automatically by sensing the pressure within the preset pressure range.

Hydro-pneumatic systems are used, to supply water at designed pressure & quantity from a single source.

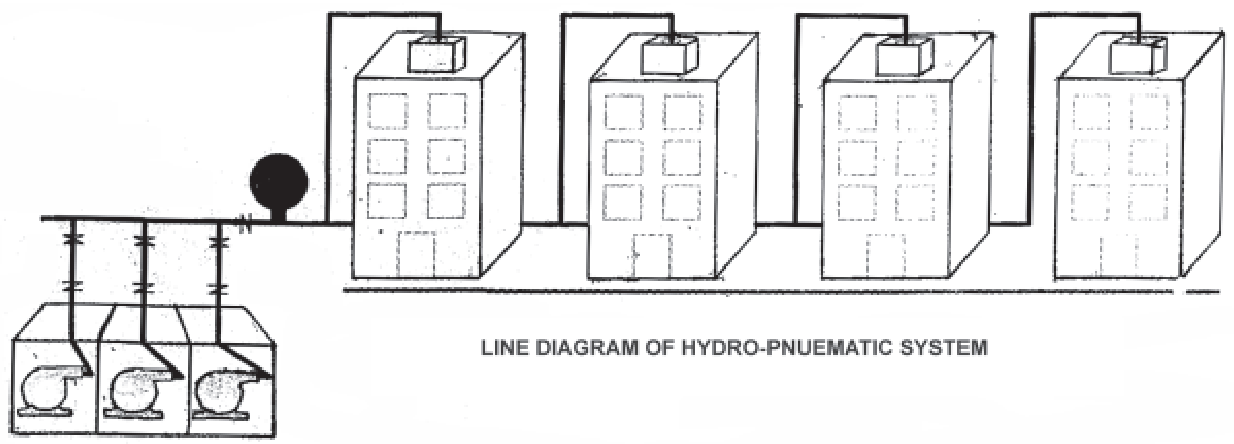
Two types of Hydro-pneumatic systems are commonly used.

1) TAP FEEDING:

In this system, water can be directly supplied to taps from UGWT only. Thus, it eliminates all Over Head Water Tanks. Any pressure can be designed and achieved at each tap, which is not possible in gravity feeding system.

2) TANK FEEDING:

In multi-building complexes, water can be directly supplied to all overhead water tanks through a ring main, connected to them from UGWT with H.P.system (Refer sketch)



LINE DIAGRAM OF HYDRO-PNUEMATIC SYSTEM

This system, if designed properly for total automation; can reduce the maintenance cost & problems arising due to frequent maintenance.

ADVANTAGES OF HYDRO- PNEUMATIC SYSTEM

1) If tap feeding systems are used during construction for curing purpose, cost of electricity saved, is greater than the system cost..
2) This system reduces the construction cost of number of water tanks because only one tank is sufficient.
3) Overhead tanks can be avoided. The chances of failure of a building during earthquake, because of the overhead water tanks, is reduced.
4) The required designed pressure for a tap can be achieved in this system, which isnot possible in gravity feeding system.
5) The system being totally automatic, requires less maintenance resulting in reducing the cost.
6) Lesser maintenance results in reducing the wastage of manpower.
7) Since the system requires only one UG water tank, it helps to design better layouts for parking and other recreational areas.

THE CRITERIA BEHIND THE CALCULATIONS OF SYSTEM CAPACITY (LPM)

a) The design shall consider the type of building, the activities of the occupants and the human tendencies.. The other factors except the human tendency, can be covered by engineering formulae. Taking into consideration the human tendencies, the system is designed, on the basis of various operating data and records compiled over the years by various users, manufacturers and trade associations. The recommended data is as follows.

i) Assign a number, to each individual fixture in the piping system. Take the help of the fixture unit table given below.

ii) Count the total number of fixture units for the entire system.

iii) Convert the total fixture units to a fixture peak demand in LPM using the fixture **Peak demand curves**.

iv) Add the Additional quantity of flow required for any special purpose, such as air conditioning apparatus, process equipment, boiler make up, swimming pools, etc.The capacity charts show fixture peak demand only. Therefore, separately estimated special purpose demand shall be added to the fixture demand.

Notes: -

1) Occupancy – Capacity ratings are based on the assumption that an equal number of men and women are to be accommodated. Where the occupancy is predominantly female, increase the total design capacity by 15%.
2) Laundries – In case of hotels and hospitals, where a laundry is operated in connection with the building, increase the total pumping capacity by 10%.

1. FIXTURE PEAK DEMAND———————— LPM
2. SPECIAL DUTY DEMAND———————— LPM
3. SYSTEM CAPACITY (1+2)—————————LPM

EXAMPLE: -

Consider a building consisting 2 BHK flats having 4 flats on each floor and having 11 stories.

Total number of flats = 44 Nos

Total number of toilets = 88 Nos.

A Table showing the calculations of total required LPM for the considered building is as follows.

Sr.No.	Fixture	Type of control	Fixture units (lpm)	Number of fixtures	Total (lpm)
1.	Master toilet	Flush tank	6	44	264
2.	Common toilet	Flush tank	6	44	264
3.	Kitchen sink	Faucet	2	44	88
4.	Washing machine	Automatic	4	44	176
5.	½" hose connection	Faucet	4	88	352
				Total in lpm	1144

The suitable pump capacity, for this LPM and for the desired pressure, and also considering the pressure losses; is chosen. A additional stand by pump of suitable capacity is also suggested.

DISPOSAL OF WASTES

INTRODUCTION :

Every architect, engineer, planner has to think of the disposal of various wastes generated in the townships.High rising residential & commercial building complexes are being constructed in upcoming metropolitans, increasing the density of population. Change in life styles are demanding more hygienically well packed goods and the inevitable plastic containers. The 'Use And Throw' type psychology has become popular in all consumables because of fast city life. This, obviously is increasing the garbage in Metropolitans.

All these factors are exerting great pressure on collection and hygienic disposal of garbage. The collection of garbage at every single unit (flat, shop, hotel, theatre etc.) and at townships, small localities, and the networking of the collecting systems is becoming very much difficult.

A partial solution to this problem can be achieved by segregating wet and dry garbage at the collection points itself; and then utilizing the wet garbage for producing manures.

If the waste is classified in the following manner, it helps to design the proper disposal systems.

Type of waste	Recommended treatment
1) The liquid waste (from toilets, W.C.'s)	Drainage network with sewage treatment plant
2) The solid waste	
a) Dry garbage	Garbage disposal systems
b) Wet garbage	Vermiculture system

The recommended treatment plants are discussed, in brief, in following chapters :

1) SEWAGE TREATMENT PLANT

Sewage contains minerals, inorganic matters and living organisms. Therefore, sewage which is collected from residential areas, public places, industries shall be treated properly for the following reasons :

1. As sewage contains pathogenic bacteria, it causes health hazards. Therefore to prevent pollution of water in to which the sewage is let off, sewage shall be treated.
2. To prevent offensive odour, causing health hazard & irritation to the people living near such water or land where the sewage is disposed off.
3. To prevent the destruction of fish & aquatic life if such sewage is disposed off directly in a river or sea.
4. To prevent offensive odour, polluting the entire atmosphere affecting the neighbourhood by creating a messy scene is the sewage is disposed off on a land.

TREATMENT PROCESS

1. Preliminary treatment: - In the preliminary treatment, suspended floating impuritiessuch as rags, wood, metal, plastic etc. are removed. They have to be removed as they interfere with the treatment processes.
2. Primary Treatment: - It consists of the sedimentation process to remove the suspended organic matters. Sometimes chemicals are added in primary clarifiers to assist in the removal of colloidal & finely divided solid particles.
3. Secondary treatment: - (Filtration / Activated sludge process)
   To remove the finely divided suspended matters, filtration is done in contact beds or intermittent or trickling filters. In the activated sludge process, digested sludge is added to the raw sewage together with oxygen. It promotes coagulation of the suspended & colloidal matter. The coagulated matter settles down at bottom which is called as sludge. The sludge is disposed of in dry beds or dumped into sea. The effluent is disposed for sewage farming or let into a natural drain or sea.
4. Disinfection :- The process of killing the bacteria in the effluent of sewage by chlorination is called as Disinfection.

All the above processes are not always be required. The type of treatment to be given depends upon the quality of effluent required. If the water is used for drinking purposes on the downstream, complete treatment is necessary.

This practice of purifying the water is feasible for large quantity of sewage water. This type of treatments are feasible only when the total drainage network is provided in a town or city.

In some of the cities, if the total networking of drainage is not available due to some constraints; it is necessary to provide septic tanks for smaller townships. But the effluent water from such septic tanks can not be recycled economically by the conventional treatment methods.

But the water from such septic tanks can be treated to a better extent to make it useful for domestic purposes other than drinking.

It has become necessary to recycle the available water by all means, because of the increasing scarcity of good quality water.

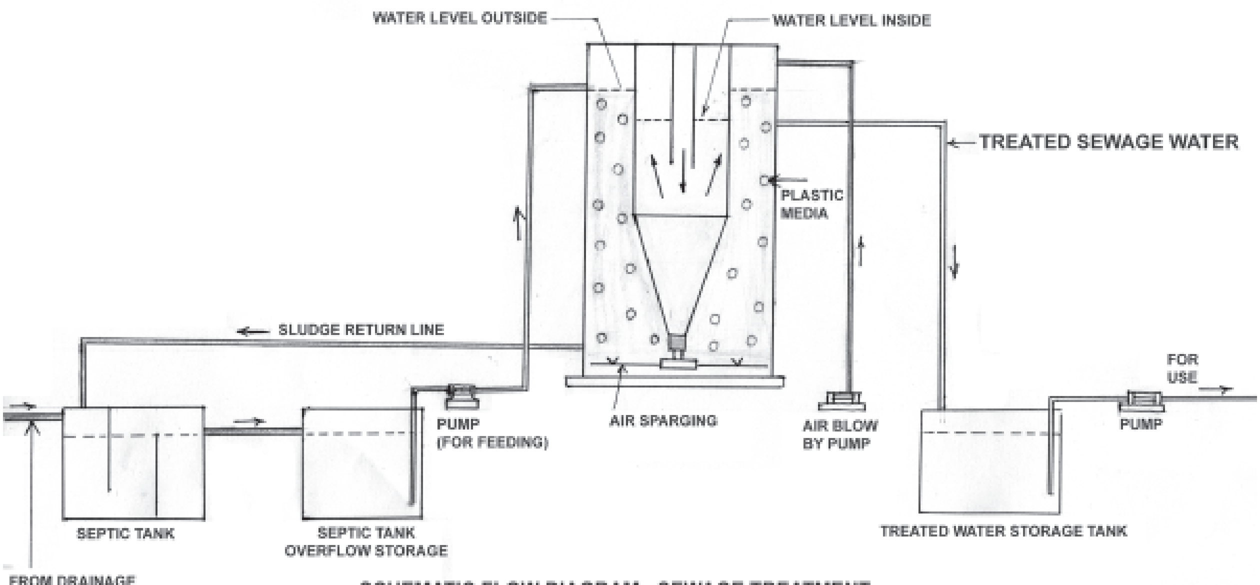
The water collected in a septic tank gets partially treated and hence is not much useful. It is required to treat this water by various means to bring it to the portability level.

The norms for deciding the purity of water are based on following criteria:-

1) B.O.D.:- Biological oxygen demand
2) C.O.D.:- Chemical oxygen demand
3) Total suspended particles
4) pH values

The standard values for the above criteria for water to be portable are as follows :

Sr. No,	Properties	Values
1.	B.O.D.	
2.	C.O.D.	
3.	Total Suspended particles	
4.	ph Value	



SCHEMATIC FLOW DIAGRAM - SEWAGE TREATMENT

The conventional methods of water treatment are not feasible practically and economically. The conventional plants require more area , space and more time for the treatment. Taking into consideration these limitations new compact and economical 'Sewage Treatment Plants' are made available by new techniques.

To attain this level of purity of water, various means are used conventionally. But in the highly populated cities more compact plants with faster purification capacity are required. Therefore the process of removing the organic wastes from the sewage water is achieved with the help of bacterias.

A special compartment with a plastic media is provided in a vessel with the necessary arrangement for aeration. The plastic media, because of its size and shape provides more surface area for increasing the bacterial growth. This helps to treat more quality of water in shorter time. The bacterias eat the organic material from the seepage and thus help to purify the water. This partially purified water is collected inside the conical vessel at center and is collected outside this rector in a storage tank. The water collected in this tank is treated by chlorination.

The quality of this water is not 100% near to the potability but this water can be recycled for many other domestic purposes except drinking.

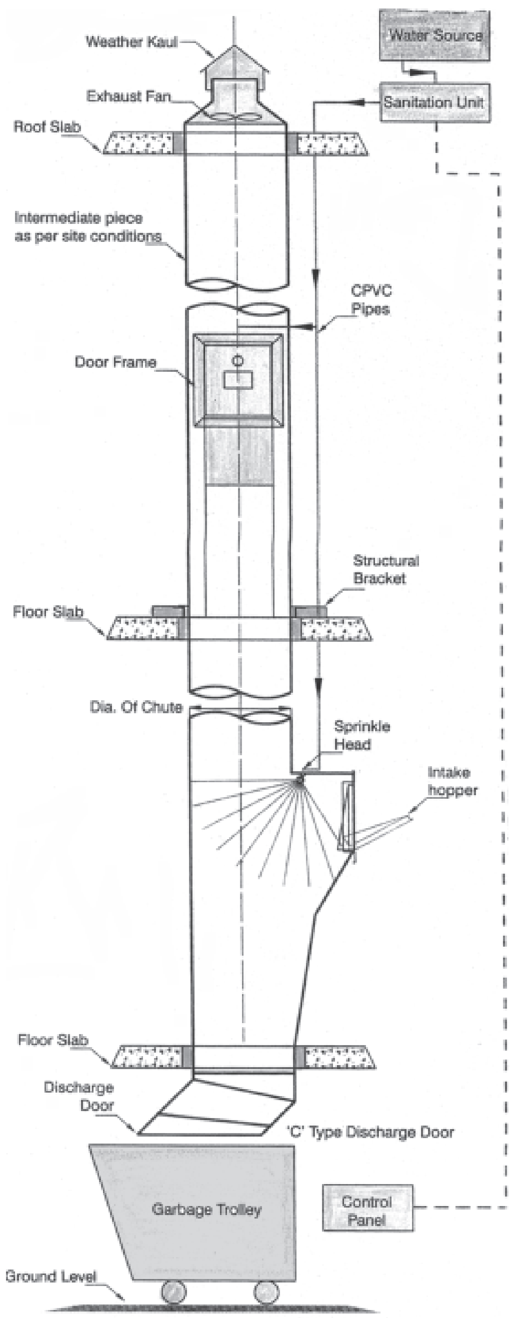
This recycling process helps indirectly to economize on the purchase cost of water and helps to maintain the environment.

2.A) GARBAGE DISPOSAL CHUTE SYSTEM

Urban civilization & fast growing cities are forcing to construct the high-rise residential & commercial buildings & complexes. As per socio-economic status of the society, the rate of garbage generation varies from building to building. In this changing scenario, the garbage collection from every floor & its disposal has become a tedious job.

To overcome this problem, with ease to the residents and caring for their hygiene, **'Centralized Garbage Collection System'** is designed for hi-rise buildings.This system can be installed at common passages, landings, utility ducts, garbage ducts, staircase landings etc, of a building.

SCHEMATIC LAYOUT OF GARBAGE-CHUTE FOR TYPICAL FLOORS



Considering the peak period volumes of garbage disposals, chutes are designed in different sizes, however the C.G.C.S. are to be designed according to requirements of the customers..

Stainless steels of the grades SS 304/SS 430 is to be used for chute hoppers and major components of the system.

The system consist of :-

1 Chute and hoppers
2 Vent
3 Discharge and disposal system
4 Sprinklers for cleaning
5 Garbage room
6 Drainage system

Chute : Recommended minimum diameter is 600mm for garbage chutes. Floor frames are used to support the chute at every floor.

Hoppers : Bottom pivoted hoppers are used for garbage chutes. To prevent clogging, hopper size should not be more than the diameter of the chute. Hoppers are designed for auto-closing operation. Hoppers are to be fitted to chute after the construction of front wall.

Vent : Vent is installed at the rooftop for the purpose of removing foul smell. A heavy duty exhaust fan operating on time control panel is also to be installed.

Garbage Collection room and disposal system : This is constructed at ground level with properly laid flooring and drain off facilities. Opening of the door shall be designed to facilitate easy placing and removal of garbage disposal trolley. It should have an electric control panel consisting main switch, sprinkler system's on off switch, timer switch for exhaust fan etc. Discharge through chute directly opens in the garbage bin/trolley which is rolling type. Fire resistant door is provided at the end.

Sprinklers – A water connection of specified range is to be provided at roof level. To ensure the proper cleaning of the inner surface of the chute ,different sprinklers of high-pressure water jets are used at different floors. When the chute is washed with the sprinkler system the wastewater is collected through a gully trap (fitted at garbage collection room), which is connected to the main drainage line.

Now a days, with latest upcoming norms, segregation of dry and wet garbage is essential. Hence modified and automated systems are developed.

In this way, by providing C.G.S. system, we may step forward to eco-friendly buildings, where proper care of hygiene is taken.

2.B VERMICULTURE

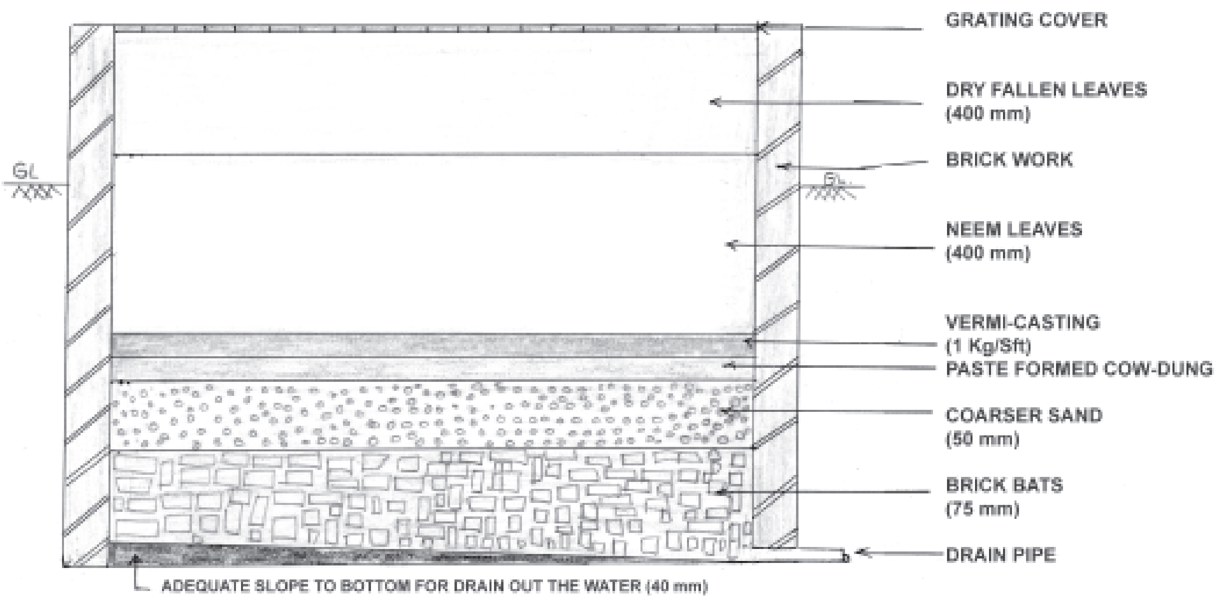
The collection and disposal of wet garbage can be done within the premises of small townships by a **'Vermiculture system'**.

Depending upon the volume of collected wet garbage, trenches are excavated to suit this volume. A layer of brickbats followed by a layer of singles and layer of cow-dung is laid by maintaining a proper slope at the bottom. The cultures Vermies casting is spread over the paste formed cow-dung. The leaves of Neem tree are spread on the layer of the Vermies. The topmost layer consists of fallen leaves. A suitable sized weldmesh is then fixed on the top of the trench to ensure aeration for the Vermies.

The collected wet garbage is spread over the topmost layer of the Vermiculture trench. This trench is watered everyday to help decompose the garbage. The wet garbage shall be spread only two times a day for the first fifteen days to ensure the proper growth of the Vermies. As the verms start growing, they utilize the wet garbage as their food. The soil left behind by the Verms, go on accumulating to form good quality manures.

This manures is very useful for trees, plants and a variety of house gardens. The Vermies usually preferred are Icynia Phetinda or Udrilus muzin.

This Vermiculture process is hygienic, economical and environment friendly.



TYPICAL SECTION FOR VERMI-CULTURE

2.C WET GARBAGE TREATMENT (BIOGAS PLANT)

Wet Garbage treatment plants are preferred over Vermiculture system. It produces organic manure and biogas as a byproduct. When the quantity of wet garbage is more, the Vermiculture system is not affordable due to high requirement of space for it, therefore for housing complex having more than fifty members, wet Garbage plants are recommended.

Following guidelines are helpful for selection and other requirements for a wet garbage treatment plant .

Assume a housing complex having 400 flats.

1. Capacity : To treat 200 Kg of wet garbage (Food waste) daily. i.e. ½ Kg per flat.
2. Area required : 5 m x 5 m.
3. Water required : 300 liter per day.
4. Man power : One person per day to load food waste, general cleanliness and maintenance.
5. Electricity : Three phase electrical supply.
6. Inlet chamber : 1.2 m x 1.2 m x 1.2 m. to be connected to the digester .

WORKING OF WET GARBAGE PLANT

1) SORTING TABLE : All wet garbage collected should be loaded onto sorting table and to be segregated for residual plastics, metal, glass and other non-biodegradable items.

2) CRUSHER :- Food waste crusher is to be provided along with sorting table. The segregated waste is then loaded with water and the slurry is passed into the inlet chamber of the digester.

3) INLET CHAMBER:- It is to be constructed in brickwork and smoothly plastered. The size of chamber should be 1.2 m x 1.2 m x 1.2 m with a 150 mm diameter P.V.C. pipe. This chamber is to be connected to the bottom of the digester.

4) UPFLOW ANAEROBIC SLUDGE BLANKET DIGESTER:

i. It should be constructed in R.C.C. or in brickwork of size 3-meter diameter and 2.75 meter in depth (0.6 meter above ground level). UASB digester is to be provided with internal proprietary modules and baffle system of FRP reinforced with steel and double internal tank system having floating dome.

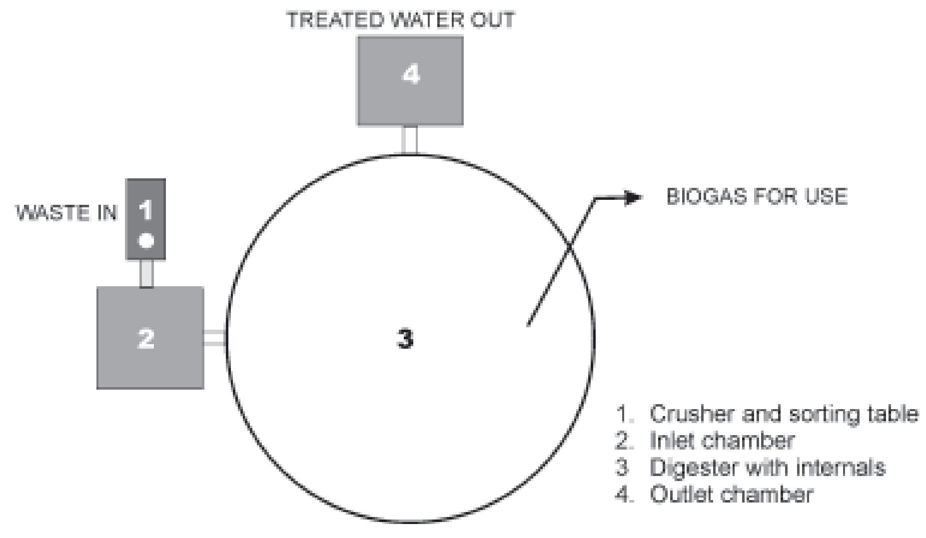
ii. The digesters are also available in 3 mm thick mild steel with FRP lining having size 2.4 meter diameter x 2.4 meter height. It has a neoprene rubber balloon at the top and is covered with a transparent FRP dome as a top cover. This digester is totally factory assembled package plant and only to be installed at site. The solids charged into the digester get converted into Biogas and liquid. Sludge accumulated at the bottom is to be removed once in a year.

5) OUTLET CHAMBER: The treated water waste is to be collected in the outlet chamber. Part of it is to be recycled back into inlet chamber and rest is to be connected to existing drain.

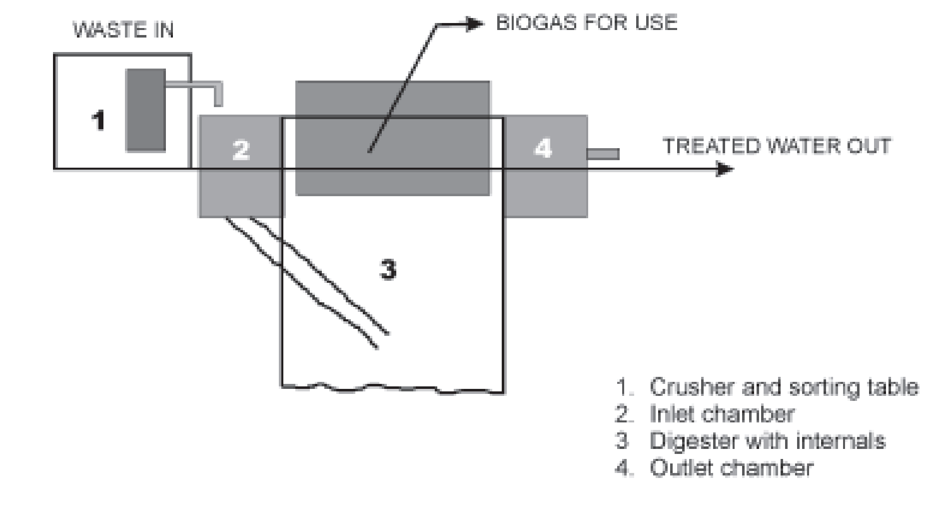
6) RECYLE PUMP :- Is to be provided to ensure period recycling of the outlet water. It is automatically controlled by a cycling timer.

7) BIOGAS PIPING : The biogas is collected under the floating dome. Once the dome is full of biogas, the valve is opened and the gas can be used up to a distance of 11 meter from the biogas plant.

8) AUTOMATION CONTROL PANEL: It should have all the switchgear and timer for complete automation of recycle pump and shredder. It has to be enclosed in a weatherproof enclosure with indication lamps and auto manual switch.



TYPICAL LAYOUT OF BIOGAS PLANT



TYPICAL FLOWSHEET OF BIOGAS PLANT

LIMITED LOCAL PUBLIC TRANSPORT FACILITY

The rapid urbanization extended the boundaries of cities to the maximum limits. ‘Twin-cities’, ‘sub-urban cities’ have become inevitable world over.

This forced the town planners to isolate Business centers, markets, and residential zones at a comparatively longer distance within a city. The new problem of connectivity arose with this type of Town-planning .

The transport of people from residential zone to the business zone in the mornings and the reversed transport in the evenings has become a great problem.

Therefore, the pressure on the Local Public Transport System is increasing day by day.

In this situation, some ‘Developers and builders’ started giving the service of ‘Local public facility’ to the members of the townships, built by those developers.

This facility of ‘Limited public transport’ is a necessity as well as a marketing tool to promote the sale of flats /shops etc. This facility is definitely appreciated by the flat purchasers in some cities, where the ‘General Public Transport’ system is unable to cope with, increasing population.

As in the recent past; the ‘Elevators’ turned from ‘Luxury’ to ‘Necessity’, the ‘Limited Public Transport Facility’ is going to become more a necessity than a marketing tool.

The layouts of the townships in the future will have to accommodate this type of service.

FUTURISTIC SERVICES

If we observe the development of the mankind through the history, we can say that the human race has created many new needs other than the three basic needs food, clothing, shelter.

So far as the construction industry is concerned, it is quite clear that, the industry being fulfilling the basic need of shelter; its future and responsibilities are quite high.

The houses built today, not only fulfill the purpose of a “shelter” but also fulfill many other demands of comfort, durability, and safety.

We can learn from the history of construction that, a luxury of yesterday becomes need of today and becomes an inevitable factor of tomorrow. The high precision equipments, computers, phone, video theaters are entering the houses as a luxury. These will be the basic needs of tomorrows’ houses.

Tomorrows’ houses will not remain only houses but they will contain offices, shops, hospitals, laboratories, nurseries, theaters, servant rooms’ gardens and many more things.

The future houses will require more electricity, water supply distribution inside the house. Centralised air conditioning, more efficient common services like lifts etc will become the basic needs.

The future will demand the services in many fields of engineering subjects and many skills simultaneously.

Therefore the houses required in the future will demand lot many things from the town planners, designers, builders, suppliers, contractors and the civil engineers.

Only specialized knowledge of civil engineering will not be sufficient. a civil engineer will require the knowledge and skill from many other branches of knowledge, than civil engineering.

Therefore the civil engineer will have to remain update in all fields of science and technology. a civil engineer will be simultaneously an electrical engineer, a mechanical engineer, an efficient manager, a trainer, a psychologist, a biologist and a mechanic having multitrade skills.

SECTION

VI

MENSURATION TABLES

LIST OF INDIAN STANDARDS

Indian Standards	Item
05-1978	Colours for ready mixed paints and enamels (third revision)
73-1951	Paving bitumen (revised)
129-1950	Ready mixed paint, brushing finishing, interior, oil gloss, for general purposes to Indian Standard Colours
164-1981	Ready mixed paint brushing for road marking (first revision)
204 (Part I & II)-1978	Tower bolts (fourth revision) Part I for Ferrous metals and Part II for non-Ferrous metals.
205-1978	Non-ferrous metal belt hinges (third revision)
208-1979	Door handles (third revision)
226-1975	Structural steel (standard quality) (fifth revision)
269-1976	Ordinary and low heat Portland cement (third revision)
277-1985	Galvanised steel sheets (plain and corrugated) (fourth revision)
278-1978	Galvanised steel barbed wire for fencing (third revision)
280-1973	Mild steel wire for general engineering purposes (third revision)
281-1973	Mild steel sliding door bolts, for use with pad-locks (second revision)
287-1973	Recommendations for maximum permissible moisture content for timber used for different purposes (Second revision)
290-1961	Coal tar black pain (revised)
303-1975	Plywood for general purposes (scond revision)
341-1973	Black Japan, Type 'A', 'B' and 'C' (first revision)
348-1968	French polish (first revision)
349-1981	Lacquer, cellulose nitrate clear finishing, glossy for metals (first revision)
362-1982	Parliament hinges (fourth revision)
363-1976	Hasps and staples (third revision)
364-1970	Fan-light catch (second revision)
371-1979	Ceiling roses (second revision)
375-1963	Marking and arrangement for switch gear, bus bars, main connections and auxiliary wiring (revised)
383-1970	Coarse and fine aggregate from natural sources for concrete (second revision)
398 (Part I & II) 1976	Aluminium conductors for overhead purposes (second revision)
1976	(i) 398 (part 1) 1976 Aluminium standard conductors (second revision) (ii) 398 (Part II) 1976. Aluminium conductors galvanised steel reinforced (second revision)
401-1932	Code of practice for preservation to timber (third revision)
412-1975	Expanded metal steel sheets for general purposes (second revision)
419-1967	Putty, for use on window frames (first revision)
427-1965	Distember, dry colour as required (revisd)
428-1969	Distemper, oil emulsion, colour as required (first revision)
430-1972	Paint remover, solvent type, non-flammable (second revision)
431-1972	Paint remover, selvent type, flammable (second revision)
432 (Part D 1982)	Mild steel and medium tensile steel bars (third revision)
451-1972	Technical supply conditions for wood screws (second revision)
455-1976	Portland slag cement (third revision)
456-1978	Code of practice for plain and reinforced concrete (third revision)
458-1971	Concrete pipes (with and without reinforcement) (Second revision)
459-1970	Un-reinforced corrugated and semi-corrugated asbestos cement sheets (second revision)
516-1959	Method of test for strength of concrete.
525-1968	Varnish, finishing exterior and general purposes (second revision)
640-1956	Ready mixed red oxide paint for Hessian.

651-1980	Salt glazed stoneware pipes and fittings (fourth, revision)
653-1980	Sheet lineleum and tiles (second revision)
654-1972	Clay roofing tiles, Mangalore pattern (Second revision)
694-1977	PVC insulated cables (for working voltage upto and including 1100 volts) (second revision)
712-1984	Building limes (third revision)
723-1972	Steel countersunk head wrire nails (second revision)
730-1978	Hoot bolts for corrugated sheet roofing (second revision)
731-1971	Porcelain insulators for overhead power lines with nominal voltage greater than 100 volts (second revision)
732-1963	Code of practice for electrical wiring installations (system voltage not exceeding 650 V) (revised)
732 (Part I, II & 1983)	Code of practive for electrical wiring installation (system voltage exceeding 650 volts) Part I definition and general requirement (second revision) Part II 1983 Design and construction (Second revision) Part III 1982 Inspection and Testing of installation (second revision)
774-1984	Flushing cistems for water closets and urinals valveless syphonic type (fourth revision)
775-1970	Cast iron supports and brackets for wash basin and sinks (second revision)
777-1970	Glazed earthen ware tiles (first revision)
784-1984	Cast cooper alloy screw down bib taps and stop valves for water services (third revision)
800-1984	Code or practice for structural steel in general building constructions (second revision)
809-1970	Rubber flooring materials for general purposes (first revision)
818-1968	Code of Practice for safely and health requirements in electric and gas welding and cutting operations (first revision)
822-1970	Code of procedure for inspection of welds.
1038-1983	Steel door window and ventilator (third revision)
1077-1986	Common burnt clay puiloing bricks (fourth revision)
1081-1960	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
1195-1978	Bitumen mastie for flooring (second revision)
1199-1959	Method of sampling and analysis of concrete.
1230-1979	Cast iron rain water pipes and fitting (second revison)
1236-1958	Ready mixed paint brushing oil gloss, heart resisting
1237-1980	Cement concrete flooring tiles (first revision)
1239 (Part I) 1979	Mild steel tubes (fourth revision)
1239 (Part II) 1982	Mild steel tubuiars and other wrought steel pipe fittings (third revision)
1254-1975	Specification for corrugated aluminium sheet.
1328-1982	Veneered decorative plywood (second revision)
1341-1981	Steel butt hinges (forth revision)
1361-1978	Steel windows for industrial buildings (first revision)
1363 (Part I to III) 1984	Black hexagon bolts, nuts and lock nuts size (M5 to M36) andblack hexagon screws (M5 to M36) (second revision)
1445-1977	Porcelain insulators for overhead power lines with nominal voltage upto and including 1000 volts (second revision)
1464-1973	Clay ridge and ceiling tiles (first revision)
1489-1976	Portland Pozzlana cement (second revision)
1536-1976	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage (second revision)
1537-1976	Vertically cast iron pressure pipes for water gas and sewage (first revision)
1538 (Part I to XXIII) 1976	Cast iron fittings for pressure pipes for water, gas and sewage (second revision)
1542-1977	Sand for plaster (first revision)
1554 (Part I)-1976	PVC insulated (Heavy duty) electric cable Part II (for working voltages from 3.3 KV upto and including 11 (KV) (first revision)

1566-1932	Hard drawn steel wire fabric for concrete reinforcement (second revision)
1568-1970	Wire cloth for general purposes (first revision)
1580-1939	Bituminous compound for water proofing & caulkings purposes (first revision)
1592-1980	Asbestos cement pressure pipes (second revision)
1596-1977	Polyethylene insulated cables for working voltage upto and including 1100 volts (second revision)
1597(Part I to II)-1967	Code of practive for construction of stone masonry.
1626 (Part I) 1980	Asbestos cement building pipes and pipe fittings (first revision)
1626 (Part II) 1980	Asbestos cement gutters and gutter fittings (first revision)
1626 (Part III) 1981	Asbestos cement gutters and roofing fittings (first revision)
1646-1982	Code of practice for fire safely of buildings (general) electrical installations
1653-1977	Fibre hard boards (second revision)
1659-1979	Block boards (second revision)
1678-1978	Pre-stressed concrete poles for overhead power traction and telecommunication lines (first revision)
1703-1977	Ballvalves (horizontal plunger type) including floats for water supply purpose (second revision)
1711-1934	Salf closing taps for water supply purpose (second revision)
1726 (parts I to VII) 1974	Cast iron manhole covers and frames (second revision)
1729-1979	Sand cast iron, spigot and socket soil waste and ventilating pipes, fittings and accessories (first revision)
1786-1985 revision)	High strength deformed steel bars and wires for concrete reinforcement (third
1795-1982	Pillar taps for water supply purposes (second revision)
1823-1980	Floor door stoppers (third revision)
1838	Preformed fillers for expansion joints in concrete, non-extruding and resilient type (bitumen impregnated fibre)
1879 (Part I to X)-1987	Malleable cast iron pipe fittings (second revision)
1905-1980	Code of practice for structural safety of Building masonry wall (second revision)
1913 (PartI)-1973	General safety requirements for luminaries part I Tubular Fluorescent lamps.
1944 (Part I & II)-1970	Code of practive for lighting of Public thoroughfares (second revision)
1977-1975	Structural steel (ordinary quality) (second revision)
2026 (Part I)-1977	Power transformers, general (first revision)
2046-1969	Decorative thermosetting synthetic resin bonded laminated sheets (first revision)
2065-1983	Code of practice for water supply in Building.
2098-1964	Ashestos cement building boards.
2114-1984	Code of practice for laying in-situ terrazo floor finish (first revision)
2116-1980	Sand for masonry mortars (first revision)
2121-1962	Fittings for aluminium and steel cored aluminium conductors for overhead power lines.
2185-Part I-1979	Concrete masonry units (second revision)
2185-Part 11-1984	Concrete masonry units
2202 (Part I)-1983	Wooden flush door shutters (solid core type) part 1, Plywood face panels (fourth revision)
2202 (Part II)-1983	Particle board and hardboard face panel (third revision)
2209-1976	Mortice lock (vertical type) (third revision)
2215-1983	Starters for fluorescent lamps (third revision)
2268-1988	Electric call bells and buzzers for in-door use (second revision)
2309-1969	Code of practice for protection of buildings and allied structures against lighting (first revision)
2326-1987	Automatic flushing cisterns for urinals (firs revision)
2339-1963	Aluminium paint, for general purposes, in dual containers.
2386 (Part I to VIII)-1963	Method of test for aggregates for concrete.
2418 (Part I to IV)-1977	Tubular fluorescent lamps for general lighting service (second revison)
2470 (Part I & II)-1985	Code of practice for septic tanks.
2486 (Part I)-1971	Insulator fittings for overhead power lines for 3.3 KV and above (Part I) General requirements and tests (firs revision)

2486 (Part II) 1974	Insulator fittings for overhead power lines for 3.3 KV and above (Part II) Dimensional requirements (first revision)
2502-1963	Code of practice for bending and fixing of bars for concrete reinforcement
2508-1984	Low density polythene films (second revision)
2544-1973	Porceiain post insulators for systems with nominal voltages greater than 1000 volts (first revision)
2548 (Part I & II)-1983	Plastic seats and covers for water closets. Part I thermostat seats and covers. Part II, thermo plastic seats and covers (Forth revision)
2548-	Plastic water closet seats and covers (third revision)
2551-1982	Danger notice plates (first revision)
2556 (Part I) 1974	Vitreous sanitary appliances (Vitreous China) Part 1, General requirements (Second revison)
2556 (Part II)-1981	Vitreous sanitary appliances (vitreous China) Part II, specific requirement of washdown water closets (third revision)
2556 (Part III)-1981	Vitreous sanitary appliances (Vitreous China) Part 1, General requirements (Second revision)
2556 (Part II) 1981	Vitreous sanitary appliances (Vitreous China) Part II, specific requirement of washdown water closets (third revision)
2556 (Part III)-1981	Vitreous sanitary appliances (Vitreous China) Part III specific requirements of squatting pans (third revision)
2556 (Part IV)-1972	Vitreous sanitary appliances (Vitreous China) Part IV) Specific requirements of Wash basins (Second revision)
2556 (Part V) 1979	Vitreous sanitary appliances (Vitreou China) Part V, specific requirements for laboratory sinks (second revision)
2556 (Part VI/SecD-1979	Vitreous sanitary appliances (Vitreous China) Part VI, specific requirements of urinals Sec. 1 Bowl type (third revision)
2556 (Part VI/Sec 2)-1974	Vitreous Sanitary appliances (Vitreous China), Part VI, Sec 2 Half urinal (Second revision)
2556 (Part VI/Sec 3)-1974	Vitreous sanitary appliances (Vitreous China) Part VI, Sec 4 partition slabs (second revision)
2556 (Part X)-1974	Vitreous sanitary appliances (Vitreous China) part X, Specific requirements of foot rest (second revision)
2645-1975	Integral cement water proofing compounds (first revision)
2667-1976	Fittings for rigid steel conduits for electrical wiring (first revision)
2675-1983	Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000 volts (second revision)
2690 (Part II)-1975	Burnt clay terracing tile, part 11, hand made (first revision)
2691-1988	Burnt clay facing bricks (second revision)
2713 (Part I to III)-1980	Tubular steel poles for overhead power lines (second revision)
2720 (Part VII)-1980	Methods of test for soils, Part VII, determination of water content-dry density relation using light compaction (second revision)
2721-1979	Galvanised steel wire chain link fences (first revison)
2751-1979	Code of practice for welding of mild steel bars used for reinforced cement concrete construction (first revision)
2835-1987	Flat transparent sheet glass (third revision)
2911 (Part I, Sec 4, Part II, III & IV)-1985	Code of practice for design and construction of pile and pile foundations.
2932-1974	Enamel, synthetic, exterior, under-coating and finishing (first revision)
2963-1979	Copper alloys waste fittings for wash basins and sinks (first revision)
3016-1982	Code of practice for fire precautions in welding and cutting operations (first revision)
3034-1981	Code of practice for fire safety of industrial buildings electrical generating and distributing stations (first revision)
3043-1987	Code of Practice for earthing (first revision)
3076-1985	Low density polyethylene pipes for potable water supply (second revision)
3087-1985	Wood particle boards (medium density) for general purpose.
3097-1980	Veneered particle boards (first revision)

3117-1965	Bitumen emulsion for roads (anionic type)
3311-1979	Waste plug and its accessories for sinks and wash basins (first revision)
3324-1982	Holders for starters for tabular fluorescent lamps (first revision)
3337-1978	Ballies for general purpose (first revision)
3348-1965	Fibre insulation boards
3384-1986	Bitumen premier for using water-proofing and damp-proofing (first revision)
3386-1979	Wodden fencing posts (first revision)
3419-1976	Fittings for non - metallic conduits (second revision)
3427-1969	Metal enclosed switchgear and control gear for voltages above 1000 volts but not exceeding 11000 volts
3461-1980	PVC asbestos floor tiles (first revision)
3462-1986	Flexible PVC flooring (second revision)
3480-1966	Flexible steel conduits for electrical wiring.
3486-1966	Cast iron, spigot and socket drain pipes.
3502-1981	Steel chequered paltes (first revision)
3536-1966	Ready mixed paint, brushing, wood primer, pink.
3553-1966	Waterlight electric lighting fittings.
3564-1986	Door closers (hydraulically regulated) (third revision)
3629-1986	Structural timber in building (first revision)
3639-1966	Fittings and accessories for power transformers.
3678-1966	Ready mixed paint, thick white for lettering.
3696(Part D- 1987)	Safety code for scaffolds and ladders, part 1, scaffolds (first revision)
3696(Part II- 1966)	Safety code for scaffolds and ladders, part 11, ladders
3764-1966	Safety code for excavation work.
3812(Part III- 1981)	Fly ash for use as pozzolona and admixture (first revision)
3818-1986	Continous (Piano) hinges (second revision)
3837-1976	Accessories for rigid steel conduits for electrical wiring (first revision)
3847-1966	Mortice night latches.
3854-1984	Switches for domestic and similar purposes.
3989-1984	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes fittings and accessories (second revision)
4014(Part II)-1967	Code of praticefor steel tubular scaffolding, part11, safely regulations for scaffold ing
4020-1967	Method and test for wooden flush doors type tests.
4064(Parts I & 11)-1987	Air break switches, air break disconnectors, air break switch disconnector and fuse combination units for voltages not execeeding 1000 VAC or 1200 VDC (first revision)
4081-1986	Safety code for blasting and related drilling operations. (first revison)
4130-1976	Safety code for demolition of building (first revision)
4160-1967	Interlocking switch socket outlets.
4237-1982	General requirement for switchgear and control gear for voltages not exceeding 1000 volts. (first revision)
4346-1982	Washers for water taps for cold water services. (first revision)
4351-1976	Steel door frames (first revision)
4648-1968	Guide for electrical layout in residential buildings
4710-1968	Switch and switcn isolators above 1000 volts but not exceeding 11000 volts.
4832 (Part II)-1969	Chemical resistant mortars, Part II, Resin type.
4832 (Part III)-1968	Chemical resistant mortars, Part III, sulphur type.
4835-1979	Polyvinyl acetate dispersion based adesive for wood. (first revision)
4860-1968	Acid resistant bricks.
4948-1974	Welded steel wire fabric for general use (first revision)
4984-1987	High density polyethylene pipes for potable water supplies, sewage and industrial effluent (third revision)
5121-1969	Safety code for pilling and other deep foundations.
5133 (Part D)-1969	Boxes for enclosures of electrical accessories Part I, steel and cast iron boxes.
5216	Guide for safety procedures and practices in electrical works
5382-1985	Rubber sealing rings for gas mains, water mains and sewers (first revision)

5410-1669	Cement paint, colour as required
5411 (Part D) 1974	Plastic emulsion paint part I for interior use (first revision)
5437-1969	Wired and figured glass.
5454-1978	Methods for sampling of clay building brick (first revision)
5613 (Part I, Sec D)-1970	Part I Lines upto and including 11KV section 2 installation and maintenance. (first revision)
5820-1970	Precast concrete cable covers.
5930-1970	Mortice latch (Vertical type)
6163-1978	Centrifugally cast (spun)iron low pressure pipes for water, gas and sewage (first revision)
6248-1979	Metal rolling shutter and rolling grills. (first revision)
6313 (Part D) 1981	Anti-termite measures in building. Constructional measures (first revision)
6313-(Part II)	Anti-termite measures in building. Pre-constructional chemical treatment measures (first revision)
6313 (Part II) 1981	Anti-terminate measures in building. Treatment for existing building (first revision)
6523-1983	Precast reinforced concrete door and window frames. (first revision)
6530-1972	Code of practice for laying of asbestos cement pipe.
6908-1975	Non pressure asbestos cement and fittings for sewage and drainage.
71641973	Stopper
7205-1973	Safety code for erection on structural steel work.
7293-1974	Safety code for working with construction machinery.
7969-1975	Safety code for storage and handling of building materials.
8008 (Part I toVII)-1976	Injection moulded high density polyethylene (HDPE) fittings for portable water supply.
8042-1978	White Portland cement (first revision)
8061-1976	Code of practice for design, installation and maintenance of service lines upto and including 650 volts.
8756-1978	Ball catches for use in wooden almirahs.
8931-1978	Cast copper alloy fancy bib taps and stop valves for water services.
8934-1978	Cast copper alloy fancy pillar taps for wter services.
9224 (Part II)-979	HRC Cartridge fuse links upto 650 volts.
9385 (Part II)-1980	High voltage explosion fuses and similar fuses.
9537-1980	Conduits for electrical installations.
1786-1985	High strength deformed steel bars and wires for concrete reinforcement (third revision) superceding IS 1653 and IS 2509
10322 (Part5 Sec.3)-1987	Particular requirement, section 3 fuminaries for road and street lighting.
12701-1989	Specification for Rotational inoulded Polythylene Water Storage Tanks

METHOD OF MEASUREMENT

1200	Building & Civil Engineering Works
1200 Pt I	1992 Measurement of Earth Work
1200 Pt II	1974 Measurement of Cement Concrete Work
1200 Pt III	1976 Measurement of Brick Work
1200 Pt IV	1976 Stone Masonry
1200 Pt V	1974 Measurement of Form Work
1200 Pt VII	1982 Steel Work and Iron Work
12 Pt XI	1977 Paving and Floor Finishes
1200 Pt X	1973 Ceiling and Linings
1200 Pt IX	1973 Roof Covering (including cladding)
1200 Pt XII	1977 Plastering and Painting
1200 Pt XIII	1987 White Washing, Colour Washing, Distempering & Other Finishes.
1200 Pt XV	1987 Painting, Polishing, Varnishing etc.
1200 Pt XVIII	1974 Demolition and Dismantling

METRIC TABLE

1 Centimetre	= 10 Milimetre	1 Milimetre	= 0.10 Centimetre
1 Decimetre	= 10 Centimetre	1 Centimetre	= 0.10 Decimetre
1 Metre	= 100 Centimetre	1 Decimetre	= 0.10 Metre
1 Decametre	= 10 Metre	1 Metre	= 0.10 Decametre
1 Hectometre	= 100 Metres	1 Decametre	= 0.10 Hectometre
1 Kilometre	= 1000 Metres	1 Hectometre	= 0.10 Kilometre

MEASURES OF LENGTH

1 yard	= 36 Inches	1 Inch	= 0.0277 Yard
1 Furlong	= 220 Yards	1 Yard	= 0.0045 Furlong
1 Mile	= 8 Furlongs	1 Furlong	= 0.125 Mile
1 League	= 3 Miles	1 Mile	= 0.33 League
1 Chain	= 22 Yards	1 Yard	= 0.0454 Chain

MEASURES OF AREA

1 Sq. Ft.	= 144 Sq. in.	1 Sq. in.	= 0.0069 Sq. Ft.
1 Sq. Yd.	= 9 Sq. Ft.	1 Sq. Ft.	= 0.1111 Sq. Yd.
1 Sq. Chain	= 484 Sq. Yds.	1 Sq. Yd.	= 0.002 Sq. Chain
1 Acre	= 10 Sq. Chain	1 Sq. Chain	= 0.1 Acre
1 Ground	= 2,400 Sq. Ft.	1 Sq. Ft.	= 0.0004 Ground
1 Acre	= 4,840 Sq. Yds.	1 Sq. Yd.	= 0.00055 Acre
1 Acre	= 43,560 Sq. Ft.	1 Sq. Ft.	= 0.000022 Acre
1 Sq. Mile	= 640 Ares	1 Acre	= 0.0015 Sq. Mile
1 Hectare	= 2.47 Acres	1 Acres	= 0.001 Hectare
1 sq. Metre	= 10.76 Sq. Ft.	1 Sq. R.	= 0.093 sq. Hectare
1 Sq. Metre	= 1.2 Sq. Yds.	1 Sq. Yd.	= 0.83 Sq. Metre

CUBIC MEASURE (VOLUME)

1 Cubic In.	= 16.4 Cubic Cm.	1 Cubic Cm.	= 0.0609 Cubic In.
1 Litre	= 61.035 Cubic In	1 Cubic In.	= 0.0163 Litre
1 Litre	= 0.035 Cubic R.	1 Cubic R.	= 2857 Litre
1 Cubic Metre	= 353 Cubic R.	1 Cubic Ft.	= 0.0283 Cubic Mt.
1 Cubic Metre	= 1.3 Cubic Yd.	1 Cubic Yd.	= 07692 Cubic Mt.
1 Cubic Ft.	= 1728 Cubic In.	1 Cubic In	= 0.0005 Cubic Ft.
1 Cubic W.	= 27 Cubic R.	1 Cubic Ft.	= 0.037 Cubic Yd.

INDIAN STANDARD ROLLED BEAMS (DIMENSIONS AND PROPERTIES)

ISMB - As per is - 808 (Part-I) 1973				
Section	Weight	Sectional	Thickness of	
Section h x b	Per Meter	Area (Sq. Cm)	Flange Tt (mm)	Web t (mm)
	W (kg.)	a		W
1	2	3	4	5
Designation (ISMB)				
100 x 75	11.50	14.60	7.2	4.0
125 x 75	13.4	16.60	7.6	4.4
150 x 80	15.0	19.0	7.6	4.8
175 x 90	19.5	24.62	8.6	5.5
200 x 100	25.4	32.33	10.8	5.7
225 x 110	31.2	39.72	11.8	6.5
250 x 125	37.3	47.55	12.5	6.9
300 x 140	46.1	56.26	12.4	7.5
350 x 140	52.4	66.71	14.2	8.1
400 x 140	61.6	78.46	16.0	8.9
450 x 150	72.4	92.27	17.4	9.4
500 x 180	86.9	110.74	17.2	10.2
550 x 190	104.0	132.11	19.3	11.2
600 x 210	123.0	156.21	20.8	12.0

INDIAN STANDARD ROLLED STEEL CHANNELS (DIMENSIONS AND PROPERTIES)

ISMC As per IS-808 (Part lil) - 1978					
Designation	Section	Thickness of Flange	Thickness of Web	Sectional Area	Weight per Metre
	h x b (mm x mm)	tf (mm)	tw (mm)	a (Cm^2)	W (Kg)
ISMC	75 x 40	7.3	4.4	8.67	7.1
	100 x 40	7.5	4.7	11.70	9.56
	125 x 65	8.1	5.0	16.19	13.1
	150 x 75	9.0	5.4	20.88	16.8
	175 x 75	10.2	5.7	24.38	19.6
	200 x 75	11.4	6.1	28.21	22.3
	250 x 80	12.4	6.4	33.01	30.60
	300 x 90	13.6	7.6	45.64	36.3
	300 x 100	13.5	8.1	53.66	42.7

INDIAN STANDARD ROLLED STEEL EQUAL ANGLES (DIMENSIONS AND PROPERTIES)

As per IS-808 (Part V) - 1976				
Designation	Size	Thickness of Flange	Sectional Area	Weight per Metre
	h x b	t	a	w
	2	3	4	5
	(mm x mm)	(mm)	(Cm2)	(Kg)
ISA 2020	20 x 20	3.0	1.12	0.9
		4.0	1.45	1.1
ISA 2525	25 x25	3.0	1.41	1.1
		4.0	1.84	1.4
		5.0	2.25	1.8
TSA 3030	30 x 30	3.0	1.73	1.4
		4.0	2.26	1.8
		5.0	2.77	2.2
ISA 3535	35 x 35	3.0	2.03	1.6
		4.0	2.66	2.1
		5.0	3.27	2.6
		6.0	3.86	3.0
ISA 4040	40 x 40	3.0	2.34	1.8
		4.0	3.07	2.4
		5.0	3.78	3.0
		6.0	4.47	3.5
ISA 4545	45 x 45	3.0	2.64	2.1
		4.0	3.47	2.7
		5.0	4.28	3.4
		3.0	5.07	4.0
ISA 5050	50 x 50	3.0	2.95	2.3
		4.0	3.88	3.0
		5.0	4.79	3.8
		6.0	5.68	4.5
ISA 5555	55 x 55	5.0	5.27	4.1
		6.0	6.26	4.9
		8.0	8.18	6.4
		10.0	10.02	7.9
ISA 6060	60 x 60	5.0	5.75	4.5
		6.0	6.84	5.4
		8.0	3.96	7.0
		10.0	11.00	8.6
ISA 6565	65 x 65	5.0	6.25	4.9
		6.0	7.44	5.8
		8.0	9.76	7.7
		10.0	12.00	9.4

As per IS-808 (Part V) - 1976				
Designation	Size	Thickness of Flange	Sectional Area	Weight per Metre
	h x b	t	a	w
	2	3	4	5
	(mm x mm)	(mm)	(Cm2)	(Kg)
ISA 7070	70 x 70	5.0	6.77	5.3
		6.0	8.06	6.3
		8.0	10.58	3.3
		10.0	13.02	10.2
ISA 7575	75 X 75	5.0	7.27	5.7
		6.0	8.66	6.8
		8.0	11.38	8.9
		10.0	14.02	11.0
ISA 8080	80 X 80	6.0	9.29	7.3
		8.0	12.21	9.6
		10.0	15.05	11.8
		12.0	17.81	14.6
ISA 9090	90 X 90	6.0	10.47	8.2
		8.0	13.79	10.8
		10.0	17.03	13.4
		12.0	20.19	15.8
ISA 100100	100X100	6.0	11.67	9.2
		8.0	15.39	12.1
		10.0	19.03	14.9
		12.0	22.59	17.7
ISA110110	110 X 110	8.0	17.20	13.4
		10.0	21.06	16.5
		12.0	25.02	19.6
		15.0	30.81	24.2
ISA 130130	130 X 130	8.0	20.22	15.9
		10.0	25.06	19.7
		12.0	29.82	23.4
		15.0	36.81	28.9
ISA 150150	150 X 150	10.0	29.3	22.8
		12.0	34.59	27.2
		15.0	42.78	33.6
		18.0	50.79	39.3
ISA 200200	200 X 200	12.0	46.61	36.6
		15.0	57.80	45.5

MS PLATES (PLAIN)

Thickness in mm	Weight in Kg. Per Sq. M.	Thickness in mm	Weight in Kg.
5	39.25	16	125.60
6	47.10	18	141.30
8	62.80	20	157.00
10	78.50	22	172.70
12	94.20	25	196.25
14	109.90	-	-

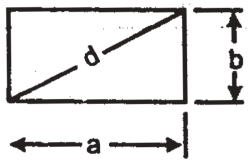
GALVANISED PLAIN STEEL SHEETS

Description and class of sheet	Weight in Kg. Per Sq. M. Thickness in mm				
	1.60	1.25	1.00	0.80	0.63
IS 277-1977 Class 2 600 g, of zinc (spelter) coating/ sq. m. both sides inclusive	13.16	10.41	8.45	6.88	5.55
Class 3 450 g, of zinc (spelter) coating/ sq. m., both sides inclusive	13.01	10.26	8.30	6.73	5.40

Dimension and Weights of Hot-Rolled Steel Flats As per is 1731-1971 (Clause 3.1)

Width mm	Thickness in mm 3.0	4.0	5.0	6.0	8.0	10.0
	Weight Per Metre Length, kg					
10	0.236	0.314	0.393	0.471	-	-
14	0.330	0.440	0.550	0.659	0.879	-
20	0.471	0.628	0.785	0.942	1.26	1.57
25	0.589	0.785	0.981	1.18	1.57	1.96
30	0.707	0.942	1.18	1.41	1.88	2.36
35	0.824	1.10	1.37	1.65	2.20	2.75
40	0.942	1.26	1.57	1.88	2.51	3.14
45	-	1.41	1.77	2.12	2.83	3.53
50	1.18	1.57	1.96	2.36	3.14	3.93
55	-	1.73	2.16	2.59	3.45	4.32
60	1.41	1.88	2.36	2.83	3.77	4.71
65	-	2.04	2.55	3.06	4.08	5.10
70	-	2.20	2.75	3.30	4.40	5.50
75	-	2.36	2.94	3.63	4.71	5.89
80	-	2.51	3.14	3.77	5.02	6.28
90	-	-	3.53	4.24	5.65	7.07
100	-	-	3.93	4.71	6.28	7.85

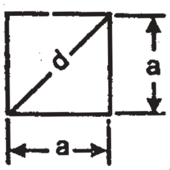
AREAS



1. Rectangles

i) $A = ab$ where A = area; a = lenght;

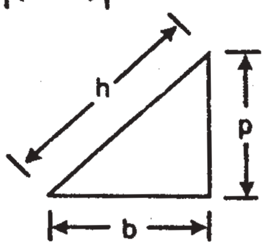
ii) $d = \sqrt{a^2 + b^2}$ b = breadth; d = diagonal.



2. Squares

i) $A = a^2$ where a = area;

ii) $d = a\sqrt{2}$ a = side; d = diagonal

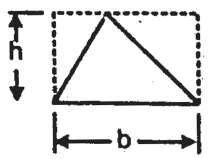


3. Righr- angled triangles

i) $h = \sqrt{b^2 + p^2}$ where h = hypotenuse;

ii) $b = \sqrt{(h-p)(h+p)}$ b = base;

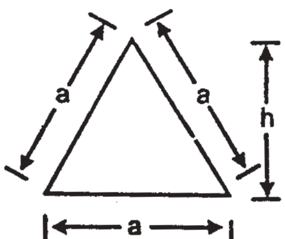
iii) $p = \sqrt{(h-b)(h+b)}$ p = perpendicular



4. Triangles

i) $A = \frac{1}{2} bh$ where A = area; base; h = height

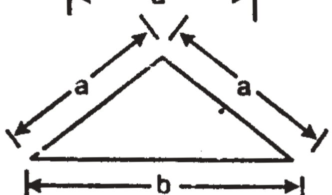
ii) $A = \sqrt{s(s-a)(s-b)(s-c)}$ where A = area; a, b, & c are the three sides; and $s = \frac{a+b+c}{2}$



5. Equilateral triangles

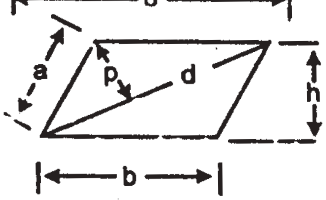
i) $h = \frac{a\sqrt{3}}{2}$ where h = height; a = side

ii) $A = a^2 x \frac{\sqrt{3}}{4}$ A = area



6. Isosceles triangles

$A = \frac{c}{4} \sqrt{4a^2 - c^2}$ where A = area; a = side; c = base



7. Paralleiograms Triangles

i) $A = bh$

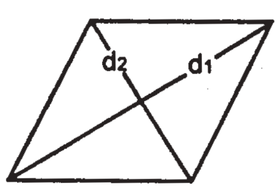
where A = area: b = base; h = height.

ii) $A = dp$

where A = area, diagonal, p = offset of diagonal

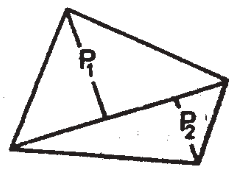
iii) $A = 2\sqrt{s(s-a)(s-b)(s-d)}$ where A = area; d = diagonal

a and b are two adjacent sides; and $s = \frac{a+b+d}{2}$



8. Rhombus

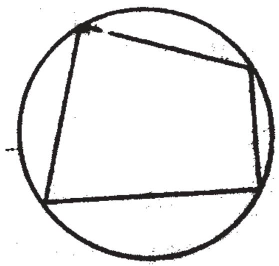
$a = \frac{1}{2} d_1 d_2$ where A = area; d_1 and d_2 are two diagonals



9. Quadrilaterals

$$A = \frac{1}{2} d (p_1 + p_2)$$

where A = area; d = diagonal; p2 and p1 are the offsets of the diagonal

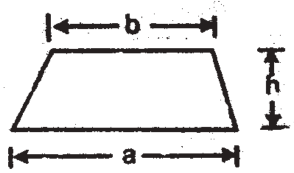


10. Quadrilaterals inscribed in circles

$$A = \sqrt{(s-a)(s-b)(s-c)(s-d)}$$

where a = area; a, b, c, d are the sides and

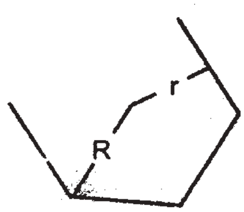
$$s = \frac{a+b+c+d}{2}$$



11. Trapezoids

$$A = \frac{1}{2} (a + b)\ h$$

where A = area, a and b are the parallel sides;
h = the perpendicular distance between the prallel sides



12. Regular polygons

i) $A = \frac{n}{2} \times ar$

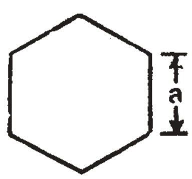
ii) $A = \frac{na}{2} \sqrt{R^2 - \left(\frac{a}{2}\right)^2}$

iii) $A = a^2 \times \frac{n}{4} \cot \frac{180^0}{n}$

iv) $A = r^2 \times n \tan \frac{180^0}{n}$

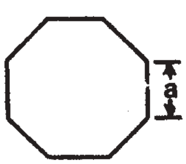
v) $A = R^2 \times \frac{n}{2} \sin \frac{360^0}{n}$

where A = area; n = number of sides, a = side, r = radius of inscribed circle
R = radius of circumscribed circle



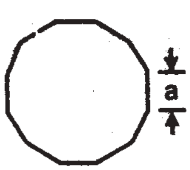
13. Regular hexagons

$$A = \frac{3a^2\sqrt{3}}{2}$$ where A = area, a = side



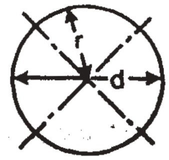
14. Regular octagons

$$A = 2a^2 (1 + \sqrt{2})$$ where A = area; a = side



15. Regular dodecagons

$$A = 6a^2 \sqrt{\frac{7}{4} + \sqrt{3}}$$ where A = area ; a = side

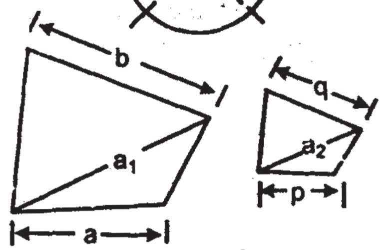


16. Circles

i) $c = \pi d$

ii) $a = \pi r^2$

where c = circumference; d = diameter; r = radius



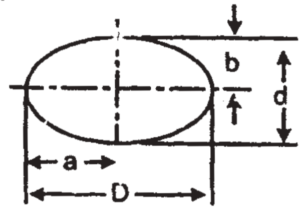
17. Similar figures

i) $a : b = p : q$

where a and b are lengths in one figure, corresponding to p and q respectively in the other.

ii) $A_1 : A_2 = (a_1)2 : (a_2)^2$

where A_1 and A_2 are the areas of the two figures; a_1 and a_2 are corresponding lengths, one in each figure.

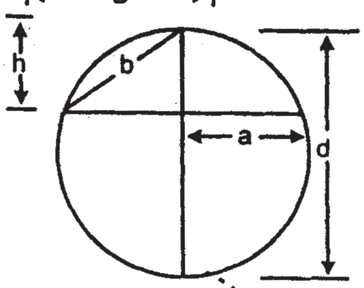


18. Ellipses

$A = \pi ab$ $\qquad$ $C = DM$

Where A = area; a = semi-major axis; and b = semi-minor axis; c = circumference; M = multiplier

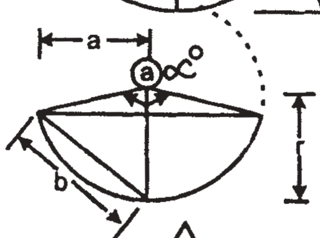
If value of $\frac{d}{D}$ = 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 or 0.9 then the corresponding multiplier (M) will be 2.21010, 2.1930, 2.3013, 2.4221, 2.5527, 2.6912. 2.8361 and 2.9866 respectively



19. Chords of circles

i) $a = \sqrt{h(d-h)}$ where a = semi-chord of the arc; b = chord of the semi-arc

ii) $A = \sqrt{dh}$ d = diameter of the circle; h = height of arc;



20. Arcs of circles

i) $L = \frac{\alpha^0}{360} \times 2\pi r$

where L = lenght of the arc; α^0 = central angle of arc;

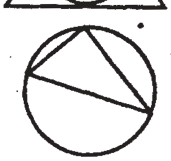
ii) $L = \frac{8b - 2a}{3}$

r = radius of the circle; a = semi-chord of the arc;
b = chord of the Circles inscribed in equilateral triangles

21. Circle inscribed in equilateral triangle

$r = \frac{a}{2\sqrt{3}}$

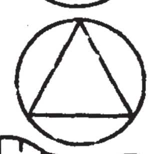
where r = radius of the inscribed circle; a = side of the triangle



22. Circles circumscribed about triangles

$R = \frac{abc}{4\Delta}$

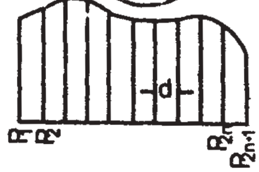
where R = radius of the circumscribing circle; Δ = area of the triangle; a, b and c are the three sides of the triangle



23. Circles circumscribed about equilateral triangles

$R = \frac{a}{\sqrt{3}}$

where R = radius of the circumscribing circle; a = side of the triangle



24. Simpson's Rule

$A = \frac{d}{3}[P_1 + P_2 + 2(P_3 + P_5 + \dots P_{2n-1}) + 4(P_2 + P_4 + \dots + P_{2n}]$

where A = area; d = common distance; 2_n = number of equal parts into which the base line is divided; $P_1, P_2 \dots P_{2n+1}$ are the ordinates taken in order.

DIMENSIONS, SECTIONAL AREAS AND WEIGHTS OF HOT ROLLED SQUARE STEEL BARS IS : 1732-1971 (Clauses 2.1, 3.1 and 3.1.1)			
Designation (1)	Diameter (2) mm	Sectional Area (3) cm^2	Weight Per Metre (4) kg
ISSQ 5	5.0	0.25	0.196
ISSQ 6	6.0	0.36	1.283
ISSQ 8	8.0	0.64	0.502
ISSQ 10	10.0	1.00	0.785
ISSQ 12	12	1.44	1.13
ISSQ 16	16	2.56	2.01
ISSQ 20	20	4.00	3.14
ISSQ 25	25	6.25	4.91
ISSQ 32	32	10.2	8.04
ISSQ 40	40	16.0	12.6
ISSQ 45	45	20.2	15.9
ISSQ 50	5.	25.0	19.6

Note : The weight per - metre of bars given in the table is calculated on the basis that steel weights 7.85 g/cm^2 and is rounded off to three significant figures. The sectional area of the bar is also rounded off to three significant figures.

Gauge Thickness G	Thickness in MM	Theoretical Weight in Kg. per sq. metre	Gauge Thickness G	Thickness in MM	Theoretical Weight in Kg. per sq. metre
0	10.05	-	12	2.50	19.60
1	8.97	-	13	2.24	17.60
2	7.98	-	14	2.00	15.70
3	7.13	-	15	1.80	14.15
4	6.34	-	16	1.60	12.55
5	5.63	-	17	1.40	11.00
6	5.03	-	18	1.25	9.80
7	4.46	-	19	1.12	8.80
8	3.97	-	20	1.00	7.85
9	3.52	-	21	0.90	7.05
10	3.15	24.75	22	0.80	6.30
11	2.80	22.00	23	0.63	4.95

WEIGHTS OF MATERIALS

Material		Kg./cum
Asphalt Flooring		2200
Ballast Stone		166-1970
Bamboo		370
Bitumen		1040
Brass		8550
Bricks :	Common Burnt Clay	1600-1920
	Rapid Handening	1840
	Sane Lime	2080
Brick Ballast		1200
Brick Dust (Surki)		1010
Brick Masonry		1920
Cement :	Ordinary & Aluminous	1440
	Rapid Handening	1280
Cement	Concrete Plain : Aerated	260
	Brick Aggregate	1840
	Stone Ballast	2240
Cement Concrete	reinforced :	
	with 1% steel	2370
	with 2% steel	2420
	with 3% steel	2580
Clay :	Dry Compact	1440
	Damp Compact	1760
	Wet Compact	2080
Earth ;	Dry Loose	1280
	Dry Compact	1550
	Most Loose	1440-1600
Glass :	Crown	2510
	Common	2530
	Tinted	3060
	Plain Glass	2750
Gravel		1300-2000
Plaster of Pans		800
Rubber		960
Sand :	Dry-Clean	1600
	River	1840
	Wet	1760-2000
Stones :	Basalt	2850-2960
	Gneiss	2400-2690
	Granite	2460-2800
	Kankar	1360-1470
	Laterite	2080-2400
	Limestone	2400-2640
	Marble	2620
	Quartz	2640
	Sandstone	2240-2400
	Slate	2800
Stone Masony	Dry Rubble	2080
	Granite-Ashlar	2640
	Granite Rubble	2400
	Limestone Ashlar	2560

Material		Kg./cum
	Marble Dressed	2700
	Sandstone Dressed	2240
Tar		1010
Terra-cota (Sold)		2080
Timber	Chir Wood	510
	Deal Wood	640
	Handwood	640-960
	Light Wood	400-480
	Medium Wood	480-640
	Sal Wood	990
	Teak Wood	670-830
Water (Pure at 39.98F)		1000
Roofing Material		**Kg./sqm.**
Aluminium Sheet per mm thickness		2.8
Asbestos Sheet Corrugated		16
1/4 thick :	Flat	11
Battens		25
Bituminous roofing felt		73
Boarding :	1 thick	14.7
	3/4 thick	9.8
Cooper Sheet per mm thickness		8.7
CGI Sheets :	18 gauge	13.4
	22 gauge	8.6
	24 gauge	73
Country tiles with battens single		68.4
	double	
Elemit Sheets or tiles	122	
Felt-Asphatted		14.7
First class mud roof	488.8	
Flat and pan-tiles		146.5
Glazed roofing (with		
1/4" glass eith lead covered steal barsh)		29.3
Jack Arch roof	732.4	
Lath and Plaster ceiling		39
Lead sheet per mm thickness		11
Linoteum per mm thickness		13
Mangalore ses	52.7	
Mangalore tiles bedded in mortar over flat tries		10/4
Mangalore tiles with battens		68.3
Mangalore tiles with flat tiles		78
Plywood per mm thickness		0.7
Rathers	49	
Thatch with Frame 9"	10	
Tatch with frame 6"	6.5	
Timber trusses : with light roofs		9.8
	with heavy roofs	14.7
Zinc sheet per mm thickness		7.1

MATERIALS REQUIRED FOR DIFFERENT ITEMS OF WORK

Material	Quantity	
	Per 100 Cft.	Per 100 Cum.
Bricks (9" x 41/2" x 3" or 200 x 100 x 100)	1350 Nos.	50,000 Nos.
Dry mortar for Brick work - 30%	30 Cft	30 Cum
Stone for rubble masonry - 125%	125 Cft	125 Cum
Dry mortar for rubble masonry - 42%	42 Cft	42 Cum
Bricks bats for brick ballast	105 Cft	105 Cum
Bricks for R. B. Work	1200 Nos. for % Cft	42336 Nos. for % Cum
Dry mortar for R. B. Work - 45%	45 Cft	45 Cum
Dry mortar for 12mm plaster	6 Cft. 36 Sft.	2 Cum% Sq.m
Dry mortar for pointing brick work	2 Cft % Sft	0.6 Cum % Sq.m
Lime for white washing 1 coat	0.65 kgs % Sft.	6.5 kgs % Sq.m
Dry distemper 1 coat	0.65 kgs % Sft.	6.5 kgs % Sq.m
Dry distemper 2nd coat	0.5 kgs % Sft.	5 kgs % Sq.m
Snowcem 1 coat	3 kgs % Sft.	30kgs 96 Sq.m
Snoweem 2nd coat	2 kgs 96 Sft.	20 kgs % Sq.m
Readymade paint for 1 coat	1/2 gal. % Sft.	10 Ltr. % Sq.m
Paint (stiff) for painting 1 coat	1 kg 96 Sft.	10 kgs % Sq.m
Bricks for half brick wall	500 % Sft	5000 96 Sq.m.
Dry mortar for above	12 Cft.% Sft.	3.2 Cum % S.m.
Bricks (9" x 4-1/2" x 3") for brick flat floor	350 Sft	3500% Sq.m.
Dry mortar for above	8 Cft % Sft.	2.25 Cum % S.m.
Bricks (9" x 4-1/2" x 3") for honeycomb wall	325 % Sft.	3500 % Sq.m.
Dry mortar for above	8 Cft % Sft	2.5 cUM % s.M.
G. C. I. Sheet for roof	128 Sft.	128 Sqm.
A. C. Sheet corrugated for roof	115 Sft.	115 m
Timber for panelled door shutter 40 mm	15 Cft	4.5 Cum.
Timber for battoned door shutter 40 mm	13 Cft	4.0 Cum.
Timber for partly panelled and glazed shutter - 40 mm thick	11 Cft	3.0 Cum.
Timber for fully glazed shutter 40 mm thick	8 Cft	2.0 Cum.

STRENGTH OF ORDINARY PORTLAND CEMENT CONCRETE AT VARIOUS AGES :

Approximate percentage of strength of ordinary portland cement concrete at different ages in comparison with the strength at 1 year.

28 davs old	60 percent
3 months old	85 percent
6 months old	95 percent
1 year old	1000 percent

RATE OF CEMENT CONSUMPTION FOR VARIOUS ITEMS OF WORKS

Description of Item	Mix by Volume	Unit	Cement Constant in kg.
Cement Concrete			
Mixed cement concrete delivered on banker	1 : $1\frac{1}{2}$: 3	cum	402.83
	1 : 2 : 4	cum	308.53
	1 : 2 : 5	cum	268.55
	1 : $2\frac{1}{2}$: 5	cum	253.18
	1 : 3 : 6	cum	213.20
	1 : 4 : 8	cum	161.95
	1 : 5 : 10	cum	129.15
	1 : 7 : 12	cum	104.55
Mixed cement contrete using all in aggregate delivered on banker	1 : 5	cum	312.63
	1 : 6	cum	264.45
	1 : 8	cum	206.03
	1 : 12	cum	138.38
Mortars	1 : 1	cum	1056.53
Cement and Sand mortar	1 : 2	cum	699.05
	1 : 4	cum	382.33
	1 : 6	cum	254.20
	1 : 8	cum	192.70
Gauged mortar (cement lime sand)	1 : 1 : 6	cum	244.98
	1 : 1 : 8	cum	189.63
	1 : 2 : 9	cum	164.00
	1 : 5 : 10	cum	147.60
	1 : 7 : 12	cum	120.95
Brickwork			
Brickwork in well burnt bricks built in cement and sand mortar	1 : 3	cum	123.00
	1 : 4	cum	95.84
-Ditto-but using modular size bricks	1 : 3	cum	113.30
	1 : 4	cum	87.90
	1 : 6	cum	58.40
	1 : 8	cum	44.30
-Ditto-but using modular size bricks	1 : 1 : 6	cum	56.80
	1 : 1 : 8	cum	43.60
	1 : 2 : 9	cum	37.70
Stone Masonry			
Walling of random or polygonal rubble, uncoursed or brought up to courses in cement mortar	1 : 3	cum	147.60
	1 : 4	cum	114.80
	1 : 6	cum	75.34
	1 : 8	cum	58.94
Stone Masonry			
Walling of random or polygonal rubble. uncoursed or brought up to courses, in gauged mortar (cement lime : sand)	1 : 1 : 6	cum	73.80
	1 : 1 : 8	cum	56.89
	1 : 2 : 9	cum	49.71

Description of Item	Mix by Volume	Unit	Cement Constant in kg.
Plastering			
10 mm (0.5 inch) thick rendering or screeding on brick or concrete surfaces in cement and sand mortar	1 : 2	sqm	11.79
	1 : 3	sqm	8.41
	1 : 4	sqm	6.77
	1 : 6	sqm	4.46
-Ditto-but on stone masorry surfaces or lathing	1 : 2	sqm	15.68
	1 : 3	sqm	11.17
	1 : 4	sqm	8.41
	1 : 6	sqm	5.64
Add or deduct for each 5 mm (02.25 inch) thickness over or under 10 mm (0.5 inch) on concrete, brick, lathing or stone masonry surfaces (cement mortar)	1 : 2	sqm	4.77
	1 : 3	sqm	3.38
	1 : 4	sqm	2.51
	1 : 6	sqm	1.69
10 mm (05 inch) thick rendering or screeding on brick or concrete surfaces in gauged mortar (cement lime sand)	1 : 1 : 8	sqm	3.38
	1 : 2 : 9	sqm	2.82
-Ditto-but on stone masorry surfaces or rathing	1 : 1 : 8	sqm	4.20
	1 : 2 : 9	sqm	3.64
Add or deduct for each 5 mm (0.25 inch) thickness over or under 10 mm (0.50 inch) on concrete, brick lathing or stone masonry srfaces (gauged mortar)	1 : 1 : 8	sqm	1.38
	1 : 1 : 9	sqm	1.13
Pointing			
Raking out joints to a depth of 10 mm and providing flush keyed or struck pointing cement mortar, on brick surfaces	1 : 2	sqm	2.51
	1 : 3	sqm	1.69
	1 : 4	sqm	1.39
Raking out joints to a depth of 10 mm and providing flush keyed or struck pointing to random rubble masonry uncoursed or brought upto courses (20 mm thick joints) with cement and sand mortar	1 : 2	sqm	5.02
	1 : 3	sqm	3.95
	1 : 4	sqm	2.83
-Ditto- but to squared rubble coursed or uncoursed masonry	1 : 2	sqm	3.95
	1 : 3	sqm	2.82
	1 : 4	dw,	2.26

Description of Item	Mix by Volume	Unit	Cement Constant in kg.	Description of Item	Mix by Volume	Unit	Cement Constant in kg.
Raking out joints to a depth of 10 mm and providing bastard turck or mason's V joint pointing to random rubble masonry uncoursed or brought upto courses	1 : 2 1 : 3 1 : 4	sqm sqm sqm	6.15 4.46 3.64	Raking out joints to a depth of 10 mm and proving dlush, keyed or struck pointing to block in course, or ashlar or concrete block walling, with cement and sand mortar	1 : 2 1 ; 3 1 ; 4	sqm sqm sqm	1.39 1.13 0.85
-Ditto- but to squared rubble, coursed or uncoursed masonry	1 : 2 1 : 3 1 : 4	sqm sqm sqm	5.02 3.64 2.32				

ESTIMATED QUANTITIES OF MATERIALS REQUIRED PER CUBIC METER OF COMPACTED MORTAR OR CONCRETE

Nominal Mix			Water Cement Ratio	Water Litres per 50 kg. Bag of Cement	Cement		Sand Litres	Crushed Stone Litres
Cement	Fine Aggregate	Coarse Aggregate			by Wt. kg.	by No. of Bags		
1	1	-	0.25	12.5	1,015	20.3	710	-
1	1-1/2	-	0.28	14.0	815	16.3	855	-
1	2	-	0.30	15.0	687	13.75	963	-
1	2-1/2	-	0.35	17.5	585	11.7	1,023	-
1	3	-	0.40	20.0	505	10.1	1,023	-
1	4	-	0.53	26.5	395	7.9	1,106	-
1	6	-	0.70	35.0	285	5.7	1,197	-
1	8	-	0.90	45.0	220	4.4	1,232	-
1	1	20.30	0.30	15.0	560	11.2	392	784
1	2	2	0.42	21.0	430	8.6	602	602
1	1-1/2	3	0.42	21.0	395	7.9	414	828
1	1-1/2	3-1/2	0.46	24.0	363	7.25	491	838
1	2	3	0.50	25.0	385	7.7	539	808
1	2	3-1/2	0.53	26.5	330	6.6	462	808
1	2	4	0.55	27.5	310	6.2	434	868
1	2-1/2	3-1/2	0.57	28.5	305	6.1	534	748
1	2-1/2	4	0.60	30.0	285	5.7	4,499	798
1	3	4	0.65	32.5	265	5.3	556	742
1	2-1/2	5	0.65	32.5	26.5	5.1	446	892
1	3	5	0.69	34.5	240	4.8	504	840
1	2	6	0.75	37.5	215	4.3	452	904
1	4	8	0.95	47.5	165	3.3	462	924

MATERIALS REQUIRED FOR VARIOUS THICKNESS OF PLASTER

Mix	Material	Thickness, mm					
		5	10	20	30	40	50
1 : 1	C	5.1	10.1	20.3	30.5	40.6	50.8
	FA Sand	3.5	7.1	14.2	21.3	28.4	35.5
1 : 1	C	4.1	8.2	16.3	24.3	32.6	48.8
FA Sand	4.3	8.6	17.1	25.6	34.2	42.7	
1 : 2	C	3.4	6.9	13.7	20.6	27.5	34.3
	FA Sand	4.8	9.6	19.3	28.9	38.5	48.1
1 : 2 - 1/2	C	2.9	5.9	11.7	17.5	23.4	29.2
	FA Sand	5.1	10.2	20.5	30.7	41.0	51.2
1 : 3	C	2.5	5.1	10.1	15.2	20.2	25.3
	FA Sand	5.33	10.6	21.2	31.8	42.4	53.0
1 : 4	C	2.0	4.0	7.9	11.9	15.8	19.7
	FA Sand	5.5	11.1	22.1	33.2	44.2	55.3
1 : 6	C	1.4	2.9	5.7	8.6	11.4	14.3
	FA Sand	6.0	12.0	23.9	35.9	47.9	59.9
1 : 8	C	1.1	2.2	4.4	6.6	8.8	11.0
	FA Sand	6.2	12.3	24.6	37.0	49.3	61.6

C = Cement in KilogramsFA = Fine aggregate (Sand) in liters
Note : No allowance has been made in table bulking and wastage.

OUTPUT OF LABOUR

Task : The capacity of doing work by an artisan or skilled labour in the form of quantity of work per day is known as the task of work or out-turn of the labour. The out turn of work per artisan varies to some extent according to the nature size, height, situation, location, etc., in bigger cities where specialized and experienced labour is available, the out-turn is greater than small towns and country sides. In well organized work less labour is required. The following may be taken as the approximate quantity of work out is as for an average artisan per day.

Particulars of Item	Quantity per day				
	M^2	M^3	F^2	F^3	
1. Brick work in 1 lime or cement mortar in Foundation and plinth	-	1.25	-	45	Per mason
2. Do in Superstructure	-	1.00	-	35	--
3. Half brick wall in partition	2.00	-	50	-	-
4. Coursed rubble stone Masonry in lime or cement mortar	-	-	-	-	-
including dressing	-	0.80	-	30	-
5. Random rubble stone Masonry	-	1.00	-	35	-
6. Ashlar, masonry in lime or Cement mortar	-	0.40	-	15	-
7. Lime concrete in foundation	-	8.50	-	300	-
8. Lime concrete in roof terracing	-	6.00	-	200	-
9. Cementconcrete 1:2:4	-	6.00	-	200	-
10. R. B. Work	-	5.00	-	175	-
11. R. C. C. Work	-	1.00	-	35	-
12. 12 R. C. C. work (1/2") Plastering with cement or lime mortar	8.00	-	-	80	-
13. Pointing with cement or lime mortar	10.00	-	-	80	-
14. While washing or colour washing - 1 coat	200.00	-	-	2000	-
15. Painting or varnishing Doors or windows - 1 coat	25.00	-	-	250	per painter
16. Coal tarring or solignum painting - coat	35.00	-	-	350	-
17. Painting large surface - 1 coat	35.00	-	-	350	-
18. Distempering - 1 coat	35.00	-	-	350	-
19. 2.5 cm (1") C. C. floor	7.50	-	-	75	per mason
20. Flag stone floor laying with Lime or cement mortar Excluding L. C.	10.00	-	-	100	-
21. Brick-on-edge floor in Lime or cement mortar Excluding L. C.	7.00	-	-	70	-
22. Brick flat floor as in above	8.00	-	-	70	-
23. Timber framing sal of Teak wood	-	0.07	-	2.5	per carpenter
24. Do country wood	-	0.15	-	5	-
25. Door and window shutters Panel or glazed	0.70	-	7	-	-
26. Do battened	0.80	-	8	-	-
27. Sawing hardwood	4.00	-	40	-	per pair of sawer
28. Sawing soft wood	6.00	-	60	-	-
29. Single Allahabad tiling or Manglore tiling	6.00	-	60	-	per tile layer
30. Double Allahabad tiling	4.00	-	40	-	-
31. Breaking of brick ballast 40 mm (1.1/2) guage	-	0.75	-	25	per labourer
32. Breaking of brick ballast 25 mm (1") guage	-	0.55	-	25	Per labourer
33. Breaking of stone ballast 40 mm (1.1/2) guage	-	0.40	-	15	-
34. Breaking of stone ballast 25 mm (1") guage	-	0.25	-	10	-
35. Ashlar stone dreesing	-	0.70	-	25	per stone cutter
36. Flag stone dressing	1.50	-	15	-	per stone cutter
37. Earthwork in excavation in ordinary soil	-	3.00	-	100	per bladder
38. Earthwork in excavation in hard soil	-	2.00	-	75	-
39. Excavation in rock	-	1.00	-	35	-
40. Number of brick laid by a mason in brickwork upto a height of 3 layers (10")	600 bricks per mason				
41. Amount of work done by mazdoor (helper per day)					
(1) Mix	3 cum. (100 cf.) mortar				
(2) Deliver bricks	4000 Nos. to distance of 15 m (50")				
(3) Deliver mortar	5.5 Cu. M. (200')				
42. Scaffolding cost for single building	Re 0.50 per cum. (Rs. 1.50%) cft. of brick work				

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