

**Technical Specifications for the
Construction of Access Road and Landscape Development
Sherubtse College Kanglung, Trashigang**

Technical Specifications

The Technical Specifications contain the materials, equipment, workmanship and quality control to cover major items of work contained in the Bill of Quantities/Milestone package of the contract.

The "Specifications for Building and Road Works-2023" produced by Ministry of Infrastructure and Transport, Royal Government of Bhutan and other relevant international standards such as IS code of practice has been referred for preparation of this Technical Specifications, as appropriate.

This technical specification is prepared by Engineering Cell, Sherubtse College, Royal University of Bhutan for the **“Construction of Access Road and Landscape Development”**

Chapter 1: GENERAL

01 GENERAL

The Technical Specifications and Bill of Quantities shall be read in conjunction with the other Contract Documents. All the documents and drawings are to be regarded as mutually explanatory. In the event of any discrepancy or assumed discrepancy being found between them, the Contractor shall immediately inform the Engineer of the matter in writing and the Engineer will issue his instructions in the matter in accordance with the Conditions of Contract including the Environmental Codes of Practice for Building and other Constructions.

The terminology Engineer in these Technical Specifications shall be read as Project Engineer/site Engineer according to the General and Particular Conditions of the Contract.

The Sections, Clauses and/or Sub-clauses mentioned in these Specifications deem to apply those of these Specifications only, if otherwise not specified. The Specifications or Technical Specifications shall denote the same meaning of the specifications.

02 PROGRAM OF WORKS

Right after the issuance of letter of acceptance and before signing of the Contract Agreement, the

Contractor shall submit in triplicate the Program and particulars required under General Conditions of Contract. The Contractor shall provide all information needed for fulfillment of the Program and required in accordance with the Conditions of Contract including the sequence in which the Contractor intends to work including implementation of quality assurance plan. In the Program and particulars the Contractor shall provide details of how the Contractor proposes to carry out the Works including:

(1) The Program for the construction and completion of the works shall be established using CPM/PERT techniques or equivalent. The Program shall be detailed enough to give, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials, procurement/rental/leasing of equipment, progress milestones, fabrication of special products/equipments, if any, and their installation and testing, and for all activities of the Engineer that are likely to affect the progress of work. It shall be prepared so as to permit revisions, inclusion of additional detail and regular updates as the work progress. Such agreement shall not relieve the Contractor of his responsibility to obtain specific approval for each closure or series of closures. In all respects the Contractor shall pay particular attention to seasonal weather pattern including rainfall and snow conditions (if any), and the construction sequencing while preparing the Program and executing the Works in accordance with this. Any proposal for night working shall also be stated in the Program.

(2) A detailed Statement of Construction Management Procedures the Contractor proposes to adopt.

(1) Samples shall be indelibly and clearly marked with the date of submission, material reference and any other data required to determine the source and kind of sample.

(2) One or more “accepted” samples will be retained by the Engineer for comparison with materials and workmanship supplied and will form the standard of acceptance.

(3) One or more “accepted” samples shall be retained at the Contractor’s site office and be available for reference on request.

(4) The Engineer may reject any materials and goods which in his opinion are inferior to the samples thereof previously approved and the Contractor shall promptly remove such materials and goods from the Site.

04 Diversions and temporary works

(1) Scope

This Clause covers the construction and maintenance of the necessary detours and diversions, barricades and signs, and everything necessary for the safe and easy passage of all public traffic during the construction period and also the removal of diversions as they become redundant including bringing up the area under use into its original condition. The Contractor shall take necessary safety procedures regarding traffic diversion or temporary road closures that are needed in execution of the works.

(2) General Requirements

The Contractor shall at all-time carry out works for building and related construction in a manner creating least interference to the flow of pedestrians. The Contractor shall take prior approval of the Engineer regarding arrangements of passage during construction if any.

The Contractor may be allowed to stop passage temporarily. The period of such closure shall be as agreed by the Engineer. For this the Contractor shall submit the time and period of the closure to the Engineer at least 07 days in advance, to enable the Engineer to issue the relevant notices.

(a) Access to Properties

Access to properties which fall within or adjoining the area over which work is being carried out shall be provided in the manner as existed before the start of the work.

(b) Temporary Drainage Works

All necessary temporary drainage works required for proper surface run-off, such as side drains, catch drains, temporary cross-drainage structures, etc. shall be constructed.

(3) Construction Safety and Control

The Contractor shall provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required for the information and protection of human. Barricades, traffic signs and warning boards shall be provided as per the requirements of RUB or as per code of practice. Suitable regulatory and/or warning signs shall be installed for the guidance of the passers.

Measurement and Payment

No measurement and/or payment shall be made for works required under Clause 04 of the Technical Specifications. All costs in connection with the work specified herein shall be considered to be included with other related items of the work in the Bill of Quantities or Mile Stone package.

05 MAINTENANCE OF SERVICES

- (1)** If any government, publicly and privately owned service for drinking water, electricity, drainage, irrigation channels, sewers, telecommunication cables/lines and other services and structures, passing through the site is affected by the works, the Contractor shall provide a satisfactory alternative service in full working order to the satisfaction of the owner of the services and of the Engineer before terminating the existing service.

- (2) Drawings and scheduling the affected services like water pipes, sewers, cables, etc. owned by various authorities including government and public undertakings and local authorities shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.
- (3) The Contractor must also allow for any effect of these services and alternations upon the works and for arranging regular meetings with the various bodies at the commencement of the contract and throughout the period of the works in order to maintain the required co-ordination.
- (4) No clearance or alterations to the utility shall be carried out unless ordered by the Engineer.
- (5) Any services affected by the works shall be restored immediately by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the works.
- (6) The Contractor may be required to carry out the permanent removal or shifting or diversion of certain services/utilities on specific orders from the Engineer. Such works shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

Measurement and Payment

No separate measurement and payment shall be made for the work of temporarily supporting; maintaining and protecting the government, publicly and privately owned services. All costs in connection with the work specified herein shall be considered to be included with other related items of the work.

06 SURVEY AND SETTING OUT

- (1) During the period of Commencement of works the Contractor shall resurvey the Base Lines, Traverse Points, Bench Marks and confirm the co-ordinates and levels of the stations. He shall immediately notify the Engineer of any discrepancies and shall agree with the Engineer any amended values to be used during the contract, including replacements for any stations missing from the original stations.
- (2) All stations and reference points shall be clearly marked and protected to the satisfaction of the Engineer.
- (3) The center lines shall be accurately referenced in a manner satisfactory to the Engineer.
- (4) The Contractor shall provide the Engineer with all necessary assistance for checking the setting out, agreement of levels and any other survey or measurement which the Engineer needs to carry out in connection with the contract during the entire period of contract.

Measurement and Payment

No separate measurement or payment shall be made for the work required under Clause 06 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included in the related items of the works.

07 ACCESS TO ABUTTING PROPERTIES

For the duration of the works the Contractor shall at all times provide convenient access to site or drives for all entrances to property abutting the site and maintain them clean, tidy, and free from mud or objectionable matter.

Measurement and Payment

No separate measurement and/or payment shall be made for the work required under Clause 07 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included in the related items of the works.

08 NOTICE BOARD

The Contractor shall erect and maintain notice boards (2m x1.2m) at one end of the site giving details of the contract in the format and wording as directed by the Engineer. These boards shall be erected within 14 days after the Contractor has been given the Possession of Site. The Contractor shall not erect any advertisement sign board on or along the work without the written approval of the Employer. All sign boards shall be removed by the Contractor by the end of the Defects Liability Period.

Measurement and Payment:

No separate payment shall be made to contractor and is deemed to include in his BoQ.

09 ENVIRONMENTAL PROTECTION WORKS

The environment has been defined to mean surrounding area including human and natural resources to be affected by execution and after completion of works.

The Contractor shall take all precautions for safeguarding the environment during the execution of the contract. He shall abide by all prevailing laws, rules and regulations governing environmental protection. In particular, the Contractor shall fully comply with the Environmental Codes of Practice for Building Construction/Highways and Roads. The Contractor shall prohibit employees from unauthorized use of explosives, poaching wildlife, fishing and cutting trees. Where possible the workers must be provided with kerosene/electrical for cooking. Where it is not possible to get firewood must be provided by purchasing it through the local firewood contractor. Where there is no local firewood contractor, proper forestry permits must be obtained for collection of firewood. The Contractor shall be responsible for the action of his employees.

Environmental protection works, among others, shall also include the following:

(1) Provision and Maintenance of Camps, Offices, Stores, Equipment Yards and Workshops if any.

Various works defined under this item are related to provision and maintenance of camps for workmen and employees, Contractor's site offices, temporary accommodation to the supervision engineers, stores, equipment yards and workshops. These camps must be adequate, rain-proof, spacious, airy and hygienic with proper lighting and materials storage facilities. The area shall be kept neat and clean.

Permission may be granted by the Engineer to erect temporary suitable camps free of charge, if such establishments do not cause obstructions to human or animals, nuisance to works execution and adverse effect to the environment.

Written information must be given to and approval be taken from the Engineer regarding proper establishment and maintenance of such camps. Failure in compliance with Engineer's instruction in respect of overall standard will lead to reduction or withholding of any payment to the Contractor.

The Contractor shall ensure that proper drinking water, waste disposal and toilet facilities are provided to the camps. This arrangement shall be enforced to avoid proliferation and generation of various water borne diseases.

Provision of toilets for labour, employees and supervision engineers shall be made to avoid public nuisance as well as pollution of water courses and air. The Contractor shall construct suitable septic tanks and/or soak pits along with room

of pit-type latrines. Sufficient water must be provided and maintained in the toilets. The contractor shall provide waste disposal facilities such as dustbins and waste disposal pits.

A first aid kit along with proper medical supplies must be available in the camps for treating injuries or common health problems. All workers shall be provided with adequate safety wear such as, water boot, gloves, face masks, ear plugs, helmets, safety jackets and safety belts to prevent injuries and health hazards.

The site engineer shall have the power to order basic facilities put in place through days work or local laborers and or procure such basic facilities to maintain adequate safety and hygiene for the contractors workers/employees and deduct the same from the contractor's running bill in the event the contractor does not comply the requirement as per environmental code of practice and or as per labour laws of the kingdom.

(2) Disposal of Spoil and Construction Waste

Materials in excess of the requirements for permanent works and unsuitable materials shall be disposed off in locations and in the manner as agreed with the Engineer. The locations of disposal sites shall be such as not to promote instability, destruction of properties and public service systems. Exposed areas of such disposal sites shall be suitably dressed and be planted with suitable vegetation. Provisions shall be made to facilitate proper drainage around the site.

(3) Hazardous Materials

The Contractor shall not store hazardous materials near water surfaces. The Contractor shall provide protective clothing or appliances when it is necessary to use some hazardous substances. High concentration of airborne dust resulting in deposition and damage to crops and water resources shall be avoided. The Contractor shall take every precaution to control excessive noise resulting in disruption to human population.

(4) Operation of Machinery and Equipment

The contractor shall regularly maintain all machinery and equipment in order to minimize exhaust pollution. Oil and lubricants must be stored properly to prevent any spills and leakage and pollution of the surrounding soil as well as water bodies.

10 PHOTOGRAPHS

The Contractor shall provide photographic/video clip records of work progress every end of month. Further, contractor will keep the photographic evidence of any important findings, events that related to the project.

11 CONSTRUCTION EQUIPMENT

In addition, the conditions of the contract, the following conditions regarding use of equipment in the Works shall be satisfied by the Contractor:

- a) All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer;
- b) All the plant/equipment to be deployed on the works shall be approved by the Engineer for ensuring their fitness efficiency before commencement of work;
- c) Any equipment not meeting the approval of the Engineer shall be removed from the site;
- d) No equipment will be removed from site without permission of the Engineer; and

- e) The Contractor shall promptly make available the equipment for site quality control work as directed by the Engineer.

No extra payment shall be made to the Contractor for fulfilling the above conditions regarding the use of equipment in the Works.

12 SITE INFORMATION

The information about the site of work and site conditions in the Bidding Documents is given in good faith for guidance only but the Contractor shall satisfy himself regarding all aspects of site conditions.

The Contractor shall have to make his own arrangement for the land required by him for site offices, labour camps, stores, etc.

It is assumed that the Contractor has inspected any quarries; borrow areas etc., before quoting his rates for the work to assess the availability of construction materials in required quantity and quality.

13 NOTES CONCERNING MEASUREMENT AND PAYMENT

(1) General Rules for the Measurement of Works for work execution

1.1 General

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections read in conjunction with the General Conditions of Contract. All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits.

| | | |
|----|---|---------|
| i | length and breadth | 10 mm |
| ii | height, depth or thickness of earthwork | 10mm |
| ii | areas | 0.1 sqm |
| iv | volume contents | 0.1 cum |

Notwithstanding the above, the measurements may be taken at closer intervals also, if so desired by the Engineer.

(2) Scope of Rates for Different Items of Work

2.1 ***For BoQ rate contract***, the contract rates for entire works shall be paid in full/partially for completing the work detailed in the relevant sections for these specifications under "Rates". In the absence of any directions to the contrary, the rates are to be considered as the full inclusive rate for finished works covering all labour, materials, wastage, transportation, temporary work, plant, equipment, overhead charges and profit as well as the general liabilities, obligations, insurance and risks arising out of General Conditions of Contract.

2.2 The Lump sum rates quoted by the contractor shall, unless otherwise specified, also include compliance with/supply of the following:

- (i) General works such as survey and setting out, clearance of site before setting out and clearance of works after completion;
- (ii) A detailed Program for the construction and completion of the works (using CPM/PERT techniques) giving, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment and their installation and testing, and for all activities of the Employer that are likely to affect the progress of work, etc., including

updating of all such activities on the basis of the decisions taken at the periodic site review meetings or as directed by the Engineer.

- (iii) Samples of various materials proposed to be used on the Work for conducting tests thereon as required as per the provisions of the Contract;
- (iv) Design of mixes as per the relevant Clauses of the Specifications giving proportions of ingredients, sources of aggregates and binder along with accompanying trial mixes as per the relevant clauses of the Technical Specifications to be submitted to the Engineer for his approval before use on the Works.
- (v) All incidental costs

2.3 The other contractors employed by the Employer may be working in the vicinity of the Works being executed by the Contractor. The Contractor shall liaise with such contractors and carry out activities for the completion of work accordingly and no claim or compensation due to any reason whatsoever will be entertained on this account.

14 EQUIVALENCY OF STANDARDS

Wherever reference is made in these Specifications to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work to be performed or tested, the provisions of latest current edition or revision of relevant standards and codes in effect shall apply. Other authoritative standards which ensure a substantially equal or higher performance than the specified standards and codes shall be accepted subject to the Engineer's prior review and approval. In the event that the Engineer determines that such proposed deviations do not ensure substantially performance, the Contractor shall comply with the standards and codes specified in the contract documents.

15 FACILITIES FOR THE ENGINEER

(1) General

The Contractor shall provide, maintain and supply services to the site office, for use of the Engineer. All facilities provided to site supervising Engineer and his staff shall be new unless otherwise specifically stated. The full details of the facilities, which the Contractor proposes to provide for the site Engineer shall be submitted for the approval within 30 days of the Letter of Acceptance.

All furniture and equipment provided by the Contractor to facilities the Clint engineer shall become the property of the Contractor at the end of the Contract.

The contractor is required to provide, furniture, equipment and to maintain office/services, equipment and other related facilities.

A typical drawing, if required, shall be provided. All rooms for the office shall be adequately ventilated and fitted with sufficient ceiling lights and power outlets.

The office shall be suitably furnished and equipped by the Contractor in accordance with the schedules. The Contractor shall be responsible for the costs of installation and maintenance of office equipment and other associated cost.

I Schedule of Office Equipment & safety gadget:

- | | |
|---|-----------------|
| a) White board and board marker | – 1set |
| b) Good quality Helmet for visitors and staff | -10Nos (white) |
| c) Gum boot (good quality) for visitors | - 10 pairs |
| d) Safety boot(Steel toe) | - 2 pairs |

II Schedule of Furniture for the Office:

| P a g e

- a) Office desk (1.5 x 0.75 m with 3 drawers) -1No

- b) Half Revolving chair with arms - 1No
- c) Meeting table (2 m x 1.2 m) -1Nos
- d) Office chair, cushioned with arms - 4Nos
- e) Book shelves (1.5 m x 2 m, 4 shelves) - 1No
- f) Office cupboard, steel (1 m wide, 4 shelves) - 1No

III Site office, Field Lab cum Camp for site Engineers

Contractor shall construct decent site office, Field Lab and camp for the site engineers as per the instruction of Project Management. The temporary huts must be installed with power points, telephone line, and toilets with proper ventilations and locking systems. As per the requirement, Project Manager will provide the drawings/sketch and contractor shall maintain the shed and shall clear all the utility bills pertains to running the site office.

Measurement and Payment

No measurement and/or payment shall be made for works required under Clause 15 of the Technical Specifications.

16 HEALTH AND SAFETY

The Contractor shall take due care and ensure that first aid room are available at the camps, housing and on the jobsite at all times throughout the period of the contract and that suitable arrangements are made for the prevention of epidemics and for all necessary welfare and hygiene requirements.

Measurement and Payment

No separate measurement and payment shall be made for the works described in this Clause.

Chapter 2: MATERIALS AND TESTING OF MATERIALS

01 SCOPE

This section covers the general requirements relating to materials; the specific requirements for basic materials and the tests and methods of testing which are required for the selection and quality control of materials.

02 QUALITY OF MATERIALS

The materials supplied and used in the works shall comply with the requirements of the Technical Specifications. They shall be new, except as provided elsewhere in the contract or permitted by the Engineer - in writing. The materials shall be manufactured, handled and used skillfully to ensure completed works to comply with the contract.

03 SOURCES OF MATERIALS

The use of any type of material from more than one source is prohibited, except by written permission of the Engineer. Such permission, if granted, shall set forth the conditions under which the change may be made. If the product of any source proves unacceptable, the Contractor shall make necessary arrangements for the supply of acceptable material. Any claims for compensation associated with such arrangements or changes shall not be considered.

04 INSPECTION AND ACCEPTANCE OF MATERIALS

Final inspection and acceptance of materials shall be made only at the site of the work. The Engineer reserves the right to sample, inspect, and test the materials throughout the duration of the Works and to reject any materials which are found to be unsatisfactory. The Contractor and Clint Engineer shall strictly follow the system of joint sampling and testing for material/ works as per normal format.

A preliminary inspection of materials may be made at the source for the convenience and accommodation of the Contractor, but the presence of a representative of the Engineer shall not relieve the Contractor of the responsibility of furnishing materials complying with their Specifications.

The Engineer shall have free entry at all times to those parts of any plant which concern production of the materials ordered.

09 SIEVES

IS sieves shall be used for all tests. Based on IS-460 the standard sieves series shall be used. Where test methods specify a non-standard sieve, results may be interpolated from the grading graph. In addition, sieves of other test standards shall be used as required in the Technical Specifications.

10 STONE, AGGREGATE, SAND AND FILLERS

(1) Sampling and Preparation of Samples

Sampling shall be carried out as per IS code and the samples shall be prepared in accordance with IS 2386 or according to sampling procedures specified for the Standard Methods of testing given in Table 2.2.

(2) Standards Methods of Testing

Tests on stone, aggregate, sand and filler shall be performed in accordance with the standard procedures given in the Table 2.2. The type of tests shall be as directed by the Engineer.

Table 2.2: Tests Procedures Applicable to Stone, Aggregate and Fillers

| Tests | Test Procedure |
|---|-------------------------------|
| Determination of: | |
| a) Particle Size Distribution (Gradation) | IS 2386 Part 1 |
| b) Clay, Silt, Dust in Aggregates | IS 2386 Part 2 |
| c) Flakiness Index | IS 2386 Part 1 |
| d) Specific Gravity | IS 2386 Part 3 |
| e) Moisture Content | IS 2386 Part 3 |
| f) Bulk Density, Voids & Bulking | IS 2386 Part 3 |
| g) Mica Content | Manual mineralogical counting |
| h) Water Absorption | IS 2386 Part 3 |
| i) Crushing Ratio | |
| k) Los Angeles Abrasion | |
| l) AIV - ACV | |

11 CEMENT

Ordinary Portland Cement (OPC) shall be sampled according to IS 3535 and tested according to IS 4031. The requirements on their physical characteristics shall be as given in Table 2.3.

Table 2.3: Requirements on the Physical Characteristics of Cement

| S.N. | Physical Characteristics | OPC | Test Procedure |
|------|--|-----|----------------|
| i) | Fineness, m ² /kg: (by Blaine's Air Permeability method) | 225 | IS-4031 Part 2 |
| ii) | Setting Time : | 45 | |
| | (a) Minimum Initial Setting Time (minutes) (b) Maximum Final Setting Time (minutes) | 600 | IS 4031 Part 5 |
| iii) | Soundness by Lechatelier method, mm, maximum | 10 | IS 4031 Part 3 |
| iv) | Compressive Strength : | | |
| | Minimum Average Compressive Strength of three mortar cube(N/mm ²) (a) 3 days | | |

| | | | |
|--|-------------|----|----------------|
| | (b) 7 days | 16 | IS 4031 Part 6 |
| | (c) 28 days | 22 | |
| | | 33 | |

12 CONCRETE

Sampling and testing on concrete shall be carried out in accordance with the standard methods given in the Table 2.4. The type of tests shall be as specified by the Engineer.

Table 2.4: Tests Procedures Applicable to Concrete

| Tests | Test Procedures |
|--|-----------------|
| Determination of : | |
| (i) Compressive strength of concrete cubes | BS 1881-116 |
| (ii) Water absorption | BS 1881-122 |
| (iii) Mixing and sampling fresh concrete in laboratory | BS 1881-125 |
| (iv) Normal curing of test specimens (20o C method) | BS 1881-111 |
| (v) Making test cubes from fresh concrete | BS 1881-108 |

The test specimens shall be cured at a temperature of $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

13 REINFORCING STEEL

All reinforcement for use in the Works shall be tested for compliance as specified in a Laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. In addition to the testing requirements described above, the Contractor shall carry out additional testing as instructed by the Engineer.

14 BRICKS

Bricks shall conform to the requirements of IS 1077.

1 General

Bricks required for brick work in cement mortar shall be adequately soaked in water before use. Brickwork shall be laid in English bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closures, in such cases, shall be cut to the required size and used near the ends of the walls.

A layer of mortar shall be spread on full width over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. On the completion of course, all vertical joints shall be fully filled from the top with mortar.

Joints: Brick shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 10mm. All face joints shall be raked to a minimum depth of 15mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where, plastering or pointing is not required to be done the joints shall be struck flush and finished at the time of laying.

Curing: Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days.

2 One Brick Masonry/Half Brick Masonry

The specification shall be same as explained above in general brick works. However, in special cases like one/half brick walls for water tanks and long length of half brick thick walls etc. where reinforcement is considered necessary from structural consideration, the same shall be provided at required intervals and the cost of reinforcement shall be paid for separately.

3 Water proofing materials: Water proofing materials shall be added in the cement mortar according to the specifications of manufacturer.

4 Brick/GRC Cornices

The cornice at each floor level shall conform in all respects to the approved design and made as per the direction of the Engineer. The plastered brickwork /GRC works shall conform to the dimensions and shape of the approved design. Care must be taken to maintain proper line and level.

5 Pointing on Brick Masonry

Preparation of Surface: The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm.

Application and Finishing: The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall be then finished with the proper tool, in the manner described below:

Flush Pointing: The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

Ruled Pointing: The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued until a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

Raised and Cut Pointing: Raised and cut pointing shall project from the wall facing with its edges cut parallel as so to have uniformly raised band about 6 mm raised and width 10 mm or more as directed.

The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean.

Curing: The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages. The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in random rubble masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

Chapter 3: QUALITY CONTROL

01- QUALITY CONTROL

This Section covers the Quality Control System and procedures; Quality Assurance Plan; program of tests; trials; and general procedures for acceptance as well as laboratory arrangements and related facilities which are required for the selection and control of the quality of materials and workmanship.

02 CONTRACTOR RESPONSIBLE FOR THE QUALITY OF THE WORKS

All materials incorporated and all workmanship performed shall be strictly in conformity with the requirements of the Technical Specifications and the Contractor shall be responsible for the quality of the works in the entire construction within the contract.

Laboratory equipment operated by competent staff for carrying out tests required for the selection and control of the quality of materials and for the control of workmanship in accordance with these Specifications. The Contractor shall assume that tests shall be required on all materials to be used in the works and on all finished works or part of works.

03 QUALITY CONTROL SYSTEM

The Quality Control System comprises the methods, procedures and organization for the Quality Control of the works. The Contractor shall implement the Quality Control System in the following sequences:

In certain circumstances, tests may be carried out at the place of manufacture as per the Conditions of Contracts. Before commencement of the work, the Contractor shall demonstrate a trial run of all construction equipment for establishing their capability to achieve the laid down specifications and tolerances to the satisfaction of the Engineer.

04 QUALITY ASSURANCE PLAN

The Contractor shall submit to the Engineer for his approval, the Quality Assurance Plan (QAP) which shall be based on the detailed Program of the Works as the Technical Specifications.

The Contractor shall monitor and update the QAP on the basis of the decisions taken at the periodic review meetings or as directed by the Engineer and in accordance with the program of the works.

05 TESTING PROCEDURES AND SET OF TESTS

For ensuring the quality of the work, the materials and the workmanship shall be subjected to testing in accordance with procedures, sets of tests and frequencies as specified and respective Sections of these Specifications. The specified testing frequencies are not restrictive. The Engineer shall direct for the tests to be carried out as frequently as deemed necessary that the materials and workmanship comply with their Specifications.

Where no specific testing procedure is mentioned in the Specifications, the tests shall be carried out as per the prevalent accepted engineering practice or directions of the Engineer.

06 LABORATORY TRIALS TO CONFIRM COMPLIANCE WITH SPECIFICATIONS

(1) Concrete

Laboratory trials for concrete mixes as specified shall be carried out by the Contractor to demonstrate that the composition of the mixes proposed for the concrete meets the requirements of the Technical Specifications.

The compositions of concrete mixes which meet the specified requirements and are accepted by the Engineer shall be then used for mass concreting

07 SITE TRIALS OR TRIAL SECTIONS

(1) Concrete

Site trials for concrete mixes as specified shall be carried out by the Contractor to demonstrate the suitability of his mixing equipment. During the site trials, compliance with the Specifications for weighing equipment, storage of ingredients, means of transport for concrete, placing, compaction and curing shall be checked by the Engineer.

08 FIELD LABORATORIES

(1) Scope

This Clause covers the laboratories as required for testing of materials as part of quality control for the construction works executed under the contracts for the project. The following laboratory provision will be required to cover the quality control of construction materials.

1.1 Establishment of Field Laboratory

The Contractor shall establish a small and affordable field laboratory. The laboratory shall be manned by the contractor with suitable laboratory technicians. The space should be adequate to provide testing facilities for construction works. As required, the space shall be partitioned to provide rooms/space for testing, sample preparation, sample storage.

The Contractor shall give the following consideration to the preparation of space for laboratory. Sufficient power for lighting and other electrical appliances and test apparatus shall be provided.

All the establishment cost shall be deemed to be included in his overhead cost and no additional claim shall be entitled.

(2) Laboratory Equipment

All equipment necessary for testing of materials and workmanship shall be deemed to form part of the permanent works unless otherwise provided in the contract. It shall be delivered to the site in accordance with the schedule of requirements for such equipment described in the contract. However the non-inclusion of any item of such equipment in the schedule of requirements shall not relieve the Contractor of the responsibility to supply if it is required for the proper control of the quality of the materials and/or workmanship, notably when identified in the list of appropriate equipment to be supplied Table 2.0 : Schedule of Laboratory Equipment

| Sl. No | Item Description | No. of Items |
|--------|------------------|--------------|
|--------|------------------|--------------|

| | | |
|----|---|--------|
| 1. | Concrete Test and Slump Cone Apparatus | |
| | - Cube Moulds (150 mm) | 9 nos. |
| | - Cube mould (50mm) | 3Nos |
| | - Slump cone apparatus | 2 nos. |
| | - Tamping rod (16 mm dia) | 2 nos. |
| | - Steel ruler (calibrated) | 2 nos. |
| 2. | Compression Testing machine set (hand driven), 100 tons | Nil |
| 3. | Flakiness and Elongation Index | |
| | - Set of Flakiness and Elongation gauges | 1 no. |
| 4. | Balances: (as specified) | |
| | a) Electronic Balance, 500 gm nominal capacity, 0.01 g accuracy | 1 no |
| | b) Electronic Balance, 2500 g nominal capacity, 0.1g accuracy | 1 no |
| | c) Electronic balance with carrying case, 10 kg, 0.1 g accuracy | 1 no |
| 5. | Glassware: (as specified) | 2 no. |
| | a) Flat bottom flasks 500 ml b) Volumetric Flask, 500 ml | 2 no |
| | c) Graduated glass beakers (100 ml - 1000 ml) | 3 no |
| | d) Measuring cylinder (100 ml - 1000 ml) | 3 no |
| | e) Spring balance (100Kg) | 1 No |
| | f) Measuring glass cylinder 250ml | 4Nos |
| | g) Sprit level 1 mtr length | 4Nos |

(3) Ownership

Testing equipment and furniture procured for field laboratory shall become the property of the Contractor upon completion of the project and contractor is instructed to include the cost in his bid and no separate payment shall be made.

(4) Serviceability

The Contractor shall maintain all laboratory equipment in good working condition throughout the period of the contract at his own expense. Testing apparatus shall be maintained in serviceable condition and all measuring and control equipment will be checked and calibrated from time to time, as required by the Engineer, and immediately adjusted or replaced if it is found that correction is not possible. Any equipment, which become unserviceable during use shall be repaired or replaced by the Contractor at no extra cost to the Employer. The Contractor shall provide all tools, accessories, services for utility, communication, consumable items for testing and operating, and all the assistance as may be required by the Engineer and his staff for measuring and checking the works.

(5) Testing

Without relieving the Contractor of any of his responsibility for the testing of materials the Engineer may as and when he desires carry out any of the tests specified above using the facilities. The Engineer may order the Contractor to carry out additional laboratory tests in an independent laboratory, as deemed necessary.

For all testing which cannot be carried out in the field Laboratory, the Contractor shall be responsible for arranging for such testing to be carried out at an independent laboratory to be approved by the Engineer. The Contractor shall be responsible for all attendance on staff from these approved testing laboratories, including if necessary the provision of transport for personnel, equipment and test specimens. No testing by external laboratories shall be carried out without the written instruction of the Engineer.

Measurement and Payment

No separate measurement and/or payment shall be made for the above work. All costs in connection with the quality control test equipment and the test specified herein shall be considered included in the related items of the works.

Chapter 4: EARTHWORKS

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction in accordance with requirements of these specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling of suitable cut materials as required, to sites of embankment and sub-grade construction, and also the disposal of unsuitable cut materials in specified manner, trimming and finishing to specified dimensions or as directed by the Engineer. The excavation shall be done manually or by mechanical means as directed by Engineer in charge considering feasibility, urgency of work, availability of labor/mechanical equipment and other factors involved.

Classification of materials for purpose of manual excavation shall be as follows:

Ordinary Soil – Generally any soil which can be excavated by the ordinary application of pick and shovel, rake or any other ordinary digging equipment; such as vegetable or organic soil, turf gravel, sand, silt loam, clay, peat etc.

Hard Soil – Generally any soil which requires close application of picks or jumpers or scarifiers to loosen; such as stiff clay, gravel, cobble stone, water bound macadam and soling of roads.

Ordinary Rock: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means of excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level. If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as “Hard Rock”.

Hard Rock : Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

Hard Rock (blasting prohibited): Hard rock requiring blasting as described above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

Marshy Soil: This shall include soils like soft clays and peat excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

For machine excavation, materials shall be classified as follows:

All types of soil: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton soil, moorum, shingle, river or nallah bed boulders, soling of roads, paths etc. and hard core macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to the application of picks, shovels, jumpers, scarifiers, ripper and other manual digging implements.

All types of rock which include the above mentioned categories of rocks.

Authority for classification: Engineer shall decide the classification of excavation, and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

Setting out: After the site has been cleared (as per the specifications in Chapter 2), the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawing or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of the benchmarks and other marks and stakes as long as they are required for the work in the opinion of the Engineer.

The ground levels shall be taken at 5m to 15m intervals in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. These plans shall be drawn to a suitable scale with North direction line and the position of benchmark invariably shown on it. The contractor and the Engineer shall sign the plan before the earthwork is started. The contractor shall, at his own expense, supply the labour required for taking levels.

Stripping and storing topsoil: When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to the specified depths and stockpiled at designated location for re-use in covering embankment slopes, cut slopes, and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with the approval of the Engineer.

Excavation: All excavations shall be carried out in conformity with the directions laid hereinunder and in a manner approved by the Engineer. The works shall be so done that the suitable materials available from excavation are satisfactorily utilized as agreed upon beforehand.

While planning of excavation, the Contractor shall take adequate precautions against soil erosion, water pollution etc. and take appropriate drainage measures to keep the sites free of water.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawing or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the levels/dimensions specified on the drawing shall be made good at the cost of the Contractor with the suitable material of characteristics similar to that removed and compacted.

All debris and loose materials on the cut slopes shall be removed. No backfilling shall be allowed in order to obtain the required slopes excepting that when boulders or soft materials are encountered in the cut slopes, these shall be excavated to the approved depth on instructions of the Engineer and the resulting cavities filled with suitable materials and thoroughly compacted in an approved manner.

After excavation, the sides of the excavated areas shall be trimmed and contoured to minimize erosion and ponding, allowing natural drainage to take place. If trees were removed, new trees shall be planted as per the direction of the Engineer. The cost of planting the new trees shall be deemed to be incidental to the work.

Methods, tools and equipment: Only such methods, tools and equipment as approved by the Engineer shall be adopted for the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of the work. Methods, tools and equipment to be adopted for the work shall be such which will not affect the property to be preserved.

Rocks excavation: Rocks when encountered in the road excavation shall be removed up to the formation level or as otherwise indicated on 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 operations shall be so carried out that at no point on cut

formation the rock protrudes above the specified level. Rocks and large boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in full formation width including drains and cut through the side drains.

Slopes in rock cutting shall be uniform lines corresponding to the slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which moves when pierced by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out as per the RGOB blasting manual and all precautions indicated therein observed.

Marsh excavation: The excavation of soils from marshes/swamps shall be carried out as per the programme approved by the Engineer. Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of back filling. The method and sequence of excavating and back filling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits called for on the drawings or as staked by the Engineer, and to the bottom of the marsh, firm support or levels indicated.

Blasting: The contractor shall obtain a licence from the competent authority for obtaining and storing the explosives. The contractor shall procure the explosives, fuses, detonators etc. from the Government or as per the provision in terms and condition of the contract. The Engineer or his representative shall have the right to check the contractor's store and accounts of explosives. The contractor shall provide facilities for this.

All blasting work shall only be done under careful supervision of trained personnel and the contractor shall take all precautions as per rules for blasting operations.

The Contractor shall ensure safety measures for every worker present, through the provision of personal protective equipments. The contractor shall be responsible for any damage arising out of accident to the workmen, public or property due to storage, transportation and use of explosive during blasting operations.

- *Earth work in excavation over areas, exceeding 300mm in depth, 1.5m in width as well as 10 sqm in area on plan, including disposal of excavated earth within 50m lead and 1.5m lift and disposed soil to be levelled and neatly dressed.*

EW0031 All types of Soil

Measurements: The length and breadth shall be measured correct to 10 mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The area shall be worked out to the nearest two places of decimal in square metres.

Rates: The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rates shall also include, where necessary:

- Disposing of the cleared materials with all lifts and lead up to 50m;
- Bailing out or pumping of water in excavations from rains, subsoil water etc.;
- Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, removal of which if necessary, shall be arranged by the Engineer.

EW0195 Filling of trenches, sides of foundations, under floors in ground floor etc. in layers not exceeding 200mm in depth using selected available excavated materials including consolidating each deposited layer by ramming, watering etc. within lead 50 m & lift 1.5m

Earth used for filling shall be free from stone, shingle or boulder larger than 75 mm in any direction and salts, organic or other foreign matter. Normally excavated earth from the same area shall be used for filling. However if such earth contains deleterious material, it shall not be used. All clods of earth shall be broken or removed.

The spaces around the foundations pipes and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers, not exceeding 200mm in each layer. Each layer shall be watered, rammed and consolidated before the succeeding one is laid. Earth shall be rammed with iron rammers where feasible and with the butt-ends of crowbars where rammer cannot be used. Special care shall be taken that no damage is caused to the pipes, drains and masonry or concrete in the trenches, under floor, etc.

Measurements: The cubical contents of foundation concrete and masonry in foundation up to ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations to arrive at the quantity for filling sides of foundation. For filling in plinths and under floors, depth shall be the consolidated depth.

Rates: The rates shall cover the cost for carrying out all the required filling operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

Chapter 5: DRAINAGE

- *Constructing random rubble masonry open surface drain in cement mortar 1:6 including earth work in excavation, 100mm thick concrete base 1:5:10, 40 mm aggregate 25mm thick cement concrete 1:2:4, 12mm aggregate for filling haunches, including 20mm cement plaster with a floating coat of neat cement and disposal of surplus earth complete*

DR0032 250mm wide x 300mm depth

The open surface drains shall be of the size as specified in the item and laid to such gradients and in such locations as may be shown in the relevant drawing or as directed by the Engineer.

The width of the drain at the top shall be as specified, measured between the finished walls. The drain shall be given, as far as possible, uniform slope from the starting point to the discharge point.

Measurement: The drain shall be measured in running meters, correct to 10mm.

Rate: The rate shall include the cost of labour and materials involved in excavation, concreting, masonry, plastering, finishing etc. required for the item. Suitable deduction or extra payments on “per meter additional depth” basis shall be made in case there is a variation in average depths from those stated above.

Chapter 6: CONCRETE WORK

Water, Cement, fine aggregate and coarse aggregate shall conform to material specifications. Concrete can be specified by proportions or by nominating the required strength.

Concrete shall be prepared by mixing graded stone aggregate or gravel of normal size as specified with fine aggregate and cement in specified proportions with required quantity of water.

Proportioning: It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 x 25 x 40cm deep or as otherwise approved by the Engineer. The unit of measurement for cement shall be a bag of 50 kg and this shall be taken as 0.035cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand allowance for bulkage shall be made by adopting the method prescribed under IS 2386 (part III).

Mixing: It shall be done in mechanical mixer. Mixing by hand shall be employed only in special cases with the specific prior permission of the Engineer-in-Charge. Stone aggregate shall be washed with water to remove dirt, dust or any other foreign materials, where necessary.

Machine Mixing: The mixer drum shall be flushed clean with water. Measured quantity of dry coarse aggregate shall be followed with measured quantity of fine aggregate and then cement. In case damp sand is used, add half of the quantity of coarse aggregate followed by cement and sand. Finally add balance quantity of the coarse

aggregate. The skip shall be raised and dry materials slipped into the drum. The dry materials shall be mixed for at least four turns of the drum, after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution with the dry material. The total quantity of water for mixing shall be introduced before 25% of mixing time has elapsed and shall be regulated to achieve the specified water cement ratio. The complete contents of the mixed concrete shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean.

Mixing time: The materials shall be mixed for a period of not less than 2 minutes and until a uniform colour and consistency is obtained. The time shall be counted from the moment all the materials have been put into the drum.

Hand Mixing: Hand mixing shall be done on a smooth, clean and water-tight platform of suitable size in the following manner.

- (a) Measured quantity of sand shall be spread evenly
- (b) The cement shall be dumped on the sand and distributed evenly
- (c) The sand and cement shall be mixed intimately with spade, turning the mixture over and over again, until it is of even colour throughout and free from streaks
- (d) The sand cement mixture shall be spread out and measured quantity of coarse aggregate shall be spread on its top. Alternatively the measured quantity of coarse aggregate shall be spread out and the sand cement mixture shall be spread on its top.
- (e) The above materials shall be mixed at least three times by shovelling and turning over by twist from centre to side, then back to the centre and again to the sides.
- (f) A hollow shall be made in the middle of the mixed pile.
- (g) Three quarters of the total quantity of water required shall be added while the material is turned in towards the centre with spades. The remaining water shall be added by a water-can fitted with rose head, slowly turning the whole mixture over and over again until a uniform colour and consistency is obtained throughout the pile.
- (h) The mixing platform shall be washed at the end of the day.

Consistency: The quantity of water to be used for each mix of 50kg cement, to give the required consistency shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 27 litres for 1:1 1/2:3 mix and 25 litres for 1:1:2 mix. In the case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests.

The following slumps shall be adopted for different kinds of works:

Table 5.6.1 SLUMPS FOR DIFFERENT KINDS OF WORK

| Works | Slump in mm | |
|--|---------------|-------------------|
| | Vibrator Used | Vibrator not used |
| Mass concrete in foundation footings, retaining walls and pavement | 10-25 | 50-75 |
| Thin sections of flooring less than 75 mm thickness | 25-40 | 75 -100 |

The entire concrete used in the work shall be laid gently (not thrown) in layers not exceeding 150mm and shall be thoroughly vibrated by means of mechanical vibrators till a dense concrete is obtained. The Engineer may however relax the condition specifying use of mechanical vibrators at his discretion for certain items depending upon the thickness of the members and feasibility of vibrating the same and permit hand compaction. Hand

compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked into the corners of the formwork. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. For items where the vibrators are not to be used, it shall be the duty of the contractor to take the permission of the Engineer before the start of work.

During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. Please see specifications relating to cold weather concreting Reinforced Cement Concrete. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C.

When the placing of concrete is suspended, necessary removal of laitance and roughening the surface for jointing future work shall be done before the concrete sets. When the work is resumed the previous work must be thoroughly cleaned, roughened, watered and a grout of neat cement slurry of the proportion, 1 Kg of cement per 2 litres of water applied uniformly.

Curing: Green work shall be protected from rain by suitable covering. The work should also be protected from damage and rain during construction.

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected with moist gunny bags, sand or any other material approved by the Engineer against quick drying. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with wet absorbent materials. The curing shall be done for a minimum period of 14 days. In special cases, curing may have to be done for more number of days as required by the Engineer.

Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued along with the masonry work for minimum period of 14 days.

Where cement concrete is used as sub-grade for flooring, the flooring may be commenced before the curing period of sub-grade is over but the curing of sub-grade shall be continued along with the top layer of flooring for a minimum period of 14 days.

The water used for curing shall not produce any objectionable stains or unsightly deposit on concrete surface. In special circumstances and locations curing by other means such as sealing material insulating blankets etc. may be adopted with the specific prior approval of the Engineer.

The minimum compressive strength of mix 1:1.5 :3 and 1 :2 :4 shall be as follows:

Table 5.6.2 MINIMUM COMPRESIVE STRENGTH

| | Compressive strength in kg/sq.cm at 28 days Mix | |
|---------|--|------------|
| | At 7 days | At 28 days |
| 1:1.5:3 | 175 | 265 |
| 1:2:4 | 140 | 210 |

- *Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level*

CW0005 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)

- *Providing and laying in position plain cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets etc. upto floor five level, excluding the cost of centering and shuttering*

CW0022 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)

Length and breadth shall be measured correct to a 10 mm. The thickness of slab, partitions, etc. and the like shall be measured correct to the nearest 5mm.

The consolidated cubical contents shall be calculated net nearest to 0.01cu.m. Concrete laid in excess, of the sections shown in the drawing unless directed by the Engineer shall not be measured.

No deduction shall be made for:

- (a) Ends of dissimilar materials (e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, step etc.) upto 500 sq.cm in section.
- (b) Opening up to 0.1m² or as specified.
- (c) Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq.cm each in cross sectional area.
- (d) Volume occupied by reinforcement;

Rate: The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

Chapter 7: REINFORCED CONCRETE

The concrete shall be as specified under concrete works. Concrete shall be always mixed by mechanical mixer unless otherwise the Engineer permits hand mixing.

Consistency: The concrete, which will flow sluggishly into the forms and around the reinforcements without any segregation of coarse aggregate from the mortar, shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped. It shall be determined by slump test as prescribed in IS 1199. The slumps of concrete for different types of works shall be as given below, unless otherwise specified:

Table 5.8.1 SLUMPS OF CONCRETE FOR DIFFERENT TYPES OF WORK

| Sl.No | Types of Work | Slump in mm | |
|-------|---|----------------|--------------------|
| | | Vibrators used | Vibrators not used |
| 1 | Mass concrete in R.C.C foundation footings, and retaining walls | 10 - 25 | 80 |
| 2 | Beams, slabs and columns simply reinforced | 25 - 40 | 100 – 125 |
| 3 | Thin R.C.C section or section with congested steel | 40 - 50 | 125 - 150 |

- Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level

RC0001 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)

Concreting shall be commenced only after the Engineer has inspected the centering, shuttering and reinforcement as placed and passed the same.

In case of concreting of slabs and beams; wooden plank or cat- walks supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

In case of columns and walls, it is desirable to place concrete without construction joints. The programme of concreting in the vertical direction shall be restricted to one metre per hour. The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings, concrete shall be placed through chutes as directed by the Engineer. In case of columns and walls the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 meters at a time.

Cold weather concreting: During cold weather, as a rule concreting shall not be done when the temperature falls below 4.5 degrees Celsius. However in circumstances where it becomes necessary to deposit concrete at or near freezing temperatures, precautions shall be taken to ensure that at the time of placing it has a temperature of not less than 4.5 degree Celsius and that this temperature is maintained till the concrete is compacted and it is thoroughly hardened. When necessary, the ingredients shall be heated before mixing and concrete carefully protected after placing; in general heating water alone to about 60 degree Celsius may be sufficient for this purpose. Dependence shall not be placed on salt or other chemicals for the prevention of freezing. (Use of calcium chloride to accelerate the rate of hardening is not permitted as it is considered harmful). Concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

Hot weather concreting: During hot weather, precaution shall be taken to see that the temperature of wet concrete does not exceed 38 degrees Celsius. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer. It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

Concrete shall be compacted into a dense mass immediately after placing, by means of mechanical vibrators designed for continuous operation. The Engineer may however, relax this condition at his discretion for certain items, depending on the thickness of members and feasibility of vibrating the same, and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the formwork. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation, such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the center of vibrations approximates to the center of the mass being placed at the time of compacting.

Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. In case both internal and external vibrators are being used the internal vibrators shall first be withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

Construction joints: Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown in Structural drawing or as indicated in this specification or as directed by the Engineer. Such joints shall be kept to the minimum and shall not be located in valleys. The joints shall be kept at places where the shear force is the minimum and these shall be straight and at right angles to the direction of main reinforcement.

In case of columns, the joints shall be horizontal and minimum of 20 cm below the bottom of the beam running into the column head. The portion of the column between the stopping off level and the top of the slab shall be concreted with the beam. When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop-board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set. When the work has to be resumed, the joint shall be thoroughly

cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75kg of cement per square meter shall then be applied on the roughened surface before fresh concrete is laid.

Expansion Joints: Expansion Joints shall be provided as shown in the structural drawings or as directed by the Engineer including all formwork and labour necessary to form.

Curing: After the concrete has begun to harden i.e. about 1 to 2 hours after it's laying, it shall be protected from quick drying with moist gunny bags, sand or any other material approved by the Engineer. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with wet absorbent material. The curing shall be done for a minimum period of 14 days.

Finishing: In case of roof slabs, the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set.

Immediately on removal of forms, the Engineer shall examine the R.C.C. work before any defects are made good such as:

- a) The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural concept shall be rejected.
- b) Surface defect of a minor nature may be accepted. On acceptance of such work by the Engineer, the same shall be rectified as follows:
 1. Surface defects which require repair when forms are removed usually consist of bulges due to movement of forms, ridges at form joints, honeycombed areas, damage resulting from the stripping of forms, and bolt holes. Bulges and ridges are to be removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly undercut to provide a key at the edge of the patch.
 2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layer not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing, or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.
 3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.
 4. Holes left by bolts are filled with mortar carefully packed into place in small amounts. The mortar is mixed as dry as possible with just enough water so that it will be tightly compacted when forced into place.
 5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motorcars.
 6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this effect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.
 7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started, as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane-curing compound in these cases will come in most convenient.

- c) The surface, which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered it shall be cleaned and wetted so as to give good bond between concrete and plaster. The R.C.C. work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6mm.
- d) The surface of R.C.C. slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done carefully without disturbing the concrete.

Measurement: Dimensions shall be measured nearest to 10mm, except for the thickness of slab which shall be measured to nearest 5mm. The areas shall be worked out to nearest 0.01 square metres. The cubic contents shall be worked out to nearest 0.01 cubic metres.

Work under the following category shall be measured separately.

- a) In foundation upto floor one level.
- b) From floor one level to floor two level.
- c) From floor two level to floor three level and so on-
- d) R.C.C. above roof level shall be measured along with the R.C.C. work in floor just below. No deduction shall be made for the following:
 - a) Ends of dissimilar materials (e.g. joints, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 500sq.cm in cross-section.
 - b) Opening upto 0.1 sq.m

Note: In calculating area of opening upto 0.1 sq.m the size of opening includes the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.

- c) The volume occupied by reinforcement.
- d) The volume occupied by pipes, conduits, etc. not exceeding 100sq.cm each in cross-sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.
- e) Small voids not exceeding 40 Sq.cm each in cross-sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

Measurements shall be taken before any rendering is done in the concrete members. The measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

- a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face of the beam.
- b) Beams shall be measured from face to face of columns and shall include haunches, if any, between columns and beams. The depth of the beam shall be from the bottom of slab to the bottom of beam, if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of the beam shall be from the top of the slab to the bottom of the beam.
- c) The columns shall be measured from top of column base to underside of the first floor slab and subsequently from top of floor slab to underside of the floor slab above. In case of columns for flat slabs, flare of column shall be included with column for measurement.
- d) Chajja shall be measured inclusive of bearing. But when Chajja is combined with lintel, slab and beam, it shall be measured as clear portion. Whenever vertical fins and chajjas combined, chajjas shall be measured clear between fins. The vertical fins shall be measured through.
- e) The filling of expansion joints with bitumen filler, bitumen felt or any such material and the provision of copper or brass plate for covering, etc., shall be measured in running metres.

Rate: The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centring and shuttering unless otherwise mentioned in the item.

Note: The 28 days cube test shall be the basis of determination of strength for R.C.C. work. Concrete that is less than the required strength shall not be accepted unless otherwise stated.

Chapter 8: REINFORCEMENT

RC0083 Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete

The type and grade of reinforcement to be used shall be as indicated on the drawings. Where this information is not given on the drawings, hot rolled deformed bars having yield strength of 500 Mpa shall be used. Bars shall be bent cold (no heating shall be permitted), correctly and accurately to the size and shape as shown on the detailed drawings or as directed by the Engineer. Preferably, bars of full length shall be used and within the following tolerances:

Table 5.8.2 TOLERANCES ON DIMENSIONS OF REINFORCEMENT BAR

| Sl. No | Dimension | Tolerance |
|--------|-------------------------|-----------|
| 1 | Length of straight bars | ± 25 mm |
| 2 | Location of splices | ± 50 mm |
| 3 | Length of lap splices | ± 50 mm |

Minimum clear cover shall be as indicated on the drawings. Where cover is the drawings, it shall be in accordance with the following: not indicated on

Table 5.8.3 MINIMUM CLEAR COVER FOR REINFORCEMENT

| Sl. No | Location | Clear cover |
|--------|-----------------------------|-------------|
| 1 | Slabs | 20 mm |
| 2 | Beam – main reinforcement | 30 mm |
| 3 | Beam – stirrups | 20 mm |
| 4 | Column – main reinforcement | 40 mm |
| 5 | Column - ties | 20 mm |
| 6 | Footings | 75 mm |

Overlapping of bars shall be as indicated on the drawings. The overlapping bars shall not touch each other and these shall be kept apart by 25 mm or 1.25 times the maximum size of the coarse aggregate whichever is greater, with concrete between them. But where this cannot be done, the overlapping shall be bound together at intervals not exceeding twice the dia. of such bars, with two strands of annealed steel wire of 0.90 mm to 1.6 mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points, along the span, where neither shear nor bending moment is maximum. Where lap length is not explicitly shown on the drawings, the length shown in the following table shall be used:

Table 5.8.4 LAP LENGTH OF THE REBAR

| Sl. No | Bar size | Lap length |
|--------|----------|------------|
| 1 | 10 mm | 300 mm |
| 2 | 12 mm | 350 mm |
| 3 | 16 mm | 600 mm |
| 4 | 20 mm | 900 mm |
| 5 | 25 mm | 1100 mm |

The ends of rods shall be bent in to semicircular hooks, having clear diameter equal to four times the diameter of the bar, with a length, beyond the bend equal to four times the diameter of the bar. End hooks may, however, not be provided for cold twisted, hot rolled and CRS bars.

***Note:** Welding should not be used unless absolutely necessary. Reinforcement bar does not weld very well and the resulting splice can be a weak spot. Binding is better as welding can produce a reduction in strength as well.*

Reinforcement bars shall be placed in position as shown in the drawings. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.90 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during the deposition of concrete.

The bars shall be kept in position by the following methods:

- In case of beam and slab construction, pre-cast cover blocks in cement mortar 1:2 (1 cement: 2 coarse sand), about 4cm x 4cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.
- In case of cantilevered and double layer reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chain spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.
- In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them, or with block of cement mortar (1:2) suitably tied to the reinforcement.
- In case of other R.C.C. structure such as arches, domes etc, cover blocks, spacers and templates shall be used as directed by the Engineer.

Measurement: Reinforcement including authorised spacer bars and laps shall be measured in lengths of different diameters, as actually used in the work nearest to 10mm and their weight calculated on the basis of standard tables. Wastage and un-authorised overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement. Wherever welding is resorted to in lieu of over laps such welds shall be measured separately in members for different size of reinforcement.

Rate: The rate of reinforcement shall include the cost of labour and materials as required for all operations described above except welding in lieu of over laps, which shall be paid for separately. No separate payment will be made for concrete spacer blocks, timber templates, tie wire or any other accessories required for the performance of the work.

Chapter 9: Formwork

Providing & fixing formwork (centering and shuttering) including strutting, propping etc. and removal of formwork

RC0090 *Foundation and plinth etc.*

Propping and Centering: Props used for centering shall be of steel, timber posts, ballies or any other material approved by Engineer. Use of brick masonry pillars in mud mortar shall also be permissible. In no case ballies shall be of diameter less than 100mm measured at mid length and 80mm at thin end. Maximum permissible spacing shall be 1.2m center to center. Ballies shall rest squarely on wooden sole plates of 40mm thickness and minimum bearing area of 0.1sq.m laid either on ground or on 40 x 40cm brick masonry pillars in mud mortar of height not exceeding 40cm. Double wedges shall further be provided between the sole plates and the wooden props so as to facilitate tightening and easing of shuttering without jarring the concrete. In case brick masonry pillars of adequate section are used instead of props, wooden sole plates shall be provided at the top of pillars and double wedges inserted between the sole plate and the bottom of shuttering.

Formwork and concreting of upper floor shall not be done until concrete of lower floor has set for at least 28 days. In case of balconies and cantilever beams, coming one above the other, the members being cast shall be supported by props on two floors below the floor where initial supporting has been done. Ballies shall rest squarely on wooden sole plates of 40mm thickness and with minimum bearing area of 0.1sq.m.

The details of formwork stated above shall be applicable for spans of 4.50m and height upto 3.50 metres. In case any of these limits is exceeded the formwork shall be properly designed for the self-weight, weight of reinforcement, weight of fresh concrete, various live loads imposed during the construction process (such as workmen and equipment). Dumping of concrete, movement of construction equipment and action of the wind may produce lateral forces which must be resisted by the form work to prevent lateral failure for which suitable horizontal as well as diagonal bracings shall be provided. The permissible stresses in bending, buckling load of props, permissible deflection of shuttering should not be exceeded.

In case the height of centering exceeds 3.50 meters, the props may be provided in multi-stages. Before the concreting is started, the props and wedges shall be thoroughly checked to see that these are intact, and take suitable action in case these are loose. While the concreting is in progress, at least one carpenter shall be readily available at the site. The carpenter shall keep a constant watch on the props and take immediate remedial measures, as soon as any of these get loosened. Care shall be taken that props and wedges do not get loose for a minimum period specified in Table 5.8.5.

Shuttering: The shuttering shall have smooth and even surface and the joints shall not permit leakage of cement grout. Timber used shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the cement surface of concrete. It shall not be so dry as to absorb water from concrete and swell and bulge, or so green or wet as to shrink after erection. Species of timber that are not affected appreciably by its contact with water shall be used. The timber shall be accurately sawn and planed on the sides and the surface coming in contact with concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.

Wooden formwork with metal sheet lining or steel plates stiffened by steel angles shall also be permitted. Where metal forms are used, all bolts and nuts shall be countersunk and well ground to provide a smooth plane surface.

The chamfers, bevelled edges and mouldings shall be made in the formwork itself. Opening for fan clamps and other fittings connected with services shall be provided in the shuttering as directed by the Engineer-in-charge. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn. Use of double head nails shall be preferred.

Surface Treatment for Shuttering: The surfaces of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution, raw linseed oil, form oil of approved manufacture or any other approved material (such as polythene/polyethylene sheets), to prevent adhesion of concrete to form work. Soap solution, for the purpose shall be prepared by dissolving yellow soap in water to get the consistency of paint. Inside surfaces of forms shall be thoroughly cleaned before application of any of the materials mentioned above. Release agents shall be applied strictly in accordance with the manufacturers' instructions and shall not be allowed to come in contact with any reinforcement. Re-use of the shuttering shall be permitted only after the inside surface has been thoroughly cleaned in the manner described above.

Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and accept the form work as to its strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of workman, machinery, materials and for results obtained.

Camber: Suitable camber shall be provided in horizontal members of structures, especially in long spans to counteract the effects of deflection. The formwork shall be so assembled as to provide for such camber. The camber for beams and slabs shall be 4mm per metre (1 in 250) or as directed by the Engineer, so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50th of the projected length or as directed by the Engineer.

Special Formwork: For special type of work-locations like tall structures etc. use of special types of formwork like moving or climbing forms shall be permitted. The details of such formworks alongwith the sequence of working shall be got approved from the Engineer before their erection.

Removal of Form Work: No formwork or any part thereof shall be removed without prior approval of the Engineer. The formwork shall be so removed as not to cause any damage to concrete due to shock or vibration. In a slab and beam construction, sides of beam shall be stripped first, then the under sides of slab and lastly the underside of the beam. Formwork must be so designed that they can be stripped in the order required i.e.

- a) Shutters to vertical (non load bearing) faces e.g. column boxes, beam sides, wall forms,
- b) Shutters forming soffits to slabs, horizontal and inclined which carry only light load, e.g. slabs, roofs, floors and canopies etc.
- c) Soffit shutters carrying heavy load e.g. beam and girder bottoms.

The whole of the formwork should be planned and a definite scheme of operation worked out. In no circumstances should forms be struck until the concrete reaches strength of atleast twice the stress to which the concrete may be subjected at the time of striking. Where possible the formwork should be left longer as it would assist curing. Forms should be eased carefully in order to prevent the load being suddenly transferred to concrete. The period that shall elapse after the concrete has been laid, before easing and removal of centering and shuttering is undertaken shall be as given in Table below:

Table 5.8.5 MINIMUM PERIOD FOR REMOVAL OF FORMWORK

| Type of formwork | Minimum period before striking formwork |
|--|---|
| Vertical formwork to columns, walls and beams | 16 – 24 h |
| Soffit formwork to slabs (props to be re-fixed immediately after removal of formwork) | 3 days |

| | |
|--|---------|
| Soffit formwork to beams (props to be re-fixed immediately after removal of formwork) | 7 days |
| Props to slabs spanning upto 4.5 m | 7 days |
| Props to slabs spanning over 4.5 m | 14 days |
| Props to beams and arches spanning upto 6 m | 14 days |
| Props to beams and arches spanning over 6 m | 21 days |

Note 1: For rapid hardening cement, 3/7 of the above periods will be sufficient in all cases, except for vertical sides of slabs, beams and columns which should be retained for atleast 24 hours.

Note 2: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 3: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all cements in cold weather.

Note 4: Work damaged through premature or careless removal of forms shall be reconstructed.

Measurements: Where it is stipulated that the formwork shall be paid for separately, measurement shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to 10mm. The measurements shall be taken separately under each of the items mentioned above.

Centring and shuttering where exceeding 3.5 metres height in one floor shall be measured and paid for separately.

Where it is not specifically stated in the description of the item that formwork shall be paid for separately, the rate of the R.C.C. item shall be deemed to include the cost of formwork.

No deductions from the shuttering due to the openings/ obstructions shall be made if area of such openings/obstructions does not exceed 0.1sq.m. Nothing extra shall be paid for forming such openings.

Rate: The rate of formwork includes the cost of labour, materials tools and plant required for all the operations described in this section including properly supporting the members until the concrete is cured, set and hardened as required. No separate payment shall be made for items such as form release agent, connections, provisions for openings and other items required for the completion of the work unless specified otherwise.

Chapter 10: STONE WORK

Providing & laying Random Rubble Masonry with hard stone in foundation & plinth

SM0005 *In cement mortar 1:4*

SM0006 *In cement mortar 1:5*

Dressing: Stones shall be hammer dressed, on the face, the sides and the beds, to enable it to come into close proximity with the neighboring stone. The bushing in the face shall not project more than 4 cm in an exposed face, and one cm on a face to be plastered. The hammer dressed stone shall have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of stone.

Laying: Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Stones may be brought to level courses at plinth, windowsills and roof level. Levelling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar as used for the masonry and two parts of graded stone aggregate of 20mm nominal size and shall be included in the items. The bond shall be obtained by fitting in closely, the adjacent stones and by using bond-stones. Face stones shall extend and bond well into the backing. These shall be arranged to-break joints as much as possible, and to avoid long vertical lines of joints.

Curing: Masonry work in cement or composite mortar shall be kept constantly moist on all face for a minimum period of seven days. In case of masonry with fat-lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

Protection: Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

Measurement: The length, height and thickness shall be measured correct to 10 mm. The thickness of wall shall be measured at joints, excluding the bushings. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metre nearest to two places of decimal.

The work under the following categories shall be measured separately:

(i) From foundation to plinth level.

(i) Work in or under water and/or liquid mud (ii) Work in or under foul positions.

(ii) From plinth level to floor two level.

(iii) From floor two level to floor three level and so on.

- (iv) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

No deduction shall be made nor extra payment made for the following:

- (a) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 0.1 sq.m in section.
- (b) Openings each upto 0.1 sq.m in area. In calculating the area of opening, any separate lintels or sills shall be included alongwith the size of the openings but the end portions of the lintels shall be included and the extra width of rebated reveals, if any, shall also be excluded.
- (c) Wall plates and bed plates, and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof slabs shall be deducted from wall masonry.

- (d) Drain holes and recesses for cement concrete blocks, to embed holdfasts for doors, windows etc.
- (e) Building in the masonry iron fixture, pipes upto 300 mm dia. hold fasts of doors and windows.
- (f) Forming chases in masonry each upto section of 350sq.cm. Masonry (excluding fix brick work) in chimney breasts, chimney stacks, smoke or air flues upto 0.20 sq.m in sectional area, shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 0.20sq.m sectional area, deduction shall be made for the same pargetting and coring flues paid for separately. Apertures for fireplaces shall not be deducted and extra labour shall not be measured for splaying of jambs throating and making arch to support the opening.

Rate: The rate shall include the cost of materials and labour required for all the operations described above and shall include the following:

- (a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.
- (b) Preparing tops and sides of existing walls, for raising and extending.
- (c) Rough cutting and waste for forming gables, cores, skewbacks, and spandrels of arches, splays and eaves and all rough cutting unless or otherwise specified.
- (d) Bond stones or cement bond blocks.
- (e) Leaving and making holes for pipes etc.
- (f) Bedding and pointing wall plates, lintels, sills etc. in or on walls, bedding roof tiles and corrugated sheets in or on walls.
- (g) Building in ends of joints, beams, lintels, etc. and making good; and
- (h) Openings and flues for which no deduction is made.

SM0072 *Providing and laying Hand packed stone filling or soling with stones*

Stones as obtained from the quarry shall be packed with their broader surface as base. The packing shall be as dense as possible and the interstice shall be filled with small stones. The height of stones shall be as per the thickness of soling required. The stones shall be arranged neatly and the joints shall be as thin as possible.

Measurements: The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

Rate: The rate shall include the materials and labour involved in all operation described above.

Chapter 11: STEEL WORK

Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and applying priming coat of red lead paint SW0020 In R.S. joists

SW0021 In Tees, angles, flats and channels

Laying out: It shall be as specified in riveted and bolted built-up section above.

Fabrications: Straightening, shaping to form, cutting and assembling shall be as for riveted and bolted as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be made for the bolts used for temporary fastening as shown in drawings.

Welding: Welding shall generally be done by electric process. The electric arc method is usually adopted and is economical. Where public electricity is not available, generators shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Engineer. Gas welding shall not be permitted for structural steel work. Gas welding requires heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses. The work shall be done as shown in the shop drawings, which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shop drawings shall be according to IS:813.

As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia. of electrodes for welding any work shall be as under unless otherwise specified.

Chapter 12: STEEL & OTHER METAL WORK

Table 5.12.1 MAXIMUM DIAMETER OF ELECTRODES FOR WEILDING

| Average thickness of plate or section | Maximum diameter of electrodes to be used |
|---------------------------------------|---|
| Less than 5 mm | 3.2 mm |
| 5mm to 7 mm | 4 mm |
| 8mm to 9 mm | 5 mm |
| 10mm to 15 mm | 6 mm |
| 16mm to 24 mm | 9 mm |
| 25mm and over | 9 mm |

Surfaces, which are to be welded together, shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil may be permitted.

Precautions: All operations connected with welding and cutting equipment shall conform to the safety requirements given in IS:818 for Safety requirements and Health Provision in Electric and gas welding and cutting operations.

Assembly: Before welding is commenced the plate shall first be brought together and firmly clamped or spot-welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance.

Erection: The specifications shall be as described above in riveted and bolted section except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the framework until the joints are welded. Such means shall consist of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially examined and provisions made to cater for such forces. Different members those are to be fillet welded shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm. If gap exceeding 1.5 mm or more occurs locally, the size of fillet weld shall be increased at each position by an amount equal to the width of the gap.

Measurements: The method of measurement shall be as described above in riveted and bolted section except that the weight of welding material shall not be added to the weight of members for payment. Nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

Rate: The rate shall include the cost of all labour and materials involved in all the operations described above.

- Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and applying priming coat of red lead paint

SW0022 *In Tubular sections*

Fabrication: The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and is so prepared that the specified cambers, if any, are maintained.

Straightening: All material before being assembled shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

Bolting: Washers shall be specially shaped where necessary, or other means used, to give the nuts and the heads of bolts a satisfactory bearing. In all cases where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together, and washers of appropriate thickness shall be provided to allow the nut to be completely tightened.

Welding: Where welding is adopted, it shall be done as per the relevant Indian standard.

Caps and Bases for Columns: The ends of all the tubes for columns, transmitting loads through the ends, should be true and square to the axis of the tube and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

Sealing of tubes: When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube should be dry and free from loose scale.

Flattened Ends: In tubular construction the ends of tubes may be flattened or otherwise formed to provided that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

Hoisting and Erection: Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workmen. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes, etc. shall be used.

Measurement: The work as fixed in place shall be measured in running metres correct to 10 mm and their weights calculated on the basis of standard tables in kilogram correct to two places of decimal, unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective item unless otherwise specified. No deductions shall be made for skew cuts.

Rate: The rate shall include the cost of labour and materials involved in all the operations described above including one coat of approved steel primer.

Chapter 12: ROAD WORK

RW0108 Construction of lined V-shaped drain 600X300 with 50mm thick PCC 1:2:4, 150mm thick stone soling, RRM in CM 1:5 on sides, finished with 20mm thick 1:4 cement plaster including excavation, levelling and disposal of surplus earth within 50m

Trenches shall be made along the edge of the road where the drain is to be constructed. The excavation shall be done exactly to the required profile giving specified slope. The surface shall be levelled to uniform grade/level and rammed. The drain shall be maintained throughout the construction and defect liability period therefore the contractor shall keep provision in his rates for such maintenance and nothing extra shall be paid.

For the lined drain the relevant specification for concreting, soling and plastering shall be followed. The surface of the concrete shall be finished smooth. Any rough surface shall be made smooth by adding dry mix of cement and sand 1:3 (1 cement: 3 sand) on the surface immediately after concreting when the concrete is still green. No extra shall be paid for such finishes. All work shall be carried out as per the drawing and specification or as directed by the Engineer.

QA/QC

- Check the slope of the drain; it should be uniform to avoid ponding.
- The size of the drain shall not be more than the specified size.
- In case of earth drain, it shall be made by excavation and compaction of sides and bottoms, neatly finished. If the drain is made by filling, the filled earth shall be compacted as per the specification for embankment and filling.
- In case of lined drain sufficient time should be given to set and hardened the concrete before allowing the water to flow.
- All concrete and masonry work shall be thoroughly cured not less than 28 days.

Measurement: The length shall be measured in running meter correct to 10mm.

Rates: The rates shall include the cost of all material and labour involved in the above operation.

- Preparation of sub grade by excavating earth to depth equal to the pavement thickness, consolidation with roller, disposal of surplus earth up to 50m

RW0121 All kinds of soil

Preparation of sub-grade: The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It

shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

If sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operations, an insulation layer of granular materials or over size brick aggregate not less than 10 cm thick of suitable thickness shall be provided for blanketing the sub-grade.

In slushy soil or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

Consolidation: The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All the undulations in the surface that developed due to rolling shall be made good with material or quarry spoils as the case may be and the sub-grade is re-rolled.

Surface Regularity: The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified in the table below: **Table 5.21.8 PERMISSIBLE TOLERANCES OF SURFACE REGULARITY**

| Longitudinal profile | | Cross profile | |
|---|-------|---|--|
| Maximum permissible undulation with a 3 m straight edge | | Maximum permissible variation from specified when measured profile when measured with a camber template | |
| 24 mm | 15 mm | | |

When the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall rectify these with fresh material or quarry spoils as the case may be, and the sub-grade re-rolled to the satisfaction of the Engineer.

Measurement: The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal.

Rate: The rate shall include the cost of materials and labour required for all the operations mentioned above, unless specified otherwise.

RW0130 Providing and laying Granular sub-base course (GSB) to required degree of compaction with proper formation of cross fall using motor grader for laying and compacted to required density as per material gradation and aggregate quality specified

Scope: This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the engineer.

Materials: The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall

be free from organic or other deleterious constituents and conform to one of the three grading given in table 5.21.7 below.

Table 5.21.9 GRADING FOR CLOSE GRADED GSB MATERIALS

| sieve IS sieve Designation | % by weight passing the IS | | |
|----------------------------|----------------------------|------------|-------------|
| | 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 |
| Min. CBR Value | 30 | 25 | 20 |

Table 5.21.10 GRADING FOR COARSE GRADED GSB MATERIALS

| IS sieve Designation | % by weight passing the IS sieve | | |
|----------------------|----------------------------------|------------|-------------|
| | Grading I | Grading II | Grading III |
| 75.0 mm | 100 | | |
| 53.0 mm | | 100 | |
| 26.5 mm | 55 – 75 | 50 – 80 | 100 |
| 9.50 mm | | | |
| 4.75 mm | 10 – 30 | 15 – 35 | 25 - 45 |
| 2.36 mm | | | |
| 0.425 mm | | | |
| 0.075 mm | <10 | <10 | <10 |
| Min. CBR Value | 30 | 25 | 20 |

Note: The material passing 425 micron sieve shall for all the three gradings when tested shall have liquid limit and plasticity index not more than 25 and 6 % respectively

While the grading in table 5.21.7 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm. The corresponding grading for the coarse graded materials for each of the three maximum particle sizes are given at table 5.21.8. The grading to be adopted for the project shall be as specified in the contract.

Physical Requirements: The materials shall have a 10 percent fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS: 812(Part 111). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to the site as per IS: 383. For grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

Strength of sub-base: It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests as required on specimens remolded at field dry density and moisture content and any other tests for the “quality” of the materials, as may be necessary.

Construction operations

Preparation of subgrade: Immediately prior to the laying of the sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80- 100 KN smooth wheeled roller.

Spreading and Compacting: The sub-base material of grading specified in the contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and the grade during the operation or other means as approved by the engineer.

When the sub-base materials consist of combination of materials mentioned above, mixing shall be mechanically done by the mix-in place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, Trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720(Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water for uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed mechanical or other approval means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 225 mm the compaction shall be done with the help of a vibratory roller of a minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m² or equivalent capacity roller capable of achieving the

required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super-elevation and shall commence at the edges and progress towards the centre for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km per hour.

Rolling shall be continued till density is at least 98% of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

Measurements for payment: GSB shall be measured as finished work in position in cubic meters. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular subbase and as such no extra payment shall be made for the same.

Rate: The contract unit rate for granular sub-base shall be payment in full for carrying out the required operations.

RW0131 Providing and laying wet mix macadam graded aggregate base course to required degree of compaction with proper formation of cross fall by using well graded crushed aggregates premixed with OMC using suitable mixer, motor grader as per material gradation and aggregate quality specified

Scope: This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/subbase/base or existing pavement as the case may be in accordance with the requirements of these specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. when vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200mm upon approval of the engineer.

Materials:

Aggregates:

Physical Requirements: Coarse aggregates shall be crushed stone. If Gravel/shingle is used, not less than 90% by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces. The aggregate shall conform to the physical requirements set forth in the table 5.21.9 below.

Table 5.21.11: PHYSICAL; REQUIREMENTS OF COARSE AGGREGATE FOR WMM FOR THE SUB-BASE BASE COURSE

| Test | Requirements |
|---|--|
| *Los Angeles abrasion value test or | 40 percent maximum |
| Aggregate impact value test | 30 percent maximum |
| Combined flakiness and elongation | 30 percent maximum** indices(combined) |
| *Aggregates may satisfy the requirements of either of the two tests | |

***To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone divided by weight of stone sample. Only the elongated particles be separated out from the remaining non-flaky stone metal. Elongation index is the weight of elongated particles divided by total nonflaky particles. The value of flakiness index and elongation index so found are added up.*

If the water absorption value of the coarse aggregates is greater than 2 percent, the soundness test shall be carried out on the material delivered in the site as per IS: 2386 (part

5)

Grading Requirements: The aggregates shall conform to the grading given in the table 5.21.10

Table 5.21.12 GRADING REQUIREMENTS OF AGGREGATES FOR WMM

| IS sieve Designation | % 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 micron | 8 – 22 |
| 75 micron | 0 – 8 |

Materials finer than 425 micron shall have plasticity index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse o fine and shall not vary form the low limit on one sieve to the high limit on the adjacent sieve and vice-versa.

The aggregates can also conform to the grading given in the table below:

Table 5.21.13 GRADING REQUIREMENTS OF AGGREGATES

| Sieve | Percentage by mass of total aggregate passing test sieve | | |
|--------------|---|--------------|--------------|
| | Nominal maximum particle size | | |
| | 37.5 mm | 28 mm | 20 mm |
| 50 | 100 | | |
| 37.5 | 95-100 | 100 | |
| 28 | | | |
| 20 | 60-80 | 70 -85 | 90-100 |
| 10 | 40-60 | 50 – 65 | 60-75 |
| 4.75 | 25 – 40 | 35 – 55 | 40 – 60 |

| | | | |
|--------------------|---------|---------|---------|
| 2.36 | 15 – 30 | 25 – 40 | 30 – 45 |
| 0.425 | 7-19 | 12 – 24 | 13 – 27 |
| 0.075 ¹ | 5 – 12 | 5 – 12 | 5- 12 |

Note: 1. For paver laid materials lower fines content may be accepted

Construction Operations

Preparation of Base: The base of the sub-grade/sub-base/base shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

Preparation of lateral confinement of aggregates: While constructing WMM, arrangement shall be made for the lateral confinement of wet mix. This shall be done laying materials in adjoining shoulders along with that of WMM layer.

Preparation of Mix: WMM shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part 8) after replacing the aggregate fraction retained on 22.4mm sieve with material of 4.75mm to 22.4mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread by motor grader. For portions where mechanical means cannot be used, manual means as approved by the engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of roller shall not exceed 5km/h.

In portions having a unidirectional cross fall/super-elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the center

line of the road, uniformly overlapping each preceding track by at least one-third width until the entire surface had been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the center parallel to the centerline of the road uniformly overlapping each of the preceding track by at least one third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching on an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling shall not be done when the subgrade is soft yielding or when it causes a wave like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceeds 123 mm when tested with a 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed materials be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material.

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

Setting and Drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hrs.

Opening to traffic: No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

Measurement for payment

WMM shall be measured as finished work in position in cubic meters.

Rates: The unit rate for WMM shall be payment in full for carrying out all the required operations.

- Providing and laying Asphalt/Bituminous Concrete to required degree of compaction based on the job mixture design approved by the supervising engineer using asphalt plant, paver, steel roller, tyre roller etc. as per material gradation and aggregate quality specified

RW0141 35 mm

Scope:

This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

Materials

Bitumen: The bitumen shall be paving bitumen of penetration grade complying with IS Specification for paving Bitumen, IS: 73 or otherwise as specified in item. Where modified bitumen is specified, it shall conform to the requirements of IRC: SP: 53 and IS: 15462.

Coarse aggregates: The coarse aggregates shall be generally as specified for DBM, except that the aggregates shall satisfy the physical requirements of Table 5.21.19.

Table 5.21.22 PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR BITUMINOUS CONCRETE PAVEMENT LAYERS

| Property | Test | Specification |
|------------------------|---|--------------------------------|
| Cleanliness (dust) | Grain size analysis | Max. 5% passing 0.075 mm sieve |
| Particle shape | Flakiness and Elongation Index | Max. 30% (Combined) |
| Strength | Los Angeles Abrasion Value Aggregate | Max. 30% |
| | Impact Value | Max. 24% |
| Polishing | Polished Stone Value | Min. 55 |
| Durability (Soundness) | Sodium Sulphate | Max. 12% |
| | Magnesium Sulphate | Max. 18% |
| Water Absorption | Water Absorption | Max. 2% |
| Stripping | Coating and Stripping of Bitumen Aggregate Mixtures | Minimum retained coating 95% |
| Water Sensitivity | Retained Tensile Strength | Min. 80% |

Fine Aggregates: The fine aggregates shall be as for DBM.

Filler: Filler shall be generally as specified for DBM. Where the aggregates fail to meet the requirements of the water sensitivity test, then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

Aggregate grading and binder content: When tested in accordance with IS:2386 Part I (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in table 5.21.20 for grading 1 to 2 as specified in the contract.

Table 5.21.23 COMPOSITION OF BITUMINOUS CONCRETE PAVEMENT LAYERS

| Grading | | 1 | | 2 | |
|-----------------|------------------------|---|-------|---------|---------|
| | Nominal aggregate size | 19 mm | 13 mm | | |
| Layer thickness | 50 – 65 mm | 30 – 45 mm | | | |
| | IS Sieve (mm) | Cumulative % by weight of total aggregate passing | | | |
| 45 | - | - | | | |
| 37.5 | - | - | | | |
| 26.5 | 100 | - | | | |
| 19 | 79 - 100 | 100 | | | |
| 13.2 | 59 - 79 | 79 - 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 | 5.0 - 6.0 | 5.0 - 7.0 |
| | Bitumen Grade (pen) | 65 65 |

Mixture Design

Requirements for the mixture: Apart from the conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 5.21.15.

Binder Content: The binder content shall be optimized to achieve the requirements of the mixture set out in table 5.21.21 below, and the traffic volume as specified in the contract. **Table 5.21.24**
REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

| | |
|--|--|
| Minimum stability (KN at 60°C) | 9.0 |
| Minimum flow (mm) | 2 |
| Maximum flow (mm) | 4 |
| Compaction level (Number of blows) | 75 blows on each of the two faces of the specimen. |
| Percent air voids | 3-6 |
| Percent air voids in mineral aggregate (VMA) | see table 5.21.16 |
| Percent air voids filled with bitumen (VFB) | 65 - 75 |
| Loss of stability on immersion in water at 60°C (ASTMD 1075) | Minimum 75 percent retained strength. |

The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

Job mix formula:

The procedure for formulating the job mix formula shall be generally as specified in DBM and the results of tests enumerated in table 5.21.21 as obtained by the contractors.

Plant trials – permissible variations in job mix formula:

The requirements for the plant trials shall be all as specified for DBM, and permissible limits for variation as shown in Table 5.21.17 in DBM **Laying trials:**

The requirements for laying trials shall be all as specified for DBM.

Construction operations

The methodology and plant to be used for the whole project should be based arrived after plant and laying trials for the job mix ratio, which should be based on a correct and truly representative sample of the materials that will actually be used in the work, and that its different ingredients satisfy the physical and strength requirements of these specifications.

Weather and seasonal limitations: The provisions as in DBM shall apply.

Mixing and transportation of the mixture: The provisions as specified in DBM shall be applied.

Spreading: The general provisions as in DBM shall apply, as modified by the approved laying trials.

Measurement: The measurement shall be as specified in DBM.

Rate: The contract unit rate shall be all as specified in DBM, except that the rate shall include the provision of bitumen at 5.0 percent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

RW0145 Scarifying metalled (water bound) road surface including disposal of rubbish lead up to 50 meters and consolidation with road roller of the aggregate received from scarifying.

Preliminary Work: All dirt, dust, cracked up mud, slush, animal droppings, vegetation and all other rubbish shall be removed from the water bound macadam surface.

Scarifying: The macadam surface shall be scarified to a depth of approximately 5 cm with such additional picking of high parts of the road as may be necessary to the required camber and gradient as directed by the Engineer. Any hollows that remain after picking shall be filled with new aggregate 50 mm nominal size and well consolidated to bring the surface to template.

Finishing: The scarified aggregate shall be raked to bring smaller stones on the top and surface brought to the required camber and gradient with tolerance of 12 mm longitudinally as well as transversely. All rubbish etc. shall be disposed off as directed by the Engineer. Scarifying operation will also include consolidation with road roller aggregate received from scarifying although this aggregate will be consolidated along with aggregate of new wearing course to be paid separately.

Measurement: The measurement of the finished work shall be taken in sq.m. Length and breadth shall be measured correct to 10mm between the kerb or channel stones or brick edging etc. as the case may be.

Rate: The rate shall include the cost of labour and materials involved in all the operations described above except the cost of stone aggregate which shall be paid for separately.

RW0179 Providing seal coat of premixed sand with bitumen VG - 10 using 128 kg of bitumen and 0.75 cu.m of coarse sand per 100 sq.m of road surface complete

Preparation of premix: The sand shall be dry and suitably heated to temperature as directed by Engineer. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer avoiding local overheating and ensuring a continuous supply. The heated sand and bitumen are thoroughly mixed with the help of mixer. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheelbarrows. The vehicles employed for transport shall be cleaned and be covered over in transit if so directed.

Spreading and rolling: The premixed sand shall be spread on the carpet to the required thickness and distributed evenly with the drag spreader, without any undue loss of time. The surface should then be rolled with power roller 6 to 9 tonne capacity.

Measurements: The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in sq.m, correct to two places of decimal.

Rate: The rate shall include the cost of materials and labour involved in all the operations described above.

- *Providing & fixing G.I chain-link excluding the cost of posts, struts, earthwork excavation, concrete which is to be paid for separately.*

RW0209

4mm (8 SWG) x 50mm

Fencing with RCC or iron angle posts: The spacing of posts shall be 3.0m centre to centre of the posts, unless otherwise specified. The minimum length of posts shall be 1.8 m or as specified in the description of the item and that of struts being minimum 2.0 m.

Spacing of struts: Every 15th, last but one end post and corner post shall be strutted on both sides and end post on one side only.

Fixing of posts and struts: Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated, true to line and level to receive the posts. In case of struts pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The portion of the posts and struts to be embedded in concrete shall be coal tarred two coats before fixing while the visible portion shall also be coal tarred two coats unless otherwise specified after fixing barbed wire. Struts shall be fixed to posts by means of spikes of suitable size. The pits shall be filled with a layer of 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The posts and struts shall then be placed in the pits, the posts projecting 1.2 m or to the specified height above ground, true to line and position and cement concrete 1:5:10 filled in up to 15 cm for posts and 25 cm for struts below ground level to the top of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x 60 cm and struts in block of size 70 x 45 x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer and site cleared.

Fixing of mesh: The mesh shall be stretched and fixed to posts by means of G.I. staples in case of R.C.C posts and to the iron angle posts it shall be fixed by appropriate welding. The mesh shall be fixed at every 30 cm or as directed by the Engineer.

The mesh shall be painted with aluminum paints unless otherwise specified or directed. Before the paint is applied the mesh shall be cleaned off any rust, etc.

Measurement: The length and breadth of the mesh shall be measured correct to a cm for the finished work and area calculated correct to two places of decimal from center to center of the posts.

Rate: The rate shall be in sq.m of the wire mesh fixed to post including fixing of post, staples etc. complete but excluding the cost of posts, struts, and excavation, concrete in foundations for which separate payments shall be made under respective items.

Chapter 13: OCCUPATIONAL HEALTH AND SAFETY

OHS001 Incorporation of Occupational Health and Safety measures at construction sites as per the attached requirements list. The standards and specifications for the Insurance, OHS materials and (or) equipment shall be in compliance with the Labour and Employment Act - 2007, Regulation on Occupational Health, Safety and Welfare - 2012, and other relevant national documents. All OHS items will remain as the property of the bidder upon completion of the project.

The following list of OHS inputs are the minimal mandatory requirements at a construction site. These requirements had been derived in consensus with the Department of Labour (DoL), Ministry of Labour and Human Resources (MoLHR).

1. Insurance

Every worker shall be insured for the entire period of construction. The capital sum to be insured shall be as per the requirements of Labour and Employment Act of Bhutan - 2007 and its regulations.

2. Personal Protective Equipment (PPE)

Every worker shall be provided with minimal PPE to minimize exposure to hazard and to ensure safety at the construction sites “at all times”. The PPE could be grouped and provided as below:

- ☐ To be provided to all:
 - Safety helmet
 - Safety shoes
 - Protective gloves
 - High visibility Vest
 - Dust mask
- ☐ To be provided to specific workers: ¹
 - Safety belt
 - Safety harness
 - Safety goggle and spectacle
 - Ear muffs
 - Ear plugs
 - Welding shield/glass

3. Common Protection Measures (CPMs)

- First Aid tool box with aid kits
- Medical examination and records
- Adequate safety signs and signboards
- Boundary fence/barricade
- Fire and electrical safety
- Fall protection (scaffolding and safety net)
- Trained OHS Officer/ Safety Supervisor/Safety Representative ²
- Trained first aider ³
- Safety and health orientation to new workers and safety training
- Housekeeping
- Traffic management at construction site
- Trenching and excavation safety

3. The standards and specifications for the OHS materials and (or) equipment shall be in compliance with the Labour and Employment Act - 2007, Regulation on Occupational Health, Safety and Welfare - 2012, and other relevant national documents.

4. The list of the OHS requirements as per the above list with additional list (if any) shall be attached along the Bill of Materials (BoM) along with an appropriate item description to allow the bidder to quote reasonably against the item, and to enable strict compliance and ease the monitoring during the project implementation time.

5. The procuring agency may allow the reuse of OHS items so long as these reused items serve the intended purpose. Furthermore, all OHS items will remain as the property of the bidder upon completion of the project. This is to encourage the bidders to conscientiously assess the OHS cost and quote reasonably keeping in view the reusability of such items in later projects.

6. Procuring agencies may also include the OHS officer and the first aider as ‘key personnel’ required by Labour and Employment Act – 2007 and its regulations depending on the complexity of the project.

7. Monitoring: Once OHS is integrated into the project cost and the work awarded, the contractor will have to mandatorily mobilize the resources. The site engineers and the respective Procuring Agencies will have to monitor and ensure that the OHS requirements are provided by the contractor at site and used appropriately “at all times”. Besides this regular monitoring, a Third-Party monitoring of OHS will also be carried out by the Construction Development Board and the Ministry of Labour from time to time.

8. Mode of Payment: It is recommended that the payment mode be designed to suit the procuring agency. Before making the payment, the project engineer/site engineer and the project manager should verify and confirm that the OHS input requirements have been mobilized and implemented at site. It is also recommended that the payment be made in phases depending on the nature and duration of the project.

9. No additional payment for OHS shall be made for Variations (Change of rate, time extension, deviation, price adjustment, additional works, etc.)

¹ Specific workers include (but not limited to) those workers working at height, welders, workers engaged in works with high noise level, etc.

² This requirement will only come into effect after the DoL and CDB starts the required training. The site engineer/project manager of the contractor can be OHS officer after getting trained.

The site supervisor or one of the workers can be the first aider after getting trained