



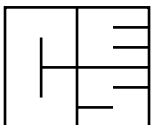
**RAJIV GANDHI INDIAN INSTITUTE OF MANAGEMENT**

**TENDER DOCUMENTS  
FOR  
CONSTRUCTION OF ROADS & PATHWAYS INCLUDING  
RETAINING WALL, SITE GRADING & PREPARATION  
FOR PROPOSED STATE-OF-THE-ART  
ACADEMIC CUM RESIDENTIAL CAMPUS  
OF RAJIV GANDHI INDIAN INSTITUTE OF MANAGEMENT  
AT UMSAWLI, SHILLONG**

**TECHNICAL SPECIFICATION**

**VOLUME - II**

**MARCH 2010**



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# TECHNICAL SPECIFICATIONS

## VOLUME – II

### ROADS & PATHWAYS

#### **Jungle clearance and felling of trees**

It is to be emphasized that any standing roadside tree, lying outside the edge of formation cutting or outside the toe of embankment, be preserved and allowed to grow. During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion and water pollution. All bushes, shrubs, stumps, roots, weeds etc. must be completely removed and dumped outside the road limit, leaving a clear space of 15 meters wide. This is to enable the officers to layout the profile and grade before commencing the excavation or filling work.

#### **Earthwork**

- All measurements are to be taken from pits. The contractors are to keep witnesses or telltales at every change of contours not exceeding 15 meters apart. Borrow pits are not to be situated near the toe of the embankment and are not to be less than 6 meters or twice the height of the embankment whichever is greater.
- The side slopes of cutting shall be 1 horizontal to 6 vertical. In embankment 1½ horizontal to 1 vertical is taken. In the event of any alterations, the Engineer-in-Charge may give decision for such changes, as will require no special of the slopes. In case of problem-ridden soil where design and analysis of the slope is needed, the Engineer-in-Charge should decide proposal for changing the slope.
- In case of high embankment of more than 8 meters or embankments of more than 3 meters but with a soil filling of heavy clay or black cotton soil, the design should be specially done and decided in consultation with the client on the basis of soil survey results. These cases must be brought to the notice of the higher officials during the survey and fixing of the alignment so as to avoid loss of time.
- Rock, when encountered in road excavation, shall be removed upto the formation level or as otherwise indicated in the drawings. Where, however, unstable shale or other unsuitable materials are encountered at the formation level, these shall be excavated to the extent of 500 mm below the formation level or as otherwise specified. In all cases the excavation shall be so carried out that at no point, on cut formation the rock protrudes above the specified levels.
- Blasting shall be carried out in a manner that completes the excavation to the lines indicated in drawing, with the least disturbances to the adjacent material.

#### **Sub-Base, Bases and Surface Course**

- The work for granular sub-base shall consist of laying and compacting well-graded materials on the prepared sub-grade in strict compliance to the specification.

- Water bound macadam Sub-Grade: This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening (blindage), binding materials where necessary and water laid on a properly prepared subgrade/sub-base/base of existing pavement.
- Physical requirements of coarse aggregates for water bound macadam for sub-base/base course:-

Test	Test Method	Requirements
1. *Los Angeles Abrasion value of Aggregate impact value	IS:2386[Part:4]	40 Percent (Max)
	IS: 2386[Part:4]	30 Percent (Max)
2. *** Combined Flakiness and Elongation indices (Total)	IS:2386[Part:1]	30 Percent (Max)

\* Aggregates may satisfy requirement of either of the two tests.

\*\* Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS:5640.

\*\*\* The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

- Except on super-elevation portions where the rolling shall proceed inner edge to outer edge rolling shall begin from the edges and gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half widths.
- Grading requirement of coarse aggregate:-

Grading No.	Size Range	Sieve Designation	Percent by Weight Passing
1	90 mm to 45 mm	125 mm	100
		90 mm	90 - 100
		63 mm	25 - 60
		45 mm	0 - 15
		22.4 mm	0 - 5
2	63 mm to 45 mm	90 mm	10
		63 mm	90 - 100
		5 mm	25 - 75
		45 mm	0 - 15
		22.4 mm	0 - 5
3	53 mm to 22.4 mm	63 mm	100
		53 mm	95 - 100
		45 mm	65 - 90
		22.4 mm	0 - 10
		11.2 mm	0 - 5

\*Note: The compacted thickness for a layer with grading 1 shall be 100 mm while for a layer with other grading i.e. 2 & 3, it shall be 75 mm.

- Approximate Quantities of Coarse Aggregates and Screenings required for 100/75 mm compacted thickness of water bound macadam (WBM) sub-base / base course for 10 m<sup>3</sup> area.

Classification	Size Range	Compacted Thickness	Loose Quantity	Screenings			
				Stone Screenings		Crushable Type such as Moorum or Gravel	
				Grading Classification and Size	For WBM Sub-Base Course (Loose Quantity)	Grading Classification and Size	Loose Quantity
Grading 1	90 mm to 45 mm	100 mm	0.21 to 1.43 m <sup>3</sup>	Type A 13.2 m	0.27 to 0.30 m <sup>3</sup>	Not uniform	0.30 to 0.33 m <sup>3</sup>
Grading 2	63 mm to 45 mm	75 mm	0.91 to 1.07 m <sup>3</sup>	-do-	0.12 to 0.15 m <sup>3</sup>	-do-	0.22 to 0.24 m <sup>3</sup>
Grading 3	63 mm to 45 mm	75 mm	0.91 to 1.07 m <sup>3</sup>	Type B 11.2 mm	0.20 to 0.22 m <sup>3</sup>	-do-	-do-
Grading 4	53 mm to 22.4 mm	75 mm	0.91 to 1.07 m <sup>3</sup>	-do-	0.18 to 0.21 m <sup>3</sup>	-do-	-do-

- The metal should be spread at the specified thickness on the compacted soling. Three or four templates or straight edges of the thickness equal to the spread thickness of the coarse of stone metal aggregates should be laid on the road. These templates or straight-edges should be adjusted and laid before hand to the calculated cross-fall and superelevation at about 10 meter apart with the help of the spirit levels and strings. After which stone metal be spread-flush to the templates or straight edges. It is normal to attain the required camber and superelevation at the time of preparation of the sub-grade, while laying the soling sub-base course. The grade of the road is first laid out by means of boring rod. In the curve portion of hill roads, the grades are laid out along the lower edge of the roadway and superelevation is obtained by banking the outer edge (for a single lane road).
- For the purpose of estimating, the following quantities of stone aggregates in WBM over the stone soling sub-base course may be adopted:-

Compacted Thickness	Approximate Spread Thickness	Quantity of Aggregates per 10 m <sup>2</sup>	Remarks
75 mm	105 mm	0.5 to 1.15 m <sup>3</sup>	These quantities are used when blindage, @ 20% to 26% of the coarse aggregate quantity, is used instead of screenings Type A and Type B.
100 mm	140 mm	0.4 to 1.60 m <sup>3</sup>	
Stone Soling 15 cm thick	-	1.75 to 1.85 m <sup>3</sup>	

- Grading of Screening:

Grading Classification	Size of Screenings	Sieve Designation	Percent by Weight Passing the Sieve
Type A	13.20 mm	13.2 mm	100
		11.2 mm	95 - 100
		5.6 mm	15 - 35
		1.8 mm	0 - 5
Type B	11.20 mm	11.2 mm	100
		5.6 mm	90 - 100
		1.8 mm	15 - 35

- The close graded granular sub-base materials should conform to the table below, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm.:

IS: Sieve Designation	Percent by Weight Passing the IS Sieve		
	Grading: I	Grading: II	Grading: III
75.0 mm	100	-	-
53.0 mm	80 - 100	100	-
26.5 mm	55 - 90	70 - 100	100
9.50 mm	35 - 65	50 - 80	65 - 95
4.75 mm	25 - 55	40 - 65	50 - 80
2.36 mm	20 - 40	30 - 50	40 - 65
0.425 mm	10 - 25	15 - 25	20 - 35
0.075 mm	3 - 10	3 - 10	3 - 10
CBR Value (Minimum)	30	25	20

- The contractor engaged in the preparation of the sub-base course and WBM should have necessary screens, straight edges, templates etc. The Engineer-in-Charge and the contractor should lay out the grade by means of boring rods, the superelevation and camber with the help of straight edges, templates, spirit level etc. before commencing of the work.
- Preparation of surface: This work shall consist of preparing and existing granular or black-topped surface to specified lines, grades and cross-sections in advance of laying a bituminous course. Any repair work on the WBM of existing pavement like patching of potholes and sealing of cracks is to be taken up.
- Built up spray grout: This work shall consist of a two layer composite construction of compacted crushed coarse aggregates with application of bituminous binder after each layer and key aggregates on top for the second layer. Thickness of the coarse shall be 75 mm.

- Surface Dressing: In the case of Single and Two Coat Surface Dressing using Bitumen, the size of stone chippings shall be given below:-

Sl.No.	Type of Construction	Normal size of Chippings	Specifications
1	Single coat surface dressing of the first coat of two coat surface dressing.	13.2 mm	100% passing through 22.4 mm sieve & retained on 11.2 mm sieve.
2	Second coat of two coat surface dressing (also used as renewal coat)	11.2 mm	100% passing through 13.2 mm sieve & retained on 5.6 mm sieve.

- The quantities of materials required for 10m<sup>2</sup> of road surface for surface dressing using Bitumen is as specified in the table below:-

Sl.No.	Type of Construction	Binder	Stone Chipping
1	Single coat of two coat surface dressing (also used as renewal coat)	18.0 kg	0.15 m <sup>3</sup>
2	Second coat of two coat surface dressing (also used as renewal coat)	10.0 kg	0.10 m <sup>3</sup>

- Open graded Premixed Carpet using Bitumen:- This work shall consist of laying and compacting an opening graded carpet of 20 mm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to serve as a wearing course.
- The quantities of materials required for 10 m<sup>2</sup> of road surface for 20 mm thick open graded premix carpet using bitumen is as given in the table below:-

Aggregates for Carpeting:	
• Stone for chipping 13.2 mm size, passing 22.4 mm sieve and retained on 11.2 mm sieve.	0.18 m <sup>3</sup>
• Stone for chipping 11.2 mm size; passing 13.2 mm sieve and retained on 5.6 mm sieve.	0.09 m <sup>3</sup>
Total =	0.27 m <sup>3</sup>
Binder for Premixing (quantity in terms of straight run bitumen)	
• For 0.18 m <sup>3</sup> of 13.2 mm size stone chipping at 52 kg per m <sup>3</sup>	5.1 kg
• For 0.09 m <sup>3</sup> of 11.2 mm size stone chipping at 56 kg / 5.1 kg per per m <sup>3</sup>	
Total =	14.6 kg

- Seal coat, liquid or premix type, shall be applied 4 to 6 hours after laying the premix carpet. Follow Table below for quantities of aggregates and binder for 10 m<sup>2</sup> area.

Type	Specification of Aggregates	Quantities	
		Aggregates	Binder
Liquid seal coat (Type A)	Crushed fine aggregate 6.7 mm size; passing IS: 9.5 mm sieve and retained on IS: 2.36 mm sieve.	1.15 m <sup>3</sup>	9.8 kg
Premix seal coat (Type B)	Coarse sand or stone grit passing 2.36 mm sieve and retained to 180 ..... sieve.	1.15 m <sup>3</sup>	6.8 kg

- Tack Coat: This work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction over it. Tack coat should be applied not earlier than 10 minutes before commencing the bituminous constructions. It is also mandatory to spray water over the existing surface of dampen it before applying the tack coat.

Surface Type	Tack Coat
a) Over water bound macadam surface	10 kg / 10 m <sup>2</sup>
b) Over existing black-topped surface	5 kg / 10 m <sup>2</sup>

- Recommended temperature for Bitumen and aggregates:-

Bitumen in Degree Centigrade	Mixing Temperature of Aggregates (Centigrade)	Mixing Temperature of Bitumen (Centigrade)	Discharge Temperature of mix (Centigrade)	Laying Temperature (Centigrade)	Rolling Temperature (Centigrade)	Difference of Temperature between Bitumen and Aggregate (Centigrade)	Temperature of Bitumen and Aggregate mix should be measured regularly by using Thermometer
140°C 160°C	125°C 150°C	150°C 165°C	130°C 160°C	120°C 135°C	80°C - 20°C	Not to exceed 25°C	

- The camber or cross fall on straight sections of roads should be recommended in the table below, for various types of surfaces. For a given surface, the steeper value in the table may be adopted in areas of high intensity of rainfall and vice versa.

Sl.No.	Surface Type	Camber / Cross fall
a)	High type bituminous surface or cement concrete	1.7 – 2.0% (1 in 60 to 1 in 50)
b)	Thin bituminous surface	2.0 – 2.5% (1 in 50 to 1 in 40)
c)	Water bound Macadam, Gravel earth	2.5 – 3.0% (1 in 40 to 1 in 33)
d)	Earth	3.0 – 4.0% (1 in 33 to 1 in 25)

**Note : The Items which are not covered under PWD schedule (Roads & Building) Meghalaya, Shillong shall be as per CPWD specification (latest edition).**

# TECHNICAL SPECIFICATIONS

## VOLUME – II

### CIVIL

#### (A) MATERIALS:

General: All materials to be used in works shall conform to Indian Standards specification as published by I.S.I from time to time (and in the absence thereof as approved by the Engineer-in-charge).

##### A.1 Bricks:

All bricks should be of approved quality of standard specification, made of good brick earth. Uniform deep red cherry or copper colour, thoroughly burn in kiln (machine made) without vitrified, regular in shape and size, sound, hard, homogeneous, true in shape and standard dimensions and shall be free from cracks, chips, flaws, stones or humps of any kind and not show appreciable signs of efflorescence, either dry or subsequent to soaking in water. The size of bricks shall be  $9\frac{3}{4} \times 4\frac{3}{4} \times 2\frac{3}{4}$  (Conventional) 190mm x 90mm x 90mm (Modular). The bricks shall emit a clear ringing sound on being struck and have a minimum crushing strength of 105 kg/sqcm. All the bricks, which absorb water more than 20 percent of their own dry weight after 24 hours immersion in cold water, shall be rejected.

##### A.2. Coarse Aggregates for Cement Concrete works:

Stones chips of stone ballast for cement concrete (plain or reinforced) shall be hard of uniform and fine texture, free from loam, clay or any surface coating, free from organic matter or other impurities and screened free of dust. Stone of black and hard variety as is generally available will be normally used. The ballast or chips shall be obtained by breaking from large blocks and must be more or less cubicle in shape.

Size of coarse aggregates: For any of the following nominal size coarse aggregates, grading shall be in conformity with the requirements laid down in the Indian Standards specification IS:383-1963 as shown below in Table I.

Table - I

I.S. Sieve Designation	Percentage passing for graded aggregate of nominal size			
	40 mm	20 mm	16 mm	12.5 mm
(1)	(2)	(3)	(4)	(5)
80 mm	100			
63 mm				
40 mm	95 – 100	100		
20 mm	30 – 70	95 - 100	100	100
16 mm			90 – 100	
12.5 mm				90 – 100
10 mm	10 – 35	25 – 55	30 – 70	40 – 85
4.75 mm	0 – 5	0 – 10	0 – 10	0 – 10

When coarse aggregates brought to the site is upgraded single size coarse aggregates of different nominal sizes, conforming to the requirements vide Table II given below, shall be mixed at site with the other ingredients of concrete either directly in the mixture or on the platform in the proportion indicated in the

**Table II**

I.S. Sieve Designation	Percentage passing for graded aggregate of nominal size						
	20 mm	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80 mm		100	-	-	-	-	-
63 mm		85- 100	100				
40 mm		0 – 30	85 – 100	100			
20 mm		0 - 5	0 – 20	85 – 100	100		
16 mm					85 – 100		
12.5 mm						85 – 100	100
10 mm			0 – 5	0 – 20	0 - 30	0 - 45	85 – 100
4.75 mm							0 – 20
2.36 mm				0 – 5	0 – 5	0 - 10	0 – 5

**Table III**

Sl.No.	Cement concrete mix	Nominal size of aggregate	Parts of aggregate of size 50 mm	Parts of aggregate of size 40 mm	Parts of aggregate of size 20 mm	Parts of aggregate of size 12.5 mm	Parts of aggregate of size 10 mm
1	2	3	4	5	6	7	8
1.C.C	1:6:12	63 mm	9		3		
2. C.C	1:6:12	40 mm		9	3		
3. C.C	1:5:10	63 mm	7¼		2½		
4. C.C	1:5:10	40 mm		7½	2½		
5. C.C	1:4:8	63 mm	6		2		
6. C.C	1:4:8	40 mm		6	2		
7. C.C	1:3:6	63 mm	4½		1½		
8 C.C	1:3:6	40 mm		4½	1½		
9 C.C	1:3:6	20 mm			4½		1½
10 C.C	1:2:4	40 mm			2½	1	
11 C.C	1:2:4	10 mm				3	1
12 C.C	1:2:4	12.5 mm				3	1
13 C.C	1:1½:3	20 mm			2		1

Notes:- The proportion indicated in the Table III above are by volume. Their proportion may be varied somewhat by the Engineer-in-Charge after making sieve analysis of aggregates brought to the site, when considered necessary for obtaining better density and strength of concrete, void ratio in the tune 0-25.

All in Aggregates: If combined aggregates are available, they need not be separated into fine and coarse, but necessary adjustment may be made in the grading by the addition single sized aggregates. The grading of the all in aggregates when analyzed in I.S:2386(Part I) shall be in accordance with Table IV.

**Table IV**

I.S. Sieve Designation	Percentage passing for all in aggregates	
	40 mm Nominal size	20 mm Nominal size
60 mm	100	
40 mm	95 – 100	100
20 mm	45 – 75	95 – 100
4.75 mm	25 – 45	30 – 50
600 mm micron	8 – 30	15 – 35
150 mm	0 – 6	0 – 6

Gravel, for use as coarse aggregates in cement work, must be hard, absolutely free from surface coating, and being broken the fractured surface must indicate a uniform and fine texture free from laminations or places of weakness. It shall be thoroughly washed and free from any foreign elements.

All coarse aggregates for concrete work must be well graded. These shall be screened for removal of dust and if so necessary in the opinion of the Engineer-in-Charge shall be washed at the cost and expense of the contractor.

### **A.3 Sand:**

All sand shall be clean, sharp and free from clay, loam, organic or any other foreign matter and shall be obtained from approved source. The contractor shall get the sample of sand to be used in different kind of works approved by the Engineer-in-charge before using the same in works. Sand, which in the opinion of the Engineer-in-Charge or his representative is dirty, must be washed to his satisfaction at the cost and expense of the contractor.

- (i) Sand for all cement concrete work must be coarse. The sand shall pass through a mesh, 4.75 mm square measured in the clear. Sand shall not be used for concrete works if it contains more than 10 percent of fine grains passing through a 76 mesh sieve as used for cement test, nor should the fineness modulus be less than 2.00 unless specific permission is obtained from the Engineer-in-Charge.
- (ii) Medium sand may be used for cement mortar, for masonry plaster etc and also for bituminous works of road. Fineness modulus shall be between 2 to 1.8.
- (iii) Sand filling in plinth or foundation where specified, may be done with fine sand.

### **A.4 Lime:**

All lime shall be freshly burnt and slaked and screened before use. The slaking should be done at site of work.

The specification covers lime as used in construction of building and other structures described below (I.S. 712-1973).

- (a) Quick lime means a calcined material, the major part of which is calcium oxide content in natural association with relatively small amount of magnesium oxide and capable of slaking with water.
- (b) Fat lime shall mean the lime which has high calcium oxide content (between 95-100 percent) and dependent for setting and hardening on the absorption of carbon dioxide from the atmosphere, this is defined as Class-C in I.S. 712-1973 which is used for finishing coat in plastering, white washing etc and with addition of pozzolanic material (surki) for masonry mortar.
- (c) Hydraulic lime shall mean the lime that contains small quantities of silica and alumina and/or iron oxide which are in chemical combination with some of calcium oxide content having putty or mortar that has the property of setting and hardening under water.
- (d) Hydrated lime shall mean a dry powder resulting from treatment of quick lime with water enough to satisfy its chemical affinity for water under the conditions of hydration.

#### **Classification of Lime:**

Class A: Eminently hydraulic lime (containing 25 to 30 percent of clay) used for foundations and other hydraulic structures, shall be supplied as hydrated lime only and should be used particularly in any masonry work below G.L. It should be noted here that no specified masonry work below G.L should be taken up with the use of the other lime, other than specified hydraulic lime. In case of doubt if any in respect of hydraulic one being used work below G.L., it is preferable not to use lime mortar at all below G.L.

Class C: Fat lime used mainly for lime punning white washing and with suitable admixture, such as surki or and other pozzolanic materials to produce artificial hydraulic mortar.

#### **A.5 Cement:**

Cement bags must be stored in a water tight shed having wooden floor or platform raised at least 50 mm from ground as approved by the Engineer-in-Charge. Cement which is partially set or which is lumpy or caked is to be treated as damaged and shall be removed from site immediately.

#### **A.6 Steel:**

All steel shall be clean and free from loose mill scales, dust, loose rust shall be removed before use, even though the Department may have supplied the same without any claims for extra charge for the same.

## **A.7 Paint etc:**

All paints shall be delivered in strong containers, marked with the colour of the paint, brand, volume of paint content in litres and of the best quality of approved make and brand as approved by the Engineer-in-Charge. Under no circumstances shall the paint be diluted with linseed oil or otherwise. Any paint or enamel although of approved brand, which so hardened in the container that it cannot be readily broken up with stirrer to a smooth uniform painting consistency shall be rejected. Any paint or enamel too thick for proper brush application shall be rejected.

## **(B) EXECUTION:**

General: All works shall be carried out in proper workman-like-manner. Items of works not covered by the following, shall be carried out as per best practice according to the directions of the Engineer-in-Charge and to his satisfaction. Unless otherwise specified in this section or in the description of item, the cost of all stages of works mentioned hereunder shall be deemed to have been included in the rates of items provided in the Schedule.

### **B.1 (a) Excavation of foundation and filling up trenches:**

- (i) Foundation when excavated to the level shown to the Engineer-in-charge and if on account of bad ground or for any reasons whatsoever he decides to go deeper with the foundation, the contractor shall excavate further to the depths required by the Engineer-in-charge. In no case shall the foundation soling or concrete be laid prior to receiving orders to that effect from the Engineer-in-charge or his authorized representative.
  - (ii) Excavating shall include throwing the excavated earth at least 1.00 metre or half the depth of excavation, whichever is more, clear of the edges.
  - (iii) Excavating shall include throwing the excavated earth at least 1.00 metre or half the depth of excavation, whichever is more, clear of the edges.
- (b)(i) Shoring: For loose earth and when depth of excavation exceeds 3 metres poling boards (vertical member) of 50 to 75 mm in thickness and 175 to 225 mm in width preferably of sal wood are to be placed close together and to be driven about 300 mm in the ground below the bottom of the trench with intermediate sal-bullah piling of dia not less than 100 mm at the rate of 900 to 1000 mm center to be placed in between the vertical surface of trench and the poling boards and double struts of sal-bullah of notless than 100 mm in width and 75 in thickness held horizontally between them.
- (ii) For medium clay and when the depth of excavation exceeds 2 metres but not exceeding 3 metres single struts will be provided and sal-bullah piling may not be placed. Other requirements are to be satisfied as (i) above.

## **B.2 Cement concrete works (plain of reinforced):**

- (i) Shuttering and staging: Whenever necessary, shuttering and staging must be provided. Unless otherwise stated no payment will be made for such shuttering staging and the cost thereof will be deemed to have been covered by the rate for relevant finished item of work. Where payment shuttering has been specified, the rate shall be deemed to cover the cost of the necessary staging as well. Payment if any, for shuttering will be on the basis of surface area of shuttering in actual contact with concrete.

Shuttering may be of approved dressed timber true to line, not less than 25 mm thick. Surfaces to in contact with concrete are to be placed smooth except where otherwise stated. As an alternative, sufficiently rigid steel shuttering may be used. In every case, joints of the shuttering are to be such as to prevent the loss of liquid from concrete. In timber shuttering the joints shall therefore be either tongued or grooved or the joints must be perfectly closed and lined with craft paper or other types of approved materials. In case of steel shuttering also the joints are similar lined.

All shuttering and frame must adequately be stayed and braced to the satisfaction of the Engineer-in-Charge for properly supporting the concrete during the period of hardening. It shall be constructed that it shall be removed without shock or vibration to the concrete.

Before the concrete is placed, the shuttering shall if considered necessary be coated with an approved preparation for prevention the adhesion of the concrete to moulds, and is to be of such a nature and so applied that the surface of the finished concrete is not stained. Care shall also be taken that such approved preparation shall be kept out of contact with the reinforcement.

In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress of which the concrete may be subject at the time of striking.

Interior of all moulds and boxes must be thoroughly washed out with hose pipe or otherwise so as to be perfectly clean and free from all extraneous matter previous to the deposition of concrete.

All formwork shall be removed without shock or vibration. Before the formwork is stripped, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has hardened sufficiently. In normal weather and with ordinary cement, vertical or side shuttering may be removed after three days and the bottom shuttering of horizontal members after fourteen days in case of slabs and twenty one days in case of beams and cantilevers etc from the date of placing the last portion of the concrete in the structures. The above period are the minimum and may be extended if found necessary. Before stripping the shuttering of the structural member, the contractor shall take previous permission of the Engineer-in-Charge or his representative.

No plugs, bolts, ties hold fast or any other appliances whatsoever for the purpose of supporting the shuttering are to be fixed in the structure or placed in such a way that damage might result to the work in removing the same when the shuttering is struck.

- (ii) Scaffolding: The scaffolding must be strong and rigid, stiffed with necessary cross brace and always decked and boarded on the sills with close boarded ceiling and swings to prevent any injury to persons or materials. The contractor shall have to allow other traders to make reasonable use of his scaffolding as and when directed by the Engineer-in-Charge.

If in the interest of the work the contractors have to erect scaffolding in other properties including local bodies or corporation, the arrangement for the same including the cost of licensing fees etc. shall have to be borne by the contractor and the Department should be kept free from any liability in this account.

- (iii) Mixing, placing and compacting: The proportion specified is by volume in dry condition of the different constituents.

Boxes of suitable size shall be used by measuring sand and aggregate. The unit of measurement for cement shall be a bag of cement weighing 50 kg and this shall be taken as 0.0347 cubic metre while measuring the aggregate, shaking, ramming or hammering shall not be done. The proportioning of sand shall be the basis of its volume and in case of damp sand, allowances for bulk age should be made.

Normally, all structural concrete shall be mixed in mixture machine of appropriate proportion and shall have to be vibrated with suitable vibrator. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than two minutes. The rates appearing in the Schedule of Rates against such items are inclusive of hire and operational charges of such appliances. For particular jobs, the Engineer-in-Charge may allow hand mixing and or hand tapping of concrete. In case of hand mixing concrete, extra cement upto 10 percent over the standard requirement of cement for machine mix of particular mix shall have to be provided by the contractor at his own cost.

Although the bulking of sand may vary from day to day and the different parts of the day on account of varying moisture content, frequent tests for bulking shall be carried out with the sand to be used and the amount of bulking allowed for in the field mix so as to keep the actual proportion constant throughout.

Only such quantities as are required for immediate use are to be mixed at any one time, sufficient water is to be added to obtain proper workability so that the mixture may flow readily round at the reinforcement and into every part of the mould. The workability shall be measured by the amount of slump.

The quantity of water to be used for each mix of 50 kg cement to give the required consistency shall not be more than 34 litres for 1:3:6 mix, 32 litres for 1:2:4 mix, 30 litres for 1:1½:3 mix and 27 litres for 1:1:2 mix. In case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation.

The total water content in each batch of concrete shall always be kept constant as the amount previously determined by experiments. The quantity of water to be actually added may, therefore, vary depending on the moisture content in the aggregates. In actual jobs if the quantities of the ingredients remain constant, the amount of slump may be taken as good guide indicating the total water content in the mixture. The consistency and consequently the water content of the concrete shall, therefore, be kept constant and checked from time to time as work proceeds by means of standard slump tests. The slump tests shall be carried out with concrete immediately after it has been mixed and before any initial set has commenced, the sample being taken preferably at the point where the concrete is being delivered for placing in the moulds.

The moulds shall be filled about one fourth of its height, which shall then be tamped, using 25 strokes of 16 mm diameter steel rod 60 cm, long and bullet pointed at the lower end. The filling shall be complete in successive layers similar to the first and the top struck off so that the mould is exactly filled.

The mould shall then be removed by raising vertically immediately after filling. The moulded concrete shall then be allowed to subside and the height of the specimen measured after coming to rest.

The consistency shall be recorded in terms of millimeters of subsidence of the specimen during the rest, which is known as slump.

**The following slumps shall be adopted for works:**

Sl.No.	Type of work	Slumps	
		When vibrators are used	When vibrators are not used
1.	Mass concrete in foundation, footings retaining walls and pavements	10 to 25 mm	50 to 75 mm
2.	Mass concrete in R.C.C foundation footings and retaining walls.	10 to 25 mm	80 mm
3.	Beams, slabs and columns simply reinforced	25 to 40 mm	100 to 125 mm
4.	Thin R.C.C section or section with congested steel	40 to 50 mm	125 to 150 mm

**Strength requirement of concrete (in Kg/sq.cm)**

Grade of Concrete	Comprehensive strength of 15 cm cubes		
	Work test min	Work test min	Preliminary test

	<b>at 7 days</b>	<b>at 25 days</b>	<b>min at 28 days</b>
M100 (1:3:6)	70	100	135
M150 (1:2:4)	100	150	200
M200 (1:1½:3)	135	200	260

Concrete shall be handed from place of mixing to the place of final deposit as rapid as practicable by methods, which will prevent the segregation or loss of the ingredients. It shall be deposited as nearly as practicable in the final position to avoid rehandling of flowing. Unless specially permitted by the Engineer-in-Charge, concrete shall not be dropped freely from a height of more than 2 metres.

Before placing the concrete, the moulds shall be cleaned of shavings pieces of woods or other rubbish. When placing the concrete, the finer materials must be carefully worked against the moulds so that the faces of concrete shall be left perfectly smooth and free from honeycombing upon withdrawal of the moulds. Any defect in this respect must be dealt with by the contractor as directed by the Engineer-in-Charge without any extra charge thereof.

During placing and also immediately after deposition, the concrete shall be thoroughly compacted by ramming, spearing etc until it has been made to penetrate and fill all the places between and around the steel rods, around embedded fixtures and into the corners of form work in such a manner as to ensure a solid mass entirely free from voids. If so directed by the Engineer-in-Charge in addition to usual ramming spearing etc. sufficient number and suitable type of vibrators may have to be used on important jobs to enable working with a comparatively low water cement ratio and ensure the maximum possible degree of compaction and homogeneity. It is imperative that the work should be done quickly as well as efficiently and adequate number of hands must therefore be employed to ensure this.

Concrete shall be placed and compacted in its final position before setting has commenced and shall not subsequently be disturbed.

Concrete shall be carried out continuously upon construction joints, the position and arrangements of which shall be predetermined by the Engineer-in-Charge or his representative. Any rest pauses, such as meals, shall also be subject to his approval. All concreting work should be so programmed as not to necessitate work at night. If or any reason this becomes imperative, the contractor shall obtain previous permission of the Engineer-in-Charge or his representative and make proper lighting arrangement to his satisfaction.

- (iv) **Protection and Curing:** The contractor shall adequately protect freshly laid concrete about 1 to 2 hour after its laying, from too rapid drying due to sunshine, drying winds, etc. and also from rains or surface water and shocks. About 24 hours after laying of concrete, the surface shall be cured by flooding with water of minimum 25 mm depth or by covering with wet absorbent materials. The curing shall be done for a minimum period of 10 days. Over the foundation concrete, the masonry work may be started after 48 hours of its

laying but the curing of concrete shall be continued along with masonry work for a minimum period of 10 days.

In case of cement concrete used as sub-grade for flooring, flooring may be commenced within 48 hours of the laying sub-grade. In case it is not possible to do so, due to exigencies of work, sub-grade shall be roughened with a steel wire brush without disturbing the concrete, wetted with neat cement slurry at the rate of 2.75 kg of cement per square metre applied to the base before laying floor, and will be paid separately with the specific order of the Engineer-in-Charge. The curing is to be continued along with the top layer of flooring for a minimum period of 10 days.

- (v) Construction joints: All joints in slabs and other horizontal members are to be formed by inserting vertical boards against which the concrete deposited can be properly rammed. The position where such joints may be made will be indicated by the Engineer-in-Charge or his representative. In case of horizontal joint, any excess mortar or laitance shall be removed from the surface after the concrete is deposited and before it has set.

When the work has to be commenced in the surface, which as hardened, such surface shall be well roughened and all laitance removed, the surface shall then be swept, clean thoroughly, wetted and covered with a thin layer of mortar composed of equal volumes of cement and sand. Such works shall deem to be covered by the rates for concrete.

- (v) For R.C.C works, (where concrete is specified by strength) the mix should not be leaner than 1:2:4 so as to give ultimate crushing strength not less than 200 kg/sq.cm at 28 days cured after field condition, the mix of the concrete is to be adopted and the slumps is to be so allowed as to give specified strength and proper workability at the existing site conditions. Contractor shall remain fully responsible for producing concrete of specified strength in the actual job and therefore cast at his own cost test specimens 15 cm dia and 30 cm high cylinder or 15 cm cube (minimum one set of 4 nos per day) during work and cure the same in similar way for laid concrete being tested for strength. Each set of test specimen shall be taken to cover the quantity of concrete laid on the job during the period from the time of taking the previous set of specimens and the quantity will get estimated by the Engineering-in-Charge from record maintained by him.

The interior surface of the mould and base plate shall be lightly oiled before the concrete is placed in the moulds.

- (a) When the job concrete is done by ordinary methods, the test specimens shall be moulded by placing the fresh concrete in the mould in three layer, each approximately one third of the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it in order to ensure the uniform distribution of concrete within the mould. Each layer shall be rodded 25 times with a 16 mm rod 60 mm in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall

penetrate into the underlying layer. The bottom layer shall be struck and be rodded, throughout its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machine metal plate, which may later be used in capping the cylindrical test specimens. The whole process of the moulding shall be carried out in such a manner as to preclude the alteration of water cement ratio on the concrete by loss of water either by leakage from the bottom or overflow from the top of the mould.

- (b) When the job concrete is placed by vibration and consistency of the concrete is such the test specimens cannot be properly moulded by hand rodding as described under (a) above the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in the mould in two layers each approximately half the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to ensure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for the top layer, enough concrete shall be added to bring the level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified under (a) above. The whole process of moulding shall be carried out in such manner so as to preclude the alteration of water cement ratio of the concrete by loss of water either by leakage from the bottom or overflow from the top of the mould application as per rules in each for all test specimens whatsoever. The contractor shall be responsible for proper packing of the specimens at his own cost, for safe and convenient transport of the same from the site to the testing laboratory.

### **B.3 1<sup>st</sup> Class Brickwork:**

Cement mortar shall be prepared by mixing sand and cement in specified proportion. Sand shall be measured on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

Bricks used for masonry in cement mortar shall be thoroughly soaked in clean water for at least an hour immediately before use, (the absence of bubbling when the soaked brick is immersed in water is the test for thorough soaking) the soaked brick shall be kept on a platform free from dirt, mud or any foreign element.

Brick works shall be laid in English bond. The brick shall be laid by carrying method. A layer of mortar shall spread on full width for suitable length of the lower courses. Each brick shall first be laid so as to project over the one below, both at the end and at side, then pressed into the mortar and shoved into final position so as to embed the brick and to fill its inside face fully with mortar. Cuts bricks shall not be used except where necessary.

The walls shall be taken up truly plum bob. The thickness of brick courses shall be kept uniform and for this purpose wooden straight edge with graduations giving thickness of each brick colour including joints shall be used. Also course shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate course shall come, directly one over the other. A set of tools comprising widen straight edge, masons spirit level, square half metre rule, line and pin, string and plum shall be kept for every 3 masons for frequent checking during which the work faces found not in plumb shall be dismantled.

Both faces of walls of thickness greater than 25 cm (10") shall be kept in proper place. As the connected brick works shall be carried up early at one level and no portion of the work shall be left more than one metre below the rest of the work. Where this is not possible the work shall be racked according to bond (and not left toothed) at an angle not steeper than 45°C.

Brick shall be laid that all joints are quite full mortar. The thickness of joints shall not exceed 10 mm (2/5"). Bricks shall be laid with frogs upwards except in the top course where from shall be placed downwards. The face joints shall be racked to a minimum depth of 15 mm (3/5") by racking tools daily during the progress of work when the mortar is still green so as to provide proper key for plaster or pointing to be done. Where plastering or pointing is not required to be done, the joint shall be struck flush and finished at the time of laying.

The face of brick work shall be cleaned the very day the brick work is laid daily and all mortar droppings removed.

Green work shall be protected from rain by suitable covering. The brick work shall be kept for a period of at least 7 days. The top of masonry work shall be left flooded at the close of the day.

Scaffolding shall be sound and strong and holes in masonry work for supporting the scaffolding shall be filled and made good before plastering.

#### **B.4 Damp proof course:**

This shall be laid to the specified thickness over walls for the full thickness of the super structure walls. The surface shall be leveled and prepared before laying cement concrete. Edges of damp proof course shall be straight, even and vertical. Side shuttering shall consist of wooden form and shall be strong and properly fixed so that it does not get disturbed during compacting and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be damped thoroughly to make a dense mass when the sides are removed. The surface should come out smooth without any honeycombing. The damp proof course shall be laid continuous and the surface shall be double chequered. Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry. Water proofing materials of approved quality shall be added to the concrete mixture in litres or kg per 50 kg of cement and will be paid for separately.

## **B.5 Cement Plaster:**

The proportion of mortar for exterior or interior plaster shall be specified in the items of works. The plaster shall be of thickness as specified and surface shall be similarly cured as for cement concrete. The moulding shall be carried out as shown in the drawing and shall be separately measured in over all length unless otherwise specified in the items, interior corners and edge of openings if so directed by the Engineer-in-charge shall be rounded off or chamfered with the same mortar for which no extra payment will be allowed. All cement concrete surface should be chipped off properly before taking up the plastering.

## **B.6 Rain water pipes:**

The rain water shall be of materials and of size as specified. All rain water pipes shall have suitable grating as directed at the inlet openings at roof and shall be fitted and fixed in proper position with necessary offsets, clamps, shoe, Y-junction and other accessories as required and as directed by the Engineer-in-charge. The pipes are to be fixed to walls in cement mortar (1:4) with necessary clamps, nails, suitable teak wood blocks being fixed on the walls to receive the nails. Junction should be used at the top of the pipe and the vertical leg thereof shall be provided with a cowl. All joints are to be properly packed. In case the hole is made much larger than size of the pipe, cement concrete (1:2:4) shall be used to fill the annular space. The pipes with fittings etc are to be painted with 2 coats of paint.

## **B.7 White washing, colour washing:**

Preparation of surface: All surfaces for white washing, colour washing painting shall be thoroughly brushed free from mortar droppings and foreign matter and prepared to the satisfaction of Engineer-in-charge before application of the treatment.

Before white washing, all the nails etc have to be removed from the walls and other holes, small depressions or damage in plaster or wall surface shall be filled or repaired to original condition with lime paste.

Old surface spoiled by smoke and greasy soot shall be sprinkled with surki and water and rubbed with brick bats or steel wire brushes or steel scrapers. The surface shall then be broomed to remove all dust and shall be washed with clean water.

Preparation of white wash: The white washing is to be with 5 parts of stone lime and one part of shell lime with necessary gum (2 kg per cum of lime) using indigo as necessary and to be mixed as per standard practice.

Preparation of colour wash: Colour washing shall have a primer of white wash and shall be of shade as approved by the Engineer-in-charge. Sufficient quantities of colour wash enough for a complete job shall be prepared in one operation to avoid any difference in shade.

“Procedure and preparation of the surface shall be same as in white washing”.

Application of white wash and colour wash: The operation for each coat shall consist of four consecutive strokes of the brush, one horizontally from right to left and the next from left to right and the third stroke bottom upward and the fourth top downward before the previous stroke dries. Each coat shall be allowed before the next coat is applied. No portion of the surface shall be left out initially to be patched up later on. The brush shall be dipped in white wash or colour wash press lightly against the wall of the container and then applied by light pressing against the surface with full swing of hand.

The white wash on ceiling should be done prior to that on walls.

Protective measures: Surface of doors, windows, floor, articles of furniture, beams, burghas etc and such other parts of the building not to be white or colour washed shall be protected from being splashed upon such surfaces shall be cleaned of white or colour wash splashes if any.

## **B.8 Painting::**

All surfaces for painting shall be properly sand papered and cleaned where necessary good quality putty shall be used to hide all holes, cracks, open joints etc the rate for painting includes such work.

Paint shall be applied with approved brushes and surface shall be sand papered after every coat. All work when completed shall present a smooth, clean solid and uniform surface, to the satisfaction of the Engineer-in-charge.

- (a) Primer - All surfaces for painting, if they are new should have a coat of priming before application of the paint. Old surface where existing paints have been completely worn out owing to long use should also receive a coat of priming before application of fresh painting.
  - (i) Steel primer - For steel surface red oxide primer, zinc chromate primer of approved brand and manufacture and as per direction of the Engineer-in-charge is to be applied in the surface. The surface should be made free of grease, rust, moisture and loose particles.
  - (ii) Cement primer coat (Alkali Resisting Primer) – Cement primer coat is to be used as base coat on wall finishes of cement, lime or lime cement plaster or on asbestos cement surface before application of any wall coating e.g. oil bound distemper, oil based paint, synthetic enamel, plastic emulsion etc on them. The cement primer is composed of a medium and pigment which are resistant to the Alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent course of oil bound distemper of paints priming coat shall be preferably applied by brushing and not spraying. Hurried priming shall be avoided particularly on absorbent surface. New plaster patches in old work before applying oil bound distemper paint, etc should also be treated with primer. The surface shall be thoroughly cleaned of dust, all white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48

hours. It shall then be sand prepared to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first, vertical strokes shall be applied immediately after leaving no brush marks. It shall be allowed uniform glossy surface.

- (b) Synthetic Enamel Paint - Synthetic enamel paint of approved brand and manufacture and or required shade shall be used for the top coat of shade to match the top coat as recommended by the manufacture shall be used. Under the coat of the specified paints of shades ..... to the shade of the top coat shall be applied and allowed to dry over night. It shall be rubbed next marks and all loose particles dusted off. Top coats of specified paints of the desired shade shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first, vertical strokes shall be applied immediately after leaving no brush marks. It shall be allowed uniform glossy surface.
- (c) Aluminium paint – Aluminium paint of approved brand and manufacture shall be used, the paints come in compact dual containers with the paste and the medium separately. The two shall be mixed together to all proper consistency before use. Each coat shall be allowed to dry 24 hours and lightly rubbed with fine grade sand paper and dusted before the next coat is applied. The finished surface shall present an even and uniform appearance. As aluminium paint is likely to settle in the container, care shall be taken frequently stir the paint during use. Also the paint shall be applied and laid off quickly as surface is otherwise not easily finished.

**Precaution:**

- (i) Old brush if they are used with emulsion paints should be completely dried of turpentine or oil paints by washing in warm soap water. Brushes should quickly be washed in water, immediately after use and kept immersed in water during break periods to prevent the paint from hardening to the brush.
- (ii) In the preparation of the walls for plastic emulsion painting, an oil base putty shall be used in filling cracks, holes etc.
- (iii) Splashes in floors, etc shall be cleaned without delay, as they will be difficult to remove after hardening.
- (iv) Washing of surface treated with emulsion paints shall not be done within 3 to 4 weeks of application.

## **C. MODES OF MEASUREMENT:**

General: Unless specially mentioned otherwise, the following modes of measurement shall be adopted.

### **C.1 Brick Walls:**

- (a) With conventional bricks – ( $9\frac{3}{4} \times 4\frac{3}{4} \times 2\frac{3}{4}$  or 239 mm x 119 mm x 69 mm).

The thickness of brick wall made with one brick laid on edge (with the long side parallel to the length of the wall) shall be measured as 75 mm. Similarly a wall made with one brick laid flat (with the long side parallel to the length of the wall) shall be measured as 125 mm. One brick thick walls (with the length of brick parallel to the thickness of the wall) shall be measured as 250 mm.

- (b) The width of lintels, etc. covering the entire thickness of brick wall shall also be measured as equal to corresponding wall thickness.
- (c) Net measurement of all walls will be taken after deduction of all openings, etc. The applies to 125 mm, 100 mm thick, 75 mm thick walls also. Parapets (upto 1060 mm – height) will be measured along with the brick work of the floor just below the roof and will be paid for at the same rate.
- (d) No extra will be paid for curved or chamfered work even though it may necessitate cutting of bricks. For small curves or chamfers the Engineer-in-charge may, at his discretion allow measurement in the square (i.e. without deduction for the quantity removed for forming the small curve or chamfer)>

### **C.2 Concrete Plain or Reinforced:**

Finished net measurement will be taken after deduction of large holes, rebates, etc but without deduction for the volume of reinforcement if any, in the concrete.

### **C.3 Reinforcement:**

The measurement will be on the basis of calculated weight of reinforcement only (i.e without considering the weight of tying wires) actually consumed in the finished work as per drawing and design or as per direction of the Engineer-in-charge. If the length of any rod be more than shown in the drawing but has been allowed to be used, the length will be taken as the length shown in the drawing. Hooks and laps as per standard will be reassured and paid for.

**Note : The Items which are not covered under PWD schedule (Roads & Building) Meghalaya, Shillong shall be as per CPWD specification (latest edition).**