M O R T & H (5th REVISION)

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ESSENTIAL TABLES FOR HIGHWAY FIELD ENGINEERS

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ABSTRACT OF SLIDES

- 300 EARTH WORK
- 400 NON-BITUMINOUS SUB-BASES & BASES
- 500 BITUMINOUS BASES & SURFACE COURSES
- 600 CONCRETE PAVEMENT
- 900 QUALITY CONTROL FOR ROAD WORKS
- 1000 MATERIALS FOR STRUCTURES
- 1700 STRUCTURAL CONCRETE

300

EARTH WORK

305 EMBANKMENT CONSTRUCTION

305 EMBANKMENT CONSTRUCTION

Table 300-1 : Density Requirements of Embankment and Sub-grade Materials

S. No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS:2720 (Part 8)
1)	Embankments up to 3 m height, not subjected to extensive flooding	Not less than 15.2 kN/cu.m
2)	Embankments exceeding 3 m height or embankments of any height subject to long periods of inundation	Not less than 16 kN/ cu.m
3)	Subgrade and earthen shoulders/verges/ backfill	Not less than 17.5 kN/cu.m

305 EMBANKMENT CONSTRUCTION

Table 300-2 : Compaction Requirements for Embankment and Sub-grade

S. No.	Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)
1)	Subgrade and earthen shoulders	Not less than 97%
2)	Embankment,	Not less than 95%
3)	Expansive Clays	
	a) Subgrade and 500 mm portion just below the subgrade	Not allowed
	b) Remaining portion of embankment	90–95%

305 EMBANKMENT CONSTRUCTION

305 EARTH WORK : PHYSICAL REQUIREMENTS

Physical Requirement of Earth used for Embankment, Subgrades & Earthen Shoulders.

S.No	Property	Limits
1	Liquid Limit	Should not exceed 50 %
2	Plasticity Index	Should not exceed 25
3	Free swell Index	Shall not exceed 50 %
4	Free swell Index in Sub-grade	Not permitted
5	Size of Course Aggregate in Embankment	Shall not exceed 75 mm
6	Size of Course Aggregate in Sub-grade	Shall not exceed 50 mm

400

NON-BITUMINOUS SUB-BASES & BASES

401 GRANULAR SUB-BASE

401 GRANULAR SUB-BASE

Table 400-1 : Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55 –90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	–	–	35-65	55-75
4.75 mm	25 – 55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20- 40	30-50	–	–	10-20	10-25
0.85 mm	–	–	–	–	2-10	–
0.425 mm	10-15	10- 15	–	–	0-5	0-8
0.075 mm	<5	< 5	< 5	< 5	–	0-3

401 GRANULAR SUB-BASE

401 GRANULAR SUB-BASE

Table 400-2 : Physical Requirements for Materials for Granular Sub-base

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

406 WET MIX MACADAM SUB-BASE/BASE

Table 400-12 : Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

S. No.	Test	Test Method	Requirements
1)	Los Angeles Abrasion value or Aggregate Impact value	IS:2386 (Part-4) IS:2386 (Part-4) or IS:5640	40 percent (Max.) 30 percent (Max.)
2)	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 percent (Max.)*

406 WET MIX MACADAM

406 WET MIX MACADAM SUB-BASE/BASE

Table 400-13 : Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	Percent by weight passing the IS Sieve
53.00 mm	100
45.00 mm	95–100
26.50 mm	–
22.40 mm	60–80
11.20 mm	40–60
4.75 mm	25–40
2.36 mm	15–30
600.00 micron	8–22
75.00 micron	0–5

500
BITUMINOUS BASES & SURFACE COURSES

501 GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENTS

BITUMEN

Table 500-1 : Selection Criteria for Viscosity-Graded (VG) Paving Bitumens Based on Climatic Conditions

Lowest Daily Mean Air Temperature, °C	Highest Daily Mean Air Temperature, °C		
	Less than 20°C	20 to 30°C	More than 30°C
More than –10°C	VG-10	VG-20	VG-30
-10°C or lower	VG-10	VG-10	VG-20

Table 500-2 : Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celcius)

Bitumen Viscosity Grade	Bitumen Temperature	Aggregate Temperature	Mixed Material Temperature	Laying Temperature	*Rolling Temperature
VG-40	160-170	160-175	160-170	150 Min	100 Min
VG-30	150-165	150-170	150-165	140 Min	90 Min
VG-20	145-165	145-170	145-165	135 Min	85 Min
VG-10	140-160	140-165	140-160	130 Min	80 Min

502 PRIME COAT OVER GRANULAR BASE

502 PRIME COAT OVER GRANULAR BASE

Table 500-3 : Quantity of Bitumen Emulsion for Various Types of Granular Surfaces

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7–1.0
Stabilized soil bases/Crusher Run Macadam	0.9–1.2

502 PRIME COAT OVER GRANULAR BASE

Table 500-4 : Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/sq.m)
WMM/WBM	MC 30	0.6–0.9
Stabilized soil bases/ Crusher Run Macadam	MC 70	0.9–1.2

503 TACK COAT

TACK COAT

Table 500-5 : Rate of Application of Tack Coat

Type of Surface	Rate of Spray of Binder in Kg per sq. m
Bituminous surfaces	0.20 – 0.30
Granular surfaces treated with primer	0.25 – 0.30
Cement concrete pavement	0.30 – 0.35

504 BITUMINOUS MACADAM

504 BITUMINOUS MACADAM

Table 500-6 : Physical Properties of Coarse Aggregate

Property	Test	Requirement	Test method
Cleanliness	Grain size analysis	Max. 5% passing 0.075 micron	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max. 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or	Max. 40%	IS:2386 Part IV
	Aggregate Impact Value	Max. 30%	IS:2386 Part IV
Durability	Soundness (Sodium or Magnesium)	5 cycles	
	Sodium Sulphate	Max. 12%	IS:2386 Part V
	Magnesium Sulphate	Max. 18%	IS:2386 Part V
Water absorption	Water absorption	Max. 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate	Min. Retained Coating 95%	IS:6241
Water sensitivity	Retained Tensile strength*	Min. 80%	AASHTO 283

504 BITUMINOUS MACADAM

504 BITUMINOUS MACADAM

Table 500-7 : Aggregate Grading and Bitumen Content

Grading	1	2
Nominal maximum aggregate size*	40 mm	19 mm
Layer thickness	80 -100 mm	50 -75 mm
IS Sieve size (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	–	90 – 100
13.2	35-61	56 – 88
4.75	13 – 22	16 – 36
2.36	4 – 19	4 – 19
0.3	2 – 10	2 – 10
0.075	0 – 8	0 – 8
Bitumen content ** percent by mass of total mix	3.3**	3.4**

505 DENSE BITUMINOUS MACADAM

505 DENSE BITUMINOUS MACADAM

Table 500-8 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS:2386 Part IV
Durability	Soundness either :Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min. 80%	AASHTO 283

505 DENSE BITUMINOUS MACADAM

505 DENSE BITUMINOUS MACADAM

Table 500-9 : Grading Requirements for Mineral Filler

IS sieve (mm)	Cumulative Percent Passing by Weight of Total Aggregate
0.6	100
0.3	95 – 100
0.075	85 – 100

505 DENSE BITUMINOUS MACADAM

505 DENSE BITUMINUS MACADAM

Table 500-10 : Composition of Dense Graded Bituminous Macadam

Grading	1	2
Nominal aggregate size*	37.5 mm	26.5 mm
Layer thickness	75 – 100 mm	50 – 75 mm
IS Sieve[1] (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	95 – 100	100
26.5	63-93	90-100
19	–	71-95
13.2	55-75	56-80
9.5	–	–
4.75	38-54	38-54
2.36	28-42	28-42
1.18	–	–
0.6	–	–
0.3	7 – 21	7 – 21
0.15	–	–
0.075	2 – 8	2-8
Bitumen content % by mass of total mix	Min 4.0**	Min 4.5**

505 DENSE BITUMINOUS MACADAM

505 DENSE BITUMINOUS MACADAM

Table 500-11 : Requirements for Dense Graded Bituminous Macadam

Properties	Viscosity Grade Paving Bitumen	Modified bitumen		Test Method
		Hot climate	Cold climate	
Compaction level	75 blows on each face of the specimen			
Minimum stability (kN at 600C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2 – 4	2.5 – 4	3.5 – 5	AASHTO T245
Marshall Quotient $\left(\frac{\text{Stability}}{\text{Flow}}\right)$	2 – 5	2.5 – 5		MS-2 and ASTM D2041
% air voids	3 – 5			
% Voids Filled with Bitumen (VFB)	65 – 75			
Coating of aggregate particle	95% minimum			IS:6241
Tensile Strength ratio	80% Minimum			AASHTO T 283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 500-13			

505 DENSE BITUMINOUS MACADAM

505 DENSE BITUMINOUS MACADAM

Table 500-12 : Minimum Percent Voids In Mineral Aggregate (VMA)

Nominal Maximum Particle Size[1] (mm)	Minimum VMA Percent Related to Design Percentage Air voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

505 DENSE BITUMINOUS MACADAM

Table 500-13 : Permissible Variations in the Actual Mix from the Job Mix Formula

Description	Base/binder Course
Aggregate passing 19 mm sieve or larger	± 8%
Aggregate passing 13.2 mm, 9.5 mm	± 7%
Aggregate passing 4.75 mm	± 6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5%
Aggregate passing 0.3 mm, 0.15 mm	± 4%
Aggregate passing 0.075 mm	± 2%
Binder content	± 0.3%
Mixing temperature	± 10°C

507 BITUMINOUS CONCRETE

507 BITUMINOUS CONCRETE

Table 500-17 : Composition of Bituminous Concrete Pavement Layers

Grading	1	2
Nominal aggregate size*	19 mm	13.2 mm
Layer thickness	50 mm	30–40 mm
IS Sieve[1] (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min 5.2*	Min 5.4**

507 BITUMINOUS CONCRETE

507 BITUMINOUS CONCRETE

Table 500-18 : Permissible Variations in Plant Mix from the Job Mix Formula

Description	Permissible Variation
Aggregate passing 19 mm sieve or larger	± 7%
Aggregate passing 13.2 mm, 9.5 mm	± 6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 3%
Aggregate passing 0.075 mm	± 1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

509 SURFACE DRESSING

509 SURFACE DRESSING

Table 500-20 : Recommended Nominal Size of Aggregates (mm)

Type of Surface	Traffic Intensity in Terms of Number of Vehicles Per Day in the Lane Under Consideration		
	1000-2000	200-1000	20-200
Very hard	10	6	6
Hard	13	10	6
Normal	13	10	6
Soft	19	13	13
Very soft		19	13

509 SURFACE DRESSING

509 SURFACE DRESSING

Table 500-21 : Grading requirements for Aggregates used for Surface Dressing

IS Sieve Designation (mm)	Cumulative Percent by Weight of Total Aggregates Passing for the Following Nominal Sizes (mm)			
	19	13	10	6
26.5	100			
19	85-100	100		
13	0-40	85-100	100	
9.5	0-7	0-40	85-100	100
6.3		0-7	0-35	85-100
4.75			0-10	
3.35				0-35
2.36	0-2	0-2	0-2	0-10
0.60				0-2
0.075	0-1.5	0-1.5	0-1.5	0-1.5
Minimum 65% by weight of aggregate	Passing 19 and retained on 13.2	Passing 13.2 and retained on 9.5	Passing 9.5 and retained on 6.3	Passing 6.3 and retained on 3.35

509 SURFACE DRESSING

509 SURFACE DRESSING

Table 500–22 : Approximate Rate of Application of Binder and Aggregates

Nominal Aggregate Size mm	Binder (Kg/m²)			Aggregates Cu.m/m²
	Uncoated Aggregates		Coated Aggregates	
	Bitumen	Emulsion	Bitumen	
19	1.2	1.8	1.0	0.014-0.015
13	1.0	1.5	0.8	0.009-0.011
10	0.9	1.3	0.7	0.007-0.009
6	0.75	1.1	0.6	0.003-0.005

516 MASTIC ASPHALT

516 MASTIC ASPHALT

Table 500-39 : Requirements for Physical Properties of Binder

Property	Test Method	Requirements
Penetration at 25°C	IS:1203	15 ± 5*
Softening point, °C	IS:1205	65 ± 10
Loss on heating for 5h at 163°C, % by mass Max.	IS:1212	2.0
Solubility in trichloroethylene, % by mass Min.	IS:1216	95
Ash (mineral matter), % by mass Max.	IS:1217	1.0

516 MASTIC ASPHALT

516 MASTIC ASPHALT

Table 500-40 : Grade and Thickness of Mastic Asphalt Paving and Grading of Coarse Aggregates

Application	Thickness Range (mm)	Nominal Size of Coarse Aggregate (mm)	Coarse Aggregate Content, % by Mass of Total Mix
Roads and bridge decks	25–50	13	40±10
Heavily stressed areas i.e. Junctions and toll plazas	40–50	13	45±10
Nominal size of coarse aggregate IS Sieve (mm)		13 mm Cumulative % passing by weight	
19		100	
13.2		88–96	
2.36		0-5	

516 MASTIC ASPHALT

516 MASTIC ASPHALT

Table 500-41 : Grading of Fine Aggregate (Inclusive of Filler)

IS Sieve	Percentage by weight of aggregate
Passing 2.36 mm but retained on 0.600 mm	0 – 25
Passing 0.600 mm but retained on 0.212 mm	10 – 30
Passing 0.212 mm but retained on 0.075 mm	10 – 30
Passing 0.075 mm	30 – 55

516 MASTIC ASPHALT

Table 500-42 : Composition of Mastic Asphalt Blocks without Coarse Aggregate

IS Sieve	Percentage by Weight of Mastic Asphalt	
	Minimum	Maximum
Passing 2.36 mm but retained on 0.600 mm	0	22
Passing 0.600 mm but retained on 0.212 mm	4	30
Passing 0.212 mm but retained on 0.075 mm	8	18
Passing 0.075 mm	25	45
Bitumen Content % by mass	14	17

520 SUPPLY OF STONE AGGREGATE FOR PAVEMENT COURSES

520 SUPLY OF COURSE AGGREGATES FOR PAVEMENT COURSES

Table 500-49 : Size Requirements for Coarse Stone Aggregates

S. No.	Nominal Size of Aggregate	Designation of Sieve Through which the Aggregates shall Wholly Pass	Designation of Sieve on which the Aggregates shall be Wholly Retained
1)	75 mm	106 mm	63 mm
2)	63 mm	90 mm	53 mm
3)	45 mm	53 mm	26.5 mm
4)	26.5 mm	45 mm	22.4 mm
5)	22.4 mm	26.5 mm	13.2 mm
6)	13.2 mm	22.4 mm	11.2 mm
7)	11.2 mm	13.2 mm	6.7 mm
8)	6.7 mm	11.2 mm	2.8 mm

520 SUPPLY OF STONE AGGREGATE FOR PAVEMENT COURSES

520 SUPPLY OF COURSE AGGREGATES FOR PAVEMENT COURSES

Table 500-50 : Percent Reduction In Volume of Aggregates

S. No.	Standard Size of Aggregates	Percentage Reduction in Volume Computed by Stack Measurements to Arrive at the Volume to be Paid for
1)	75 mm and 63 mm	12.5
2)	45 mm and 26.5 mm	10.0
3)	22.4 mm, 13.2 mm, 11.2 mm and 6.7 mm	5.0
4)	Fine aggregate	5.0

600
CONCRETE PAVEMENT

601 DRY LEAN CEMENT CONCRETE SUB-BASE

601 DRY LEAN CEMENT CONCRETE SUB-BASE

Any of the following types of cement may be used with prior approval of the Engineer:

S. No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade	IS:8112
ii)	Portland Slag Cement	IS:455
iii)	Portland Pozzolana Cement	IS:1489-Part I

601 DRY LEAN CEMENT CONCRETE SUB-BASE

Table 600-1 : Aggregate Gradation for Dry Lean Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
26.50 mm	100
19.0 mm	75-95
9.50 mm	50-70
4.75 mm	30-55
2.36 mm	17-42
600 micron	8-22
300 micron	7-17
150 micron	2-12
75 micron	0-10

602 CEMENT CONCRETE PAVEMENTS

602 CEMENT CONCRETE PAVEMENT

Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but preference shall be to use at least the 43 grade or higher.

S.No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade	IS:8112
ii)	Ordinary Portland Cement 53 Grade	IS:12269
iii)	Portlant slag cement	IS:455
iv)	Portland Pozzolana Cement	IS:1489-Part I

602 CEMENT CONCRETE PAVEMENTS

602 CEMENT CONCRETE PAVEMENT

Table 600-2 : Permissible Limits of Deleterious Substances in Fine and Coarse Aggregates

S. No.	Deleterious Substance	Method of Test	Fine Aggregate Percentage by Weight, (Max)		Coarse Aggregate Percentage by Weight (Max)	
			Uncrushed	Crushed*	Uncrushed	Crushed*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Coal and lignite	IS:2386 (Part II)-1963	1.0	1.0	1.0	1.0
ii)	Clay lumps	do	1.0	1.0	1.0	1.0
iii)	Mateirals finer than 75 µ IS Sieve	IS:2386 (Part I)-1963	3.0	8.0	3.0	3.0
iv)	Soft fragments	IS:2386 (Part II)-1963	–	–	3.0	–
v)	Shale	IS:2386 (Part II)-1963	1.0	–	–	–
vi)	Total of percentages of all deleterious materials (except mica) including Sl No. (i) to (v) for col 4, 6 and 7 and Sl No. (i) and (ii) for col 5 only		5.0	2.0	5.0	5.0

602 CEMENT CONCRETE PAVEMENTS

602 CEMENT CONCRETE PAVEMENT

Table 600-3 : Aggregate Gradation for Pavement Quality Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
31.5 mm	100
26.5 mm	85-95
19.0 mm	68-88
9.5 mm	45-65
4.75 mm	30-55
600 micron	8-30
150 micron	5-15
75 micron	0-5

602 CEMENT CONCRETE PAVEMENTS

602 CEMENT CONCRETE PAVEMENT

Table 600-4 : Requirement of Preformed Seals as per ASTM D 2628

S. No.	Description	Requirements	ASTM Test Methods
1)	Tensile strength, min	13.8 MPa	D 412
2)	Elongation at break	Min. 250%	D 412
3)	Hardness, Type A durometer	55 +/-5 points	D 2240
4)	Oven aging, 70 h at 100°C Tensile strength loss	20% max	D 573
5)	Elongation loss	20% max	
6)	Hardness Change Type A durometer	0 to +10 points	D 471
7)	Oil Swell, ASTM Oil 3, 70 h at 100°C Weight Change	45% max	D 1149
8)	Ozone resistance 20 percent strain, 300 pphm in air, 70 h at 40°C	No cracks	D 2240
9)	Low temperature stiffening, 7 days at -10°C Hardness Change type A durometer	0 to +15 points	
10)	Low temperature recovery, 22h at -10°C, 50% deflection	88% min	D 2628
11)	Low temperature recovery, 22h at -29°C, 50% deflection	83% min	D 2628
12)	Low temperature recovery, 70h at -100°C, 50% deflection	85% min	D 2628
13)	Compression, deflection, at 80% of normal width (min)	613 N/m	D 2628

602 CEMENT CONCRETE PAVEMENTS

602 CEMENT CONCRETE PAVEMENT

Table 600-5 : Texture Depth

Time of Test		Number of Measurements	Required Texture Depth (mm)	
			Specified Value	Tolerance
1)	Between 24 hours and 7 days after the construction of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	±0.25
2)	Not later than 6 weeks before the road is opened to traffic	An average of 5 measurements	1.00	+0.25 -0.35

602 CEMENT CONCRETE PAVEMENT

Table 600-6 : Payment Adjustment for Deficiency in Thickness

Deficiency in the Average Thickness of Day's Work	Percent of Contract Unit Price Payable
Up to 5 mm	100
6–10 mm	87

CONTRACTION JOINTS SPACING

CONTRACTION JOINTS SPACING

Contraction Joints are spaced as under:

Slab thickness (cm)	Maximum contraction joint spacing (m)	Weight of reinforcement in welded fabric (for reinforced pavements only) (kg/sqcm)
Unreinforced slabs		
10	4.5	—
15	4.5	—
20	4.5	—
25	4.5	—
30	5.0	—
35	5.0	—
Reinforced slabs		
10	7.5	2.2
15	13.0	2.7
20	14.0	3.8

DOWEL BARS DETAILS

DOWEL BARS DETAILS for RIGID PAVEMENTS

Table 5 Recommended Dimensions of Dowel Bars

Slab Thickness mm	Dowel Bar Details		
	Diameter, mm	Length, mm	Spacing, mm
200	25	360	300
230	30	400	300
250	32	450	300
280	36	450	300
300	38	500	300
350	38	500	300

Note : The values given are general guidance. Field performance under heavy loading prevalent in India will be the most appropriate guide. Dowel bars are not satisfactory for slabs of small thickness and shall not be provided for slab of less than 200 mm thickness.

TIE/ ANCHOR BARS

DETAILS OF TIE BARS FOR LONGITUDINAL JOINT OF RIGID PAVEMENT

Table 6 Details of Tie Bars for Longitudinal Joint of Rigid Pavements

Slab Thickness mm	Tie Bar Details				
	Diameter (d) mm	Max. Spacing, mm		Minimum Length, mm	
		Plain	Deformed	Plain	Deformed
150	8	330	530	440	480
	10	520	830	510	560
200	10	390	620	510	560
	12	560	900	580	640
250	12	450	720	580	640
300	12	370	600	580	640
	16	660	1060	720	800
350	12	320	510	580	640
	16	570	910	720	800

Note : The recommended details are based on the following values of different design parameters : Sst = 125 MPa for plain bars, 200 MPa for deformed bars: bond stress for plain bars = 1.75 MPa, for deformed bars = 2.46 MPa as per IRC:15. Tie bars deformed/plain shall conform to IS 1786 and IS 432 respectively.

900

QUALITY CONTROL FOR ROAD WORKS

902 CONTROL OF ALIGNMENT, LEVEL AND SURFACE IRREGULARITY

902 CONTROL OF ALIGNMEN, LEVEL AND SURFACE REGULARITY

Table 900-1 : Tolerances in Surface Levels

1)	Subgrade	±20 mm
2)	Sub-base	
	a) Flexible pavement	±10 mm
	b) Concrete pavement	±6 mm
3)	Base-course for flexible pavement	
	a) Bituminous Base/Binder course	±6 mm
	b) Granular	
	i) Machine laid	±10 mm
	ii) Manually laid	±15 mm
4)	Wearing course for flexible pavement	
	a) Machine laid	±6 mm
	b) Manually laid	±10 mm
5)	Cement concrete pavement	±5 mm

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

Table 900-3 : Control Tests and their Minimum Frequency for Sub-Bases and Bases (Excluding Bitumen Bound Bases)

S. No.	Type of Construction	Test		Frequency (min.)
1)	Granular	i)	Gradation	One test per 400 cu.m
		ii)	Atterberg limits	One test per 400 cu.m
		iii)	Moisture content prior to compaction	One test per 400 cu.m
		iv)	Density of compacted layer	One test per 1000 sq.m
		v)	Deleterious constituents	As required
		vi)	CBR	As required
2)	Lime/Cement Stabilised Soil Sub-base	i)	Quality of lime/ cement	One test for each consignment subject to a minimum of one test per 5 tonnes
		ii)	Lime/Cement content	Regularly, through procedural checks
		iii)	Degree of pulverization	Periodically as considered necessary
		iv)	CBR or Unconfined Compressive Strength test on a set of 3 specimens	As required
		v)	Moisture content prior to compaction	One set of two tests per 500 sq.m
		vi)	Density of compacted layer	One set of two tests per 500 sq.m
		vii)	Deleterious constituents	As required

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3)	Water Bound Macadam	i)	Aggregate Impact Value	One test per 1000 cu.m of aggregate
		ii)	Grading of aggregate	One test per 250 cu.m
		iii)	Combined Flakiness and Elongation Indices	One test per 500 cu.m of aggregate
		iv)	Atterberg limits of binding material	One test per 50 cu.m of binding material
		v)	Atterberg limits of screenings	One test per 100 cu.m of aggregate
4)	Wet Mix Macadam	i)	Aggregate Impact Value	One test per 1000 cu.m of aggregate
		ii)	Grading of aggregate	One test per 200 cu.m of aggregate
		iii)	Combined Flakiness and Elongation Indices	One test per 500 cu.m of aggregate
		iv)	Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 200 cu.m of aggregate
		v)	Density of compacted layer	One set of three tests per 1000 sq.m

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903 QUALITY CONTROL TESTS DURING CONSTRUCTION

Table 900-4 : Control Tests for Bituminous Works and their Minimum Frequency

S. No.	Type of Construction	Test		Frequency (min.)
1)	Prime Coat/Tack Coat/Fog Spray	i)	Quality of binder	Number of samples per lot and tests as per IS:73, IS:217 and IS:8887 as applicable
		ii)	Binder temperature for application	At regular close intervals
		iii)	Rate of spread of Binder	Three tests per day
2)	Seal Coat/Surface Dressing	i)	Quality of Binder	Same as mentioned under Serial No. 1
		ii)	Aggregate Impact Value or Los Angeles Abrasion Value	One test per 200 cu.m of each source and whenever there is change in the quality of aggregate
		iii)	Combined Flakiness and Elongation Indices	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iv)	Stripping value of aggregates (Immersion Tray Test)	One test of each source and whenever there is change in the quality of aggregate
		v)	Water absorption of aggregate	-do-
		vi)	Water sensitivity of mix	-do-
		vii)	Grading of aggregate	Two tests per day
		viii)	Soundness (Magnesium Sulphate/ Sodium Sulphate)	One test for each source and whenever there is change in the quality of aggregate

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		ix)	Polished stone value (not applicable for SAM/SAMI)	-do-
		x)	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
		xi)	Rate of spread of materials	Same as mentioned under Serial No. 1
		(xii)	Percentage of fractured faces (When gravel is used)	One test per 100 cu.m of aggregate
3)	Open-graded Premix Surfacing/Close-graded Premix Surfacing	i)	Quality of binder	Same as mentioned under Serial No. 1
		ii)	Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		iii)	Combined Flakiness and Elongation Indices	Same as mentioned under Serial No. 2
		iv)	Stripping value	Same as mentioned under Serial No. 2
		v)	Water absorption of aggregates	Same as mentioned under Serial No. 2
		vi)	Water Sensitivity of mix	Same as mentioned under Serial No. 2
		vii)	Grading of aggregates	Same as mentioned under Serial No. 2

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S. No.	Type of Construction	Test		Frequency (min.)
		viii)	Soundness(Magnesium Sulphate and Sodium Sulphate)	Same as mentioned under Serial No. 2
		ix)	Polished stone value	Same as mentioned under Serial No. 2
		x)	Temperature of binder at application	At regular interval
		xi)	Binder content	Two tests per day per plant
		xii)	Percentage of fractured faces	Same as mentioned under Serial No. 2
4)	Bituminous Macadam	i)	Quality of binder	Same as mentioned under Serial No. 1
		ii)	Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		iii)	Combined Flakiness and Elongation Indices	One test per 350 cu.m for each source
		iv)	Stripping value	Same as mentioned under Serial No. 2
		v)	Water absorption of aggregates	Same as mentioned under Serial No. 2
		vi)	Water Sensitivity of mix	Same as mentioned under Serial No. 2
		vii)	Grading of aggregates	Same as mentioned under Serial No. 2
		viii)	Soundness (Magnesium Sulphate/ Sodium Sulphate)	Same as mentioned under Serial No. 2
		ix)	Percentage of fractured faces	Same as mentioned under Serial No. 2

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		x)	Binder content	Same as mentioned under Serial No. 3
		xi)	Control of temperature of binder and aggregate for mix and of the mix at the time of laying and rolling	Same as mentioned under Serial No. 2
		xii)	Density of Comp layer	One test per 700 sq.m area
		xiii)	Rate of spread of Mixed Material	At regular intervals
5)	Dense Bituminous Macadam/Bituminous Concrete	i)	Quality of binder	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462
		ii)	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iii)	Flakiness and Elongation Indices	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iv)	Soundness test (Sodium or Magnesium Sulphate test)	One test for each source and whenever there is change in the quality of aggregate
		v)	Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate

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S. No.	Type of Construction	Test		Frequency (min.)
		vi)	Sand equivalent test	One test for each source and whenever there is change in the quality of aggregate
		vii)	Plasticity Index	One test for each source and whenever there is change in the quality of aggregate
		viii)	Polished stone value	One test for each source and whenever there is change in the quality of aggregate
		ix)	Percentage of fractured face	One test per 350 cu.m of aggregate when crushed gravel is used
		x)	Mix grading	One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xi)	Stability and voids analysis of mix including theoretical maximum specific of loose mix	Three tests for stability, flow value, density and void contents for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xii)	Moisture Susceptibility of mix (AASHTO T283)	One test for each mix type whenever there is change in the quality or source of coarse or fine aggregate
		xiii)	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals

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		xiv)	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xv)	Rate of spread of mix material	After every 5th truck load
		xvi)	Density of Compacted layer	One test per 700 sq.m area
6)	Sand Asphalt Base course	i)	Quality of binder	Same as mentioned under Serial No. 2
		ii)	Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		iii)	Sand equivalent test	Same as mentioned under Serial No. 2
		iv)	Plasticity Index	Same as mentioned under Serial No. 5
		v)	Mix grading & binder content	Same as mentioned under Serial Nos. 2 and 3
		vi)	Stability of Mix	Same as mentioned under Serial No. 5
		vii)	Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	Same as mentioned under Serial No. 2
		viii)	Thickness of layer	Same as mentioned under Serial No. 5
		ix)	Density of Compacted layer	Same as mentioned under Serial No. 5

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

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S. No.	Type of Construction	Test		Frequency (min.)
7)	Slury seal and Micro surfacing	i)	Quality of Aggregate Sand Equivalent Value Water Absorption Soundness Test (Sodium/ Magnesium Sulphate Test)	One per source/ site
		ii)	Quality of Emulsion	One per lot of 20 t as per IS:8887
		iii)	Aggregate Moisture	Two per day
		iv)	Aggregate Gradation	Two per day at site
		v)	Binder Content	Two per lane per Km
		vi)	Calibration of Machine	Once per Project
		vii)	Quantity of Slurry (By weight of aggregate)	Daily (Travel time of Machine)
8)	Stone Matrix Asphalt	i)	Quality of binder	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462
		ii)	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 100 cu.m of aggregate
		iii)	Flakiness and Elongation Indices	One test per 100 cu.m of aggregate
		iv)	Soundness Test (Sodium and Magnesium Sulphate Test)	One test for each method for each source and whenever there is change in the quality of aggregate

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		v)	Water absorption of aggregate	One test for each source and whenever there is change in the quality of aggregate
		vi)	Sand equivalent test	One test for each source
		vii)	Plasticity Index	One test for each source
		viii)	Polished stone value	One test for each source
		ix)	Percent of fractured faces	One test per 50 cu.m of aggregate when crushed gravel is used
		x)	Mix grading	One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xi)	Air voids and VMA analysis of mix including theoretical maximum specific gravity of loose mix	Three tests per day
		xii)	Moisture Susceptibility of mix (AASHTO T 283)	One test for each mix type whenever there is change in the quality or source of coarse or fine aggregate
		xiii)	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals

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903 QUALITY CONTROL TESTS DURING CONSTRUCTION

S. No.	Type of Construction	Test		Frequency (min.)
		(xiv)	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		(xv)	Rate of spread of mix material	After every 5th truck load
		(xvi)	Density of compacted layer	One test per 250 sq.m area
9)	Mastic asphalt	i)	Quality of binder	Same as mentioned under Serial No. 5
		ii)	Aggregate Impact Value and Los Angeles Abrasion Value	Same as mentioned under Serial No. 5
		iii)	Combined Flakiness and Elongation Indices	Same as mentioned under Serial No. 5
		iv)	Stripping value	Same as mentioned under Serial No. 2
		v)	Water Sensitivity of mix	Same as mentioned under Serial No. 5
		vi)	Grading of aggregates	Two tests per day per plant on the individual constituent and mixed aggregates from the dryer
		vii)	Water absorption of aggregates	Same as mentioned under Serial No. 5
		viii)	Soundness (Magnesium Sulphate/ Sodium Sulphate)	Same as mentioned under Serial No. 5
		ix)	Percentage of fractured faces	Same as mentioned under Serial No. 5

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

		x)	Binder content and aggregate grading	Same as mentioned under Serial No. 3
		xi)	Control of temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling	At regular close intervals
		xii)	Rate of Spread of Mixed Material	Regular control through check of layer thickness
		xiii)	Hardness number	Minimum two tests per day
10)	Recycled Material Grading of aggregate			Two tests per day
11)	Cold Mixes			All tests as per S. No.5
12)	Quality of Modified Binder			Number of samples per lot and tests as per IS:15462.
13)	Geotextiles			The requirements of Section 700 shall apply

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

903 EARTH WORK FOR EMBANKMENT & SUBGRADE CONSTRUCTION

S.No.	Type of Construction	Test	Frequency
14	Earth work for Embankment, Subgrade Construction	a) Sand Content	2 tests per 3000 cum. Of soil
		b) Plasticity Index	Each type to be tested, 2 tests
		c) Density Test	Each soil type to be tested, 2 tests
		d) Deleterious Content Test	As an when required by the Engineer
		e) Moisture Content Test	Two tests
		f) CBR Test on subgrade materials	One CBR test (average of three specimens)
		g) Compaction Control	One set of 10 measurements of density for each 3000 sqm.

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

Table 900-6 : Frequency of Quality Control Tests for Pavement Concrete

1)	Levels, alignment and texture			
	i)	Level tolerance		Clause 902.3
	ii)	Width of pavement and position of paving edges		Clause 902.2
	iii)	Pavement thickness		Clause 902.3 and 903.5.2.4
	iv)	Alignment of joints, widths, depth of dowel grooves		To be checked @ one joint per 400 m length or a day's work
	v)	Surface regularity both transversely and longitudinally		Once a day or one day's work without disturbing the curing
	vi)	Alignment of dowel bars and their accuracy/tie bars		To be checked in trial length as per Clause 602.6.5.2 and once on every 2 km.
	vii)	Texture depth		Clause 602.12
2)	Quality of materials and concrete shall be as under :			
	1)	Cement Physical and chemical Tests	IS:269 IS:455 IS:1489 IS:8112 IS:12269	Once for each source of supply and occasionally when called for in case of long/ improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer
	2)	Coarse and Fine Aggregates — i) Gradation	IS:2386	One test for every day's work of each fraction of coarse aggregate and fine aggregate, initially; (may be relaxed later at the discretion of the Engineer)

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

		ii) Deleterious constituents	IS:2386 (Pt. 2)	-do-
		iii) Water absorption	IS:2386 (Pt. 3)	Regularly as required subject to a minimum of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.
	3) Coarse Aggregate	i) Los Angeles Abrasion value or Aggregate Impact test	IS:2386 (Pt. 4)	Once for each source of supply and subsequently on monthly basis.
		ii) Soundness	IS:2386 (Pt. 5)	Before approving the aggregates and every month subsequently.
		iii) Alkali aggregate reactivity	IS:2386 (Pt. 7) IS:456	-do-

1000 MATERIALS FOR STRUCTURES

1007 COARSE AGGREGATE

1007 COARSE AGGREGATE

Table 1000-1 : Grading Requirements of Coarse Aggregate

IS Sieve Size	Percentage Passing for Graded Aggregate of Nominal Size		
	40 mm	20 mm	12.5 mm
63 mm	—	—	—
40 mm	95 – 100	100	—
20 mm	30 – 70	95 – 100	100
12.5 mm	—	—	90 – 100
10 mm	10 – 35	25 – 55	40 – 85
4.75 mm	0 – 5	0 – 10	0 – 10

1008 FINE AGGREGATE

1008 FINE AGGREGATE

Table 1000-2 : Grading Requirements of Fine Aggregates

IS Sieve Size	Percent Passing for		
	Grading Zone I	Grading Zone II	Grading Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

FINENESS MODULUS should not beless than 2.0 not greater than 3.5

1700
STRUCTURAL CONCRETE

1703 GRADES OF CONCRETE

1703 GRADES OF CONCRETE

Table 1700-1 : Grades of Concrete

Type of Concrete/Grade Designation			Characteristic Strength in MPa
Nominal Mix Concrete	Standard Concrete	High Performance Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M40	M35	35
	M45	M40	40
	M50	M45	45
		M50	50
		M55	55
		M60	60
		M65	65
		M70	70
		M75	75
		M80	80
		M85	85
		M90	90

1703 GRADES OF CONCRETE

1703 GRADES OF CONCRETE

Table 1700-2 : Requirement of Concrete for Different Exposure Condition using 20 mm Aggregate

Exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m³	Minimum Grade of Concrete
Moderate	0.45	340	M25
Severe	0.45	360	M30
Very Severe	0.40	380	M40

1704 PROPORTION OF CONCRETE

Table 1700-6 : Requirements for Nominal Mix Concrete

Concrete Grade	Total Quantity of Dry Aggregate by Mass per 50 kg of Cement to be taken as the Sum of Individual Masses of Fine and Coarse Aggregates (kg)	Proportion of Fine to Coarse Aggregate (by Mass)	Maximum Quantity of Water for 50 kg of Cement (Litres)	
			PCC	RCC
M 15	350	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5	25	
M 20	250		25	22

1704 PROPORTION OF CONCRETE

1704 PROPORTION OF CONCRETE

Table 1700-4 : Requirements of Consistency

	Type	Slump (mm) (at the Time of Placing of Concrete)
1)	a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40 – 50
3)	RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	50 – 75
4)	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 – 125
5)	Underwater concreting through tremie e.g. bottom plug, cast in-situ piling	150 – 200

1704 PROPORTION OF CONCRETE

1704 PROPORTION OF CONCRETE

Table 1700-5 : Current Margin for Initial Design Mix

Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69
M60	14	74
M 65	15	80
M 70	15	85
M 75	15	90
M 80	15	95
M85	16	101
M90	16	106

1706 SIZE OF COARSE AGGREGATE

1706 SIZE OF COARSE AGGREGATE

Table 1700-7 : Maximum Nominal Size of Coarse Aggregates

	Components	Maximum Nominal Size of Coarse Aggregate (mm)
I)	RCC well curb	20
ii)	RCC/PCC well steining	40
iii)	Well cap or Pile Cap Solid type piers and abutments	40
iv)	RCC work in girder, slabs wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20
v)	PSC Work	20
vi)	Any other item	As specified by the Engineer

1717 FREQUENCY OF SAMPLING

Table 1700-9 : Minimum Frequency of Sampling

Quantity of Concrete in Work, m^3	No. of Samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 and above	4 plus one additional sample for each additional 50 m^3 or part thereof

1715 HIGH PERFORMANCE CONCRETE

1715 HIGH PERFORMANCE CONCRETE

Table 1700-8 : Characteristic Compressive Strength and Target Mean Strength

Grade Designation	Specified Characteristic Compressive Strength at 28 days (MPa)	Target Mean Strength (MPa)
M 40	40	52
M 45	45	58
M 50	50	63
M 55	55	69
M 60	60	74
M 65	65	80
M 70	70	85
M 75	75	90
M 80	80	95
M85	85	101
M90	90	106

THANK YOU