

MODULE – 3 (a)**SPECIFICATION**

3.1. Definition

Specification is a statement of particulars for execution of any item of work. It describes the nature and the class of the work, materials to be used in the work, the workmanship and the tools and plants which are required to complete an engineering project in accordance with its drawing and details. Specifications are written by experts of a particular field.

3.2. Necessity of Specification

A specification is a statement of particulars. An engineering specification contains the details about nature and class of the work, quality of the material to be used, workmanship and tools and plants required for the project. The drawings show the proportions and relative positions of the various components of the structure. It is not possible to furnish the information on the drawings regarding the quality of materials to be used and the quality of workmanship to be achieved during construction, due to shortage of space. Thus details regarding materials and workmanship are conveyed in a separate contract document which is known as the specifications of the work. In general, the drawings showed what is to be done, whereas the specifications state how it is to be accomplished.

3.3. Importance of Specification

- The specification describes the quality and quantity of a materials, workmanship and equipment required for execution of the project and hence it directly affects the cost of the project. Moreover, it allows the contractor to make programs for their procurement beforehand.
- Specification provides specific guidelines for the workmanship and the method of doing work. Thus, it serves as a guideline for supervising staff to execute the work.
- Specifications enable the employer to check the quality of the materials and workmanship.
- The contractor bids the tender as per the specification and is paid as per the tendered price. Any change in specification changes the tender rate.

3.4. Legal Aspects of Specifications:

- Specifications form a part of contract document, without which the contract document becomes invalid. On each page of the specifications both the parties *i.e.*, owner and contractor should sign so that these specifications, where clear instructions, regarding the quality and procedure of works etc., are given will be binding on both the parties.
- If any dispute arises between the parties, the specifications will help the arbitrator or the court to settle the dispute. If the contractor's work deviates from the specifications, he will be liable for penalty.

- The specification also mentions the mode of measurements, quality and procedure of item, which is binding on both the parties to adhere to it. The contractor cannot ask for extra measurements or owner cannot give less measurements.
- The general character and the scope of the work is illustrated and defined by the specifications and signed by both parties. So it becomes a legal binding on both the parties to adhere strictly to the agreed specifications.
- In the absence of complete specification, the contractor's obligation is limited to performance of only what is called for in such incomplete specifications. As such great care has to be taken in preparing specifications.

3.5. Types of Specifications:

The specifications can be broadly classified as:

- 1) **General specification**
- 2) **Detail specification**

3.5.1 General Specification

In general specifications nature and class of the work, names of materials, and the proportions that should be used in the various items of the work are described. Only a brief description of each and every item is given. It is useful for estimating the project without going through lengthy detailed specifications. General information for the quantities of the materials nature and class of the work can be known from the general specifications, but they don't form a part of the contract document.

3.5.2 Detail Specification

The detailed specifications describe the item of work in details, accurately and complete in all respects in relation to the drawings of the works. Detailed specification for a particular item specifies the qualities, quantities and proportion of the materials and the method of preparation and execution and mode of measurements for that particular item of work in a project. The method and duration of protection of finished works as required are specified in the detailed specifications. The detailed specifications are arranged in the same sequence of order as the work carried out. The detailed specifications form an important part of contract document.

3.6. How to Write Specification

While writing specifications following principles shall be adopted:

1. **Description of materials:** The quality and size of materials required to do an item of work shall be fully described for checking up at site according to the clauses provided in the specifications. The proportion of mixing or treatment of materials if required before use shall be really described.
2. **Workmanship:** The complete description of workmanship. The method of mixing and proportion, the method of laying, preparation of base or surface, compaction, finishing and curing etc. specially applicable to the item of work shall be stated in different clauses.

3. **Tools and Plant (T&P):** The tools and plant to be engaged to carry out a work shall be described. The method of operation and by whom to be supplied shall be stated.
4. **Protection of New Work:** The method of protection of new works against damage or the method of curing if required, the test of completed work if necessary shall be described in separate clauses.
5. **Expression:** While writing a specification endeavor shall be made to express the requirements of the specification clearly and in concise form avoiding repetition and unusual words. The style of the tense shall remain same throughout. As the specifications are legal documents, terms such as suitable, proper and words having more than one meaning shall be avoided. The sentence shall be short simple and concise because fewer words will involve less risk or legal difficulty.
6. **Clauses of the specification:** As far as possible, the clauses shall be arranged in the order in which work shall be carried out. This does not mean to follow the works according to the order of arrangement, but it facilitates references. While framing the clauses for quality of materials, workmanship, tools and plants etc. practical possibilities should be realized. Correct and complete but not repeated information shall be given so that the owner and the contractor carryout the work following the specifications. Abbreviations which are familiar can be used.

3.8. General Specification of Building

Buildings are classified in four categories depending superiority of their construction specifications: Class A (First class buildings) are having highest specification while class D (fourth class) are having lowest specifications.

3.8.1 General specifications for first class building

1. **Foundation and plinth:** Foundation and plinth shall be of first class brick work in 1:6 cement mortar over 1:4:8 cement concrete.
2. **Damp proof course:** DPC shall be of 25 mm thick cement concrete (1:1.5:3), mixed with one kg of Impermo (or any water proofing material) per bag of cement.
3. **Superstructure:** Superstructure shall be of 1st class brickwork with 1:6 cement mortar. Lintels over doors and windows shall be of R.C.C.
4. **Roofing:** Roof shall be of 100 mm thick R.C.C. (1:2:4) slab with 100 mm lime terracing above over RCC lab as required. Height of the room shall not be less than 3.5 m.
5. **Flooring:** Mosaic/Marble flooring shall be provided in all floors including staircase.
6. **Finishing:** Inside and outside wall shall be finised with 12 mm cement mortar plaster (1:8). Inside shall be distempered over 2 coats of white wash. Outside shall be snowcem washed two coats over one coat of white wash.
7. **Doors and windows:** Chaukhats shall be seasoned teak wood and shutters shall be 40 mm paneled glazed. All fittings shall be provided with iron grills. All wooden and grills shall be painted with enamel paint over one coat of priming.

8. **Miscellaneous:** Rain water pipe shall be of cast iron. Building shall be provided with 1st class sanitary, water fittings and electrical installations.

3.9. Writing the Detailed Specifications for Construction Work

The detailed specifications of any work consist of two sets of provisions: General provisions and Technical provisions.

3.9.1 General provision

These are also known as conditions of contract and they apply to the work as a whole. In this document, the conditions governing the contract are written. The following groups of conditions of contract are generally accommodated under the general provisions.

- a) **Conditions a relating to documents:** These pertain to Bill of quantities and schedule of prices, Drawings, Standard specifications
- b) **Conditions relating to the general obligations of the contractor:** These pertain to, Acts, bye-laws and regulations, fencing, watching and lighting of the work spot, Insurance.
- c) **Conditions a relating to labour and personnel:** These pertain to Accidents to workmen, Contractors representative, Rates of wages paid to the employees, Removal of the employees of the contractor.
- d) **Conditions a relating to the execution of the work:** These provisions are related to Alterations, additions and omissions during the progress of work, Amount of extra items, Damages, Defective work, Work at night and on holidays, Workmanship etc.
- e) **Conditions a relating to measurements and payments:** These pertain to Method of measurement of completed works, Method of payments etc.
- f) **Conditions a relating to default and non-completion:** These pertain to Failure to complete the work in time, Right to suspend the work Time of completion etc.
- g) **Conditions a relating to settlement of dispute:** These pertain to arbitration, Jurisdiction of court etc.

3.9.2. Technical provisions

These specifications describe the technical requirements of each type of constructions. The technical provisions contain detailed instructions regarding the desired quality of the final product. The technical provisions are of three types.

a) Specifications for materials and workmanship

For materials the following properties should be included in the specifications:

- **Physical properties** such as size, shape, grade, strength, hardness etc., Chemical composition of the material, Electrical, thermal and acoustical properties, Appearance of the material

- A clear statement regarding the **inspection and procedure of test** of the material.
- For **workmanship**, the following important features should be included in the specifications; the results desired, the tools and plants to be engaged, detailed description of the construction method for each item, Instructions regarding the protection of the finished work as well as of the adjacent property.

b) Specifications for performance

These specifications are written for the overall performance of the finished product and hence they are written if the contract is for the supply of equipment and machinery such as pumps, motors etc. In these specifications, general description, design and installation and guarantee etc., of the equipment are specified.

c) Specifications for proprietary commodities

Commercial products which are standardized or patented are called proprietary commodities. The specifications written for such materials should include the name of a particular brand or firm. (eg. Sun brand, Everest brand etc.) However, it is not desirable in case of public works to specify certain trade names or brands. To avoid monopoly and favoritism, it is general practice to specify the selected brand and then it is followed by the phrase “or equal”.

3.10. Detailed Specifications of Civil Engineering Materials

3.10.1. Detailed specification for first class brick

The earth used for molding the bricks shall be free from organic matters salts and chemicals. The size, weight and colour of the burnt bricks should be uniform. The adjacent faces of the bricks are to be right angles to each other. The bricks shall be free from cracks, flaws and lumps. They should not break when dropped, from 1 meter height, on the ground. They should not absorb water by more 15 % of their self-weight when immersed in water for one hour. The average compressive strength of the bricks shall be not less than 7.5 N/mm^2 . The dry weight of one brick shall not be less than 3 kg.

3.10.2. Detailed Specification for cement

Ordinary Portland cement or rapid hardening Portland cement conforming to IS: 269 – 1989 and IS:8041 – 1990 shall be used. The fineness of the cement shall not be less than 30 minutes and the final setting time shall not be greater than 10 hours. The average compressive strength, after 7 days curing, of 1:3 cement mortar cubes shall be not less than 33 N/mm^2 (33 grade).

3.10.3. Detailed Specification for sand for mortar

The sand used for mortar shall be clean, sharp, heavy and gritty. It should be free from clay, salt, mica and organic impurities. It shall not contain harmful chemicals in any form. Medium and fine sand are to be used in mortars. Coarse sand shall be sieved through 600 micron sieve and used in mortars for plastering works.

3.10.4. Detailed Specification for coarse aggregate

The aggregate to be used in reinforced cement concrete shall be of blue granite stone, machine crushed and well graded with a nominal size of 20 mm. It shall be hard, dense, durable strong and free from flakes. The aggregate shall not contain harmful materials such as coal, mica clay, shells, organic impurities etc. The compressive strength, crushing value etc. of the aggregate shall be in accordance with the requirements of IS: 383 – 1970.

3.10.5. Detailed Specification for water for concrete

Water used for mixing and curing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water may be used for mixing concrete. The suspended organic solid matter in the water shall not exceed 200 mg/l and inorganic solid matter shall not exceed 3000 kg/l, the pH value of water shall be not less than 6. Water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds in the water is objectionable.

3.10.6. Detailed Specification for reinforcement

The reinforcement shall be of high strength deformed steel bars confirming to IS: 1786 – 1985. It should be bendable, weldable and have the modulus of elasticity not less than 200 kN/mm^2 . The yield strength of the steel used shall not be less than 415 N/mm^2 . All reinforcement bars shall be free from loose mill scales, loose rust and coats of paints, oil, mud or other coatings which may destroy or reduce bond.

3.10.7. Detailed Specification for wood for doors and windows

The wood shall be teak, well-seasoned and dry. It should be free from cracks, knots, defects and disease. It should be sawn in the direction of grains so that the edges are perfectly straight and square. The dimensions of the frames/scantlings/planks shall be as prescribed in the drawings. Patching or plugging of any kind is not permitted.

3.11. Detailed Specifications of Common Construction Works

3.11.1. Detailed specification of for earth work excavation for foundation

[**Sequence:** Leveling the surface; Dimensions; Shoring; Fencing; Dumping the soil; Water in foundation; Treatment of the bottom; Trench filling; Measurement]

a) Leveling the surface

The whole area of construction is to be cleared of trees, grass, roots of trees etc., complete and leveled horizontally to enable easy marking of centre line of the building.

b) Dimensions

The excavation shall be done in accordance with dimensions of trenches shown in the working drawings.

c) Shoring

The sides of the trenches should be vertical and the bottom of the trenches should be flat. In the case of loose soils the sides of the trenches should be shored with steel sheets.

d) Fencing

Suitable temporary fencing is to be provided around the site of excavation to avoid any accidental fall into the trenches.

e) Dumping the soil

The excavated soil is to be dumped and heaped at a minimum distance of 1.5 metre away from the trenches so that it does not slide again into the trenches.

f) Water in Foundation

Water, if any accumulated in the trench, should be pumped out without any extra payment and necessary precaution shall be taken to prevent surface water to enter into the trench.

g) Treatment of the bottom

The bottom of the trench shall be watered and compacted by ramming before the foundation concrete is laid. Excessive excavations should not be adjusted by filling with loose excavated soils. Sand or plain concrete may be used for the adjustment of levels, that too with proper compaction.

h) Trench filling

After the concrete has been laid and masonry has been constructed the remaining portion of the trench shall be filled up with earth free from rubbish and refuse materials, in layers of 15 cm and watered and well rammed.

i) Measurement

The measurement of the excavation shall be taken in cu. m. as for rectangular trench bottom width of the concrete multiplied by the vertical depth of the foundation from the ground level and multiplied by the length of trench even though the contractor might have excavated with slopping side for his convenience. The rate shall be for complete work for 30 m lead and 1.5 m lift, including all tools and plants required for completion of the works.

3.11.2. Detailed specification of for lime concrete in foundation

[**Sequence:** Lime; broken bricks; fine aggregate; proportioning; mixing; laying and compacting; curing; measurement]

a) Lime

The lime used for the concrete shall be freshly burnt and slaked. It should be free from clayey particles and ashes. Unslaked stone particles should be removed by shifting.

b) Broken bricks

The over burnt bricks and the pieces of well burnt bricks are to be broken to sizes ranging from 20 mm to 40 mm and stacked for easy measurement. The brick bats shall be free from dirt, dust, rubbish, leaf etc.

c) Fine aggregates

Surki made from well burnt brick bats is to be used as fine aggregate. It should pass through I.S. sieve no.48 and free from dust and dirt.

d) Proportioning

Lime, surki and broken bricks are to be mixed in the proportion of 1:2:5 by volume. The materials are to be measured loose without shaking or ramming.

e) Mixing

The mixing shall be done only by mechanical mixer. The broken bats are to be soaked in clean water for at least 2 hours before mixing. The materials are first mixed to get uniform distribution and then water is gradually added. The mixing process is to be continued till all the brick bats are coated with mortar uniformly and a workable concrete is obtained.

f) Laying and compacting

The concrete shall be laid to the required thickness, not more than 200 mm and a time, and compacted by ramming with rammers weighing 4.5 to 55 kg.

g) Curing

The lime concrete, so laid, is to be kept wet for at least 7 days.

h) Measurement

The measurement shall be taken in cu. m. for the finished concrete. The length and breadth shall be measured correct to 1 cm and depth correct to 05 cm.

[**Similar Item:** Detail specifications for lime concrete in roof terracing]

3.11.3. Detailed specification of random rubble masonry in foundation and basement [Sequence:

Materials; preparation of mortar; method of laying; curing; measurement]

a) Materials

The stone shall be obtained from the approved queries. It shall be sound, free from cracks and decay and shall have a specific gravity of not less than 2.5. [Include detail specification for cement and sand]

b) Preparation of mortar

The materials (cement and sand), with ratio 1:6, shall be first mixed dry thoroughly till uniform colour is obtained and then shall be mixed wet adding water slowly and gradually for at least turning three times to give uniform consistency.

c) Method of laying

The stones are to be laid on broadest face which gives better opportunity to fill the spaces between stones by the mortar. The stones are laid layer by layer with sufficient mortar in

between them for better binding. The outer face of the basement should be vertical and the joints are to be staggered. There shall be no gap, between the stones, unfilled by mortar.

d) Curing

The masonry should be kept in wet condition by sprinkling water thrice daily for at least 7 days after construction.

e) Measurement

The measurement shall be taken in cu. m. for the finished concrete. The length and breadth shall be measured correct to 1 cm and depth correct to 05 cm.

[**Similar Items:** Detail specifications for random rubble masonry in super structure]

3.11.4. Detailed specification for 1st class brickwork in super structure

[**Sequence:** Materials; preparation of mortar; soaking of bricks; method of laying; curing; scaffolding; measurement]

a) Materials

[Include detail specification for first class brick, cement, and sand]

b) Preparation of mortar

[Similar to 5.11.3, but the ratio of cement to sand is 1:3 or as specified.]

c) Soaking of bricks

Bricks shall be well soaked in water for at least 12 hours before their use, preferably in a tank provided at site of work.

d) Method of laying

Bricks shall be well bonded and laid in English bond unless specified. Every course shall be truly horizontal and shall be truly in plumb. Broken bricks shall not be used except as closers. All corners shall be truly in plumb. Mortar joints shall break for bonding and shall not exceed 10 mm in thickness. Only skilled masons shall be employed on the work. Brick shall be laid with frogs upward except in the top course. Brickwork shall be carried out not more than 1 m height at a time. When one part of the wall has to be delayed, stepping shall be left at an angle of 45° . All joints shall be raked and faces of the wall cleaned at the end of each day's work.

e) Curing

The work shall be kept well watered for at least 15 days.

f) Scaffolding

Necessary and suitable scaffolding shall be provided to facilitate the construction of brickwork. It shall be sound and strong enough to sustain all loads likely to come upon them.

g) Measurement

The measurement shall be taken in cu. m. The rate shall be for the complete work inclusive of scaffolding and all tools and plants.

[**Similar items:** Detailed specifications of 1st class brick work in foundation and plinth, 2nd and 3rd class brick work, brickwork in mud mortar and Reinforced Brick (R.B.) work.]

3.11.5. Detailed specification for Reinforced Cement Concrete

[**Sequence:** Materials; form work; proportioning; mixing of concrete; laying of concrete; curing; formwork; measurement]

a) Materials

[Include detail specification for cement, sand, coarse aggregate, water and reinforcement]

Reinforcement shall be hooked and bent (cold) and placed in position as per design and drawing and bound together tight with 20 S.W.G binding steel wire.

b) Centering and shuttering

Centering and shuttering shall be made of timber and tight with necessary wedges and sufficiently strong and sable not to yield under laying of concrete. A coat of oil washing or a thin layer of paper shall be spread to have a smooth finished surface preventing adherence of concrete.

c) Proportioning

Proportions of cement, sand and coarse aggregate shall be 1:2:4 for slab, beam and lintels and 1:1.5:3 for columns unless otherwise specified. The sand and coarse aggregate shall be measured by volume with boxed and cement by number of bags.

d) Mixing of concrete

Concrete shall be mixed by concrete mixture. Cement, sand and coarse aggregate shall be put into the as per the required proportions for one batch. The total quantity shall not exceed the manufactures rated capacity. The machine shall be revolved to mix materials dry and then water shall be added up to the required quantity. After 2 minutes rotation for through mixing, the mixed concrete shall be discharged on a masonry platform or iron sheet.

e) Laying of concrete

Concrete shall be laid gently in layers not exceeding 150 mm and compacted by wooden thapi or some mechanical vibrator until a dense concrete is obtained. While concreting, steel bars shall be given side band bottom covers of concrete by pacing the precast concrete blocks of 1:2 cement mortar 25x25 mm in section and thickness of specified cover. Concreting shall be laid continuously. If laying is suspended for rest or the following day, the end shall be slopped at an angle of 30⁰ and made rough for future jointing. When the work is resumed, the previous slopped surface shall be roughened, cleaned and a coat of neat cement paste shall be applied and then the fresh concrete shall be laid.

f) Curing of concrete

Freshly laid concrete shall be protected from rain by suitable covering. After 24 hrs of laying of concrete the surface shall be cured by flowing with water of above 25 mm depth or with covering by wet gunny bags. The curing shall be for a minimum period of 14 days or otherwise specified.

g) Removal of form work

The centering and shuttering shall be removed after 14 days of casting. It shall be removed slowly and carefully so that no part is disturbed.

h) Measurement

The measurement shall be taken in cu. m. The rate shall be for the complete work inclusive of form work and all tools and plants but excluding steel.

[**Similar Item:** detailed specification for plain cement concrete]

3.11.6. Detailed specification for damp proof course (D.P.C.)

[**Sequence:** Materials; preparation of mortar; Application of DPC; measurement]

a) Materials

Damp Poof Course shall be of plain cement concrete of 1:2:4 mix and 30 mm thickness. 12 mm size hard and dense stone chips shall be used as coarse aggregate and river sand of 5 mm nominal size shall be used as fine aggregate. The aggregate shall be clean and free from dust, dirt, mud, organic matter etc. The coarse aggregate is to be washed well before mixing. Fresh port land cement of I.S.I. approved brand of 43 grades is to be used as the binding material. Potable water, free from harmful salts, shall be only used for mixing the concrete.

b) Preparation of mortar

The coarse aggregate and sand are to be measured separately by volume and mixed dry in a clean and stable platform to get a mixture of uniform colour. This mixture is stacked to a uniform height and the cement of required quantity is spread over the stack, turned over in dry state first, and with water twice to get a workable and uniform concrete.

c) Application of DPC

The brickwork in basement is stopped at plinth level, cured will for 7 days, top surface cleaned well for dust by wire brushes. Form work is provided along the two sides of wall by wooden planks, to the required height. Gauge plates are to be provided at one metre interval, connecting the two side planks by nails, keeping at a clear distance equal to the width of wall at plinth level. The concrete, mixed as mentioned above, shall be placed and compacted well by tamping rods to have a net thickness of 30 mm. Damp proof course shall not have any joints, the whole concreting be completed without any break, and it need not be provided over door openings. The top surface of concrete, when starts to dry, shall be roughened to provide bondage with the super structure. The side planks shall be removed on the next day and the concrete shall be cured for 7 days by keeping the surface constantly wet.

d) Measurement

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

3.11.7. Detailed specification of for plastering with cement mortar

[**Sequence:** Materials; preparation of mortar; preparation of surface; application of mortar; curing; measurement]

a) Materials

[Include detail specification for cement and sand]

b) Preparation of mortar

[Similar to 5.11.3, but the ratio of cement to sand is 1:4 for inner wall and 1: 6 for outer wall or as specified.]

Mortar for plastering shall be prepared at a time of such amount which can be used within the initial setting of cement.

c) Preparation of surface

The joints of brick work shall be raked out a depth of 18 mm and the surface shall be brushed, cleaned, watered and kept wet for two days before plastering. In case of cement concrete surface, the face shall lightly roughen, cleaned, washed and wetted.

d) Application of mortar

Plastering shall be started from the top and proceed towards the bottom. The plastered surface shall be made level and flush with wooden straight edges and rubbed thoroughly with wooden floats to ensure smooth and even surface.

e) Curing

The work shall be kept well watered for at least 15 days.

f) Measurement

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

3.11.8. Detailed specification for form work and centering to R.C.C. Roofing

[**Sequence:** Strutting; formwork; centering]

a) Strutting

Props used for strutting shall be of casuarinas posts of 100 to 130 mm diameter. The props are to be vertical and rest on firm ground or on wooden sole plates of thickness not less than 40 mm. All props shall be provided with double wedges to facilitate tightening and loosening

of shuttering. The horizontal spacing of props in both directions shall not exceed 750 mm. When the height of strutting exceeds 3.5 m, suitable horizontal bracings should be provided. Splicing of props shall be as per the approved drawings. The props shall be constantly watched, by a carpenter, during the process of concreting and immediate remedial measures are to be taken in any of them get loosened.

b) Form Work

The formwork shall be of stiff and strong wood, easily workable with nails and light in weight. The form work shall be true to shape and size specified in the structural drawings and strong enough to with stand the forces caused by vibration of concrete and the incidental loads imposed on it during concreting. The unsupported length of the planks, particularly of the side plates shall not exceed 1.0 m to avoid buckling. The levels of the form work are to be checked before placing the reinforcement bars in position.

c) Centering

Well-seasoned wooden planks or steel sheets are to be used for the shuttering work. The joints shall be water tight to avoid leakage of cement slurry during compaction. The surfaces of planks and sheets which would come into contact with concrete shall be cleaned well and coated with oil of approved quality to the prevent adhesion of concrete. The complete centering work shall be assembled so that it can be removed, on completion of the specified period, easily without causing any demand to the concrete surfaces and edges.

3.11.9. Detailed specification for cement concrete flooring

a) Bottom Layer

The base shall be of cement concrete of 1:2:4 mix, 25 mm thick. The coarse aggregate, 12 mm size stone chipping, shall be hard, durable strong and free from dust and organic matters. The fine aggregate, 5 mm size river sand, shall be also free from dirt, clay, mud etc. Fresh Portland cement having initial setting time not less than 30 minutes and of grade 33 shall be used. Portable water, free from harmful substances shall be used for mixing and curing. The concrete mixed as mentioned above shall be spread over the well prepared base, to a uniform thickness of 25 mm, compacted and leveled using wooden floats. The top surface shall be roughened with 2 mm deep lines at 100 mm intervals, with scratching sticks, to provide bond to the top layer. The bottom layer shall be cured for at least 3 days before the top layer being laid over it.

b) Top Layer

The top layer is of 1:3 cement mortars, 12 mm thick finished with a floating coat of neat cement. Fine sand, sifted through 5 mm size mesh and free from clay and dust shall be used. To have a red coloured finish, 3 kg of red oxide of approved quality may be mixed with 50 kg of cement and is used in preparing the mortar. The cement with red oxide is mixed with sand in the ratio 1:3 by volume in dry state to obtain a uniform colour. Water is then added slowly; a paste of uniform consistency is prepared and laid over the base layer to a uniform thickness of 12 mm. It is leveled and smoothed by wooden floats. In the process of finishing cement slurry mixed with enough red oxide is sprayed on top of cement mortar layer. The surface should be covered with a thin layer of water constantly from next day for at least seven days for better curing.

c) Measurement:

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

3.11.10. Detailed specification for mosaic tile flooring**a) Base Course**

The basic course shall be of 25 mm thick cement concrete of a 1:2:4 mix using 12 mm size granite stone chips as coarse aggregate and sand as fine aggregate. The top of flooring concrete or R.C.C. slab shall be cleaned well and applied with cement slurry of 2 kg/m² before placing the chips concrete. The base course is to be compacted, leveled and smoothed by wooden floats.

b) Mosaic Tiles

Precast tiles of 200 mm x 200 mm x 20 mm size are to be used. They shall be manufactured under hydraulic pressure of not less than 14 N/mm² and given the first grinding with machine before laying. The proportion of cement to sand in the backing of the tiles shall not be leaner than 1:3 by weight. Similarly the proportion of cement to marble powder to marble chips in the wearing layer of the tiles shall be not leaner than 3:1:7. The marble chips shall be hard, dense sound and homogeneous in texture.

c) Laying of Tiles

The bedding for the tiles shall be with cement mortar 1:3. The average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall be not less than 10 mm. Cement bedding shall be spread, tamped and corrected to proper levels and allowed to harden before the tiles are set. Neat cement slurry of honey like consistency shall be spread over the bedding at the rate of 4.4 kg/m². Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1.5 mm and in straight lines.

d) Curing, Polishing and Finishing

The day after the tiles are laid, all joints shall be cleared of the grey cement grout with a wire brush to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grounded with white cement mixed with pigment to match the shade of tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat. The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with the polishing machine fitted with coarse grade grit blocks, adding required water during the process. After grinding, the surface shall be washed clean and covered with thin coat of cement slurry with pigment. The surface shall be again cured and polished with machine fitted with medium grade grit blocks. Similarly a third grinding shall be done by fine grade grit blocks. After the final polish, the surface shall be cleaned using diluted oxalic acid and wiped with a soft cloth. The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

3.11.11. Detailed specification for distempering

The distemper shall be of the approved colour and quality. Water shall be added as prescribed by the manufacture, stirred well often during use, to maintain uniform colour and consistency.

The plastered surface of the wall is scraped and cleaned with wire brushes and rubbed smooth with sand papers. Distemper shall not be applied in wet weather. It shall be applied with good brushes, first horizontally and then immediately crossed off vertically which together shall constitute one coat. The second coat will be also applied in the same manner after the first coat has dried. The finished surface shall be even and uniform and shall show no brush marks. The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

[**Similar Items:** Detail specifications for white wash and colour wash]

3.11.12. Detailed specification for Pointing

The joints of the brickwork shall be raked out to a depth of 20mm (3/4") and the surface of the wall washed and cleaned and kept wet for two days before pointing.

The materials of mortar cement and sand, or lime and surkhi or sand, or kankar lime as specified, shall be of standard specification. The materials of mortar shall be first dry mixed by measuring with boxes to have the required proportion as specified (1:2 or 1:3 for cement sand mortar, 1:1 for lime surkhi mortar or kankar lime mortar), and then mixed by adding water slowly and gradually and thoroughly mixed.

Mortar shall then be applied in the joints slightly in excess and pressed by a proper tool of the required shape. Extra mortar if any is removed and surface finished. Mortar shall not spread over the face of bricks, and the edges of the bricks shall be clearly defined to give a neat appearance. After pointing the surface shall be kept wet for seven days.

Flush pointing

The mortar shall be pressed into the ranked, cleaned and wet joints and shall be finished off flush and level with edges of brick to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

Ruled pointing

The mortar shall be passed into the ranked, cleaned and wet joints and a groove of shape and size of 5 to 6mm deep shall be formed running a forming tool of steel along the center line of the joints. The vertical joints also shall be finished in a similar way at right angles to the horizontal line. The finished work shall give a neat and clean appearance with straight edges.

Weather or truck pointing

The mortar shall be applied on the cleaned and wet joints and horizontal joints shall be pressed and finished with a pointing tool so that the joints is sloping from top to bottom. The vertical joint shall be finished as ruled pointing.

Raised or trucked pointing

The mortar shall be applied in raked, cleaned and wet joints in excess to from raised bands. The mortar shall be pressed and run with proper tool to from bands of 6mm(1/4") raised and 10mm (3/8") width or as directed.

3.11.13. Detailed specification for wood work for door and window frames**a) Materials**

Timber shall be of teak, sal, deodar etc., as mentioned, well-seasoned, dry, free from sap, knots, crack or any other defects or diseases. It shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The scantling shall be planned smooth and accurate to the full dimensions, rebates, rounding and mouldings as shown in the drawing made, before assembling. Patching or plugging of any kind shall not be permitted except as provided.

b) Joints

These shall be mortise and tenon type, simple, neat and strong. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glued framed, put together and pinned with hardwood or bamboo pins not less than 10 mm dia. after frames are put together pressed in position by means of a press.

c)Surface Treatment

Wood work shall not be tainted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or with boiling coal tar.

d) Gluing of Joints

The contract surface of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer-in-Charge.

e)Fixing in position

The frame shall be placed in position truly vertical before the masonry reaches half the highest of the opening with iron clamps or as directed by the Engineer-in-Charge. In case of door frames without sills, the vertical members shall be embedded in the flooring to a depth of 40 mm or as directed by the Engineer-in-Charge. The door frames without sills while being placed in position shall be suitably strutted and wedged in order to prevent warping during construction. The frames shall also be protected from damage, during construction.

3.11.13. Detailed specification for wood work for door and window shutters**a) Materials**

Specified timber shall be used, and it shall be well seasoned, dry, free from sap, knots crack or any other defects or disease. Patching or plugging of any kind shall not be permitted except as provided.

b) Joinery work:

All pieces shall be accurately cut and planned smooth to the full dimension. All members of the shutters shall be straight without any warp or bow and shall have smooth, well planned faces at right angles to each other. In case of panelled shutters the corners and edges of panels shall be finished as shown in drawings, and these shall be feather tongued into styles and rails. The panels shall be framed into groovers to the full depth of the groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove. In case of glazed shutter, sash bars shall have mitred joints with styles. Styles and rails shall be properly and accurately mortised and tenoned. Rails which are more than 180 mm in width shall have two tenons. Styles and end rails of shutters shall be made out of one piece only. The tenons shall pass through styles for at least 1 th of the width of the style. When assembling a leaf, styles shall be left projecting as a horn. The styles and; rails shall have 12 mm groove in panelled portion for the panel to fit in.

c) For battened shutters:

Planks for batten shall be 20 mm thick unless otherwise specified and of uniform width of 125 to 175 mm. These shall be planned and made smooth, and provided with minimum 12 mm rebated joints. The joint lines shall be chamfered. Unless otherwise specified the battens for ledges and Braces shall be 30 mm thick and fixed with the battens on the inside face of shutter with minimum two number 50 mm long wood screws per batten. The ledges shall be 225 mm wide and braces 175 mm wide, unless otherwise specified. The braces shall incline downwards towards the side on which the door is being hung.

d) Gluing of joints for paneled or Glazed shutters :

The contact surfaces of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer-in-Charge.

Shutters shall not be painted, oiled or otherwise treated, before these are fixed in position and passed by the Engineer-in-Charge.

For glazed shutters, mounting and glazing bars shall be tub-tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less.

e) Fittings:

Details of fittings to be provided shall be as per the schedule of fittings supplied by the Engineer-in-Charge in each case. The cost of providing and fixing shutters shall include the cost of hinges and necessary screws for fixing the same. All other fittings shall be enumerated and paid for separately. The fittings shall conform to their respective IS specifications. Where fittings are stipulated to be supplied by the department free of cost, screws for fixing the fittings shall be provided by the contractor and nothing extra will be paid for the same.

3.11.14. Detailed specification for painting new wood work**a) Paint**

Ready mixed paint of approved quality and colour shall be used

b) Preparation of surface

The surface to be painted shall be rubbed down smooth with medium and fine sand papers and cleaned off any dust. Knots, cracks holes etc., shall be filled with putty made of 2 parts of whiting. 1 part of white lead mixed together in linseed oil and leveled to the surface. A primer coat is applied to the surface with ready mixed wood primer of best quality.

c) Application

Painting shall be carried out at the driest season of the year. Paint shall be applied with brushes, smoothly spread without any visible brush mark. The second coat shall be applied when the first coat is perfectly dried. The paint shall be stirred often with stick so that it does not settle down.

CHAPTER 3 (b)**RATE ANALYSIS****3.1. Rate Analysis**

The process of determining rate per unit of any work in Civil Engineering project like earthwork, concrete work, brickwork, plastering, painting etc. is known as Analysis of Rates or simply Rate Analysis. The rates of materials and labour vary from place to place and hence the rates of different items of works also vary from place to place. The rates of these works further help in determining cost of particular work and in turn cost of the project.

3.2. Necessity of Rate Analysis

- To determine the actual cost per unit of the items.
- To work out the economical use of materials and processes in completing the particulars item.
- To calculate the cost of extra items which are not provided in the contract bond, but are to be executed as per the directions of the department.
- To revise the schedule of rates due to increase in the cost of material and labour or due to change in technique.

3.3. Factors Deciding Rate of Items

The various factors that are involved in determining rate of any item, process or work are mentioned below:

- Specifications of works and material about their quality, proportion and constructional operation method.
- Quantity of materials and their costs.
- Cost of labour and their wages.
- Location of site of work and the distances from source and conveyance charges.
- Overhead and establishment charges
- Profit and miscellaneous expenses of the contractor

3.4. Procedure of Rate Analysis

The analysis of rates is worked out for the unit payment of the particular item of work under two heads: Materials and Labour.

- ☐ The cost of items of work = Material cost + Labour cost
- ☐ Other costs included to the above cost of items of work are:

- o Tools and Plants (T & P) = 2.5 to 3 % of the labour cost
- o Transportation cost (if conveyance more than 8 km is considered.)
- o Water charges = 1.5 to 2 % Of total cost
- o Contractor's profit = 10 %

3.4.1 Material cost

The rate of various materials as per specifications for the items under consideration can be chalked out from market survey. The costs of materials are taken as delivered at site of work. This is inclusive of:

- ☐ The first cost (cost at origin),
- ☐ Cost of transport, railway freight (if any), etc.
- ☐ Local taxes and other charges.

a) Lead statement

The distance between the source of availability of material and construction site is known as "Lead" and is expressed in Km. The cost of conveyance of material depends on lead. This statement is required when a material is transported from a distant place, more than 8kms (5 miles). The lead statement will give the total cost of materials per unit item including first cost, conveyance loading-unloading, stacking charges etc.

A typical lead statement is provided as follows:

Sl. No.	Materials	Unit	Cost at Source (per unit)	Lead (in Km)	Conveyance charges (Per Km/ Per Unit)	Total Conveyance charges (/Per Unit)	Total Cost (In Rs. /Per unit)
1	Rough Stone	Cum	1000.00	200	100.00	120.00	1420.00
2	Sand	Cum	800.00	200	150.00	100.00	1250.00
3	Cement	Bag	400.00	Local	-	-	-

3.4.2. Labour cost

To obtain labour cost the number and wages of different categories of labourers, skilled (Skilled 1st Class), semi-skilled (Skilled 2nd Class) and unskilled, required for each unit of work should be known and this number is multiplied by the respective wage per day. The labour charges can be obtained from the standard schedule of rates. 30% of the skilled labour provided in the data may be taken as 1st class, remaining 70% as 2nd class.

The length of time required to do a certain piece of the work may vary according to the skill and mental development of the workmen and working conditions to the particular job.

OUT-TURN OR TASK

Particulars of items	Quantity of work per day (8 hrs a day)
1. Earthwork in excavation in foundation in ordinary soil, lead up to 50m and lift up to 1.5 m	3.00 cum per mazdoor/Beldar
2. Earthwork in excavation in hard soil for 100m lead and 1.5 m lift.	2.00 cum per mazdoor/Beldar
3. Excavation in rock	1.00 cum per mazdoor
4. Sand filling in plinth	4.00 cum per mazdoor
5. Breaking of brick ballast 40mm gauge	0.75 cum per labour/breaker
6. Breaking of stone ballast 40mm gauge	0.40 cum per labour
7. Breaking of stone ballast 20mm gauge	0.25 cum per labour
8. Brickwork in cement mortar in foundation and plinth	1.25 cum per mason
9. Brickwork in cement mortar in superstructure	1.00 cum per mason.
10. Half brick wall in partition	5.00 square meter per mason
11. Brick work in cement mortar in arches	0.55 cum per mason
12. Lime concrete in foundation/ floor	8.50 cum per mason
13. Lime concreting in roof terracing	6.00 cum per mason
14. Cement concrete (1:2:4)	5.00 cum per mason
15. R.C.C. work	3.00 cum per mason

16. 12 mm plastering with cement mortar	8.00 square meter per mason
17. Pointing with cement/lime mortar	10.00 sq.m. per mason
18. 25 mm I.P.S. (cement concrete) floor	7.50 sqm per mason
19. Terrazo floor 6 mm thick mosaic work over 20 mm cement concrete (1:2:4)	5.00 sq.m. per mason
20. Brick flat floor in cement or lime mortar	8.00 sq. m per mason
21. Timber framing sal or Teak wood	0.07 cum per carpenter
22. Timber framing in country wood	0.15 cum per carpenter
23. Door and window shutters panelled or glazed	0.15 sq.m. per carpenter
24. White washing or colour washing one coat	200 sq.m. per white washer
25. White washing or colour washing 3 coats	70 sq.m. per white washer
26. Painting or varnishing doors or windows one coat	25 sq.m. per painter
27. Distempering one coat	35 sq.m. per painter
28. Amount of work done by a mazdoor (helper) per day.	
i) Mix	3 cum per mazdoor
ii) Delivery bricks	4000 to a distance of 15 m per mazdoor
iii) Delivery mortar	5.5 cum of brick work

a) Task or out-turn work

This is the quantity of work which can be done by an artisan or skilled labour (with the help of semiskilled and unskilled labours) of the trade working for 8 hours a day. The out-turn of work per artisan varies according to the nature, size, height, situation, location etc. Out-turn is more in larger cities, as the more specialized and experienced labours are available, than the small cities and country sides.

The recommendation of All India Standard Schedule of Rates and various other govt. reports are used to work out approximate quantity of labour required to prepare the analysis of rates. IS: 7272 (part 1)-1974, provides recommendations for labour output constants for building work which can be used to fix up the labour cost.

A typical labour output constant issued by National Building Organization is provided bellow:

LABOUR REQUIREMENTS

Description of work	Quantity	Labour
1. Earthwork in excavation in foundation, trenches etc. in ordinary soil including disposal up to 30 m and lift of 1.5 m	28.30 m ³ (1000 cft)	Beldar - 5 nos. Mazdoor-4 nos.
2. Refilling of excavated earth in foundation, plinth etc. including consolidation in 150 mm layer.	28.30 m ³ (1000 cft)	Beldar-3 nos. Mazdoor-2 nos. Bhisti-0.5 nos.
3. Laying cement concrete	2.83 m ³ (100 cft)	Beldar-2 nos. Mazdoor-3 nos. Bhisti-3/4 nos. Mason-1/4 nos.
4. Laying of R.C.C. work	2.83 m ³ (100 cft)	Beldar-3 nos. Mazdoor-3 nos. Bhisti-1.5 nos. Mason-0.5 no.
5. Reinforcement work for R.C.C.	1 quintal	Blacksmith-1 no. Beldar-1 no.
6. First class Brickwork in 1:4 cement mortar in superstructure	2.83 m ³ (100 cft)	Mason-2.25 nos. Mazdoor-4.5 nos. Bhisti-0.5 no.
7. Wood work in door/window frames	0.18 m ³	Carpenter-2 nos. Beldar-1 nos.
8. Wood work in panelled, glazed shutters etc.	0.30 m ³	Carpenter-15 nos. Beldar-4 nos.
9. 40 mm cement concrete flooring	40 m ²	Mason-5 nos. Beldar-4 nos. Mazdoor-3 nos. Bhisti-1 no.
10. 12 mm cement mortar plastering	40 m ²	Mason-3 nos. Mazdoor-3 nos. Bhisti-1 no.
11. Three coats white washing/colour washing	60 m ²	White washer-1 no. Mazdoor-1 nos.
12. Two coats painting on wood or steel	10 m ²	Painter-3 nos. Mazdoor-2 nos.

3.4.3. Miscellaneous cost

a) Cost of equipment, Tools and Plants (T & P)

The cost of equipment and ordinary tools and plants and miscellaneous petty items (sundries) are added to the specific item rate as lump-sum. A provision of 2.5 to 3 % of the labour cost is made for such items. In certain tools and plants if it is difficult to allocate their use for a particular item of rate; then the cost of such tools or plants may be allocated to the over-head expenditure.

For big works and projects where it becomes necessary to use special types of equipment like batching plants or WMM plant or dumpers or cranes for transportation of concrete mix, provisions of an amount 1% to 1.5% of the estimated cost is provided in the estimate under the head “special tools and plants”.

b) Water charges

For drinking purpose of the workers and for the work, arrangement of water is made sinking tube well; bore well or from temporary connection from municipality. For this purpose a provision of 1.5 to 2 % of total cost (Material + Labour+ Sundries) is made in the estimate.

c) Over head charges

Overhead charges include general office expenses, rents, taxes, supervision and other cost which are indirect expenses on the job. Expenses for small tools such as planks, ladders, ropes and other hand tools are also included in the over-head charges. A provision of 2.5% to 5% is made in the rate analysis as overhead charge. Overhead charges can be divided under two categories: General Overhead and job overhead.

General overhead:

These are the expenses made throughout the year irrespective to running works in hand.

These include:

- o Establishment charge including rent of office space and taxes
- o Salaries to office staff
- o Purchase of stationary, Printing, postage etc.
- o Electricity, telephone and water bills
- o Travelling expenses

Job overhead:

These are the expenses indirectly incurred for the job or the project. These include:

- o Salaries of personnel engaged for the work (Site engineers, Surveyors or site office staff)
- o Rent of temporary site office space, electricity, telephone and water bills
- o Handling of materials
- o Repairs, carriage and depreciation of T & P.
- o Labour welfare, safety measures and insurance etc.
- o Interest on investment
- o Theft and other losses.

c) Contractor's profit

Generally a provision of 10% is made in the rate analysis as contractor's profit for ordinary contracts. For small jobs 15% profit and for large jobs 8% profit may be considered as reasonable. Contractors profit is not included in rate analysis if material is supplied by the department.

3.5. Rate Analysis of Important Items**3.5.1. Earthwork in excavation in foundation including filling in trenches up to 30m lead and 1.5 m lift**

Assume volume of excavation = 100 cu m

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges	-	-	-
Labour Charges			
1. Head Mason	0.5 Nos.	450.00 per day	225.00
2. Beldar	18 Nos.	250.00 per day	4500.00
3. Mazdoor	14 Nos.	220.0 per day	3080.00
T&P, Sundries, etc.	LS	240.00 LS	240.00
Total Materials and Labour			8045.00
Add 1.5% water charges			120.67
Add 10% Contractors profit			804.50
Grand Total			8970.17
Rate per cu m			Rs. 89.70

3.5.2. First class brickwork in super structure with cement mortar (1:6)**a) Estimation of Materials**

Assume volume of brickwork = 10 cu m

Nominal size of modular brick = 10 cm×10 cm× 20 cm Hence, the number of bricks required =

Actual size of modular brick = 9 cm× 9 cm× 19 cm

The remaining space is filled by mortar, hence the volume of mortar required for 10 cum = $10 - (5000 \times 0.09 \times 0.09 \times 0.19) = 2.3$ cu m.

Additional mortar required for frog filling, brick bonding and wastages @ 15%.

Thus volume of set mortar = $2.3 + 2.3 \times 15/100 = 2.64$ cum.

But, 1.25 cu m of dry volume of mortar materials produces 1.0 cu m set mortar.

Hence, volume of dry materials required for 2.64 cu m of set mortar = 1.25×2.64 cu m = 3.30 cu m.

[Note: As a thumb rule, dry volume of mortar materials is 30% of brick work] Sum of proportion of cement and sand = 1+6 = 7 Hence, volume of cement = $3.3/7 = 0.47$ cu m.

However, cement is available in 50 kg bag whose volume is 0.0347 cu m.

[Mass = 50 kg; Density = 1440 kg/m³; Thus, Volume = $50/1440 = 0.0347$ cu m] [Thumb rule: 1 cu m of cement = 30 bags of cement.]

Therefore, number of bags required = $0.47 / 0.0347 \approx 13.5$ bags.

Volume of sand required = $0.47 \times 6 = 2.82$ cu m.

b) Rate Analysis

Assume, the volume of brickwork = 10 cu m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Brick	5000 Nos.	250.00 (/100 nos.)	12500.00
2. Cement	13.5 bags	320.00 per bag	4320.00
3. Sand	2.82 cu m	350 per cu m	987.00
Labour Charges			
1. Head Mason	2 Nos.	450.00 per day	900.00
2. Mason	6 Nos.	350.00 per day	2100.00
3. Mazdoor	16 Nos.	220.00 per day	3520.00
4. Bhisti	08 Nos.	220.0 per day	1760.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
Total Materials and Labour			26287.00
Add 1.5% water charges			394.30
Add 10% Contractors profit			2628.70
Grand Total			29310
Rate per cu m			Rs. 2931.00

3.5.3. 12 mm thick plaster with cement mortar (1:6)

a) Estimation of Materials

Assume plastering area = 100 sq m

Hence volume of mortar for 12 mm plaster = $100 \text{ m} \times 0.012 \text{ m} = 1.2 \text{ cum}$

Add 30 % more to the above volume for filling of joints, for making un uniform surface well and for wastages

Thus total set volume of mortar including wastages and joint filling etc.

$$= 1.2 + 1.2 \times 30/100 = 1.56 \text{ cu m.}$$

As, 1.25 cu m of dry volume of mortar materials produces 1.0 cu m set mortar;

Volume of dry materials required for 1.56 cu m of set mortar is

$$= 1.25 \times 1.56 \text{ cu m} = 1.95 \text{ cu m,}$$

Hence, volume of cement = $1.95/7 = 0.28 \text{ cu m.}$

Number of bags required = $0.28 / 0.0347 \approx 8 \text{ bags.}$

Volume of sand required = $0.28 \times 6 = 1.68$ cu m.

b) Rate Analysis

Assume, the area of plastering = 100 sq. m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	8 bags	320.00 per bag	2560.00
2. Sand	1.68 cu m	350 per cu m	588.00
Labour Charges			
1. Head Mason	2 Nos.	450.00 per day	900.00
2. Mason	6 Nos.	350.00 per day	2100.00
3. Mazdoor	08 Nos.	220.00 per day	1760.00
4. Bhisti	02 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	200.00 LS	130.00
Total Materials and Labour			8478.00
Add 1.5% water charges			127.17
Add 10% Contractors profit			847.80
Grand Total			9452.97
Rate per sq m			Rs. 94.53

6.5.4. Cement Concrete (1:2:4) for RC work excluding reinforcement and form work

a) Estimation of Materials

Assume volume of R.C.C. = 10 cu m (Set volume)

1.54 cu m dry volume of concrete making materials produces 1.0 cu m set concrete

Therefore volume of dry materials required for 10 cu m of set concrete is 15.4 cu m.

Sum of proportion of cement, sand and coarse aggregate = $1+2+4 = 7$

Hence, volume of cement = $15.4/7 = 2.2$ cu m.

Number of bags required = $2.2 / 0.0347 \approx 64$ bags.

Volume of sand required = $2.2 \times 2 = 4.4$ cu m.

Volume of coarse aggregate required = $2.2 \times 4 = 8.8$ cu m.

b) Rate Analysis

Assume, volume of R.C.C. = 10 cu m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	64 bags	320.00 per bag	20480.00
2. Sand	4.4 cu m	350 per cu m	1540.00
3. C. aggregate	8.8 cu m	800 per cu m	7040.00
Labour Charges			
1. Head Mason	/ Nos.	450.00 per day	225.00
2. Mason	2 Nos.	350.00 per day	700.00
3. Beldar	10Nos.	220.00 per day	2200.00
4. Mazdoor	10Nos.	220.00 per day	2200.00
5. Bhisti	05Nos.	220.0 per day	1100.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
Scaffolding	LS	400.00 LS	400.00
Total Materials and Labour			36085.00
Add 1.5% water charges			541.28
Add 10% Contractors profit			3608.50
Grand Total			40234.78
Rate per sq m			Rs. 4023.50

Note: If concrete mixture is employed for mixing of concrete, hiring and running charges may add @ Rs. 100.00 per cu m of concrete; but the labour may be reduced by 2 beldars per 10 cu m of concrete.

3.5.5 Lime Concrete in foundation with 25 mm down brick chips (or jhama chips) with lime surki mortar (1:2:5½)

a) Estimation of Materials

Assume volume of lime concrete = 10 cu m (Set volume)

1.54 cu m dry volume produces 1.0 cu m set concrete

Therefore volume of dry materials required for 10 cu m of set lime concrete is 15.4 cu m.

Sum of proportion of cement, sand and coarse aggregate = $1+2+5\frac{1}{2} = 8\frac{1}{2}$

Hence, volume of slaked lime = $15.4/8\frac{1}{2} = 1.8$ cu m.

Volume of surki required = $1.8 \times 2 = 3.6$ cu m.

Volume of jhama brick chips required = $1.8 \times 5\frac{1}{2} = 10$ cu m.

b) Rate Analysis

Assume, volume of R.C.C. = 10 cu m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Slaked lime	1.8 cum	600.00 per cum	1080.00
2. Surki	3.6 cu m	250.00 per cu m	900.00
3. Brick chips	10.0 cu m	350.00 per cu m	3500.00
Labour Charges			
1. Head Mason	/ Nos.	450.00 per day	225.00
2. Mason	1 Nos.	350.00 per day	350.00
3. Mazdoor	18 Nos.	220.00 per day	3960.00
4. Bhisti	02 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	300.00 LS	150.00
Total Materials and Labour			10605.00
Add 1.5% water charges			159.08
Add 10% Contractors profit			1060.50
Grand Total			11824.58
Rate per sq m			Rs. 1182.50

Note: In case of cement concrete in foundation, the labours and T&P will be same as this item. The materials like cement, sand and coarse aggregate can be calculated by the example 21.5.6 and accordingly rate analysis can be made.

3.5.6 Providing cold twisted steel reinforcement in R.C.C. slab including bending, binding and placing in position complete.

a) Estimation of Materials

If bar bending schedule is available, then reinforcement quantity may be estimated from the schedule. Alternatively, reinforcement steel for beams and slabs may be taken as @ 1% of volume of concrete and for columns @ 2% of volume of concrete. The weight of 1 cum of steel is 78.5 quintals.

Consider, first 10 m × 10 m of continuous slab of thickness 100 mm.

The volume of reinforced concrete = $10 \text{ m} \times 10 \text{ m} \times 0.1 \text{ m} = 10 \text{ cu m}$

Reinforcement required by volume = $10 \times 1/100 = 0.1 \text{ cu m}$

Weight of reinforcement required = $0.1 \times 78.5 \text{ qu.} = 7.85 \text{ qu.}$

Increase this amount by 5% for wastages.

Thus the volume of reinforcement required = $7.85 \times 5/100 = 8.25 \text{ qu.}$

Black iron wire @ 1kg per quintal = 8.25 kg.

b) Rate Analysis

Assume, volume of R.C.C. slab = 10 cu m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Reinforcement	8.25 qu.	3800.00 per qu	31350.00
2. Black Iron wire	8.25 kg	45.00 per kg	371.25
Labour Charges			
1. Blacksmith	8.25 Nos.	450.00 per day	3712.50
2. Mazdoor	8.25 Nos.	220.00 per day	1815.00
T&P, Sundries, etc.	LS	300.00 LS	130.00
Total Materials and Labour			37378.75
Add 1.5% water charges			560.70
Add 10% Contractors profit			3737.88
Grand Total			41677.33
Rate per cu m			Rs. 4167.73

Note: R.C.C. works are paid separately for cement concrete work; for steel reinforcement and for centering and shuttering as per the PWD practices.

3.5.7 25 mm thick cement concrete (1:2:4) damp proof course.**a) Estimation of Materials**

Assume area of DPC is = 100 sq m

The volume of concrete will be = $0.025 \times 100 = 2.5$ cum.

Following example 21.5.4, the quantity of cement, sand and coarse aggregates required for 2.5 cu m concrete are estimated as:

Number of cement bags required = $16\frac{1}{2}$ bags.

Volume of sand required = 1.10 cu m.

Volume of coarse aggregate required = 2.20 cu m.

Quantity of water proofing compound required = 3% by weight of cement =

= 3% of $16\frac{1}{2} \times 50$ kg = 25 kg.

b) Rate Analysis

Assume, area of DPC = 100 sq m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	$16\frac{1}{2}$ bags	320.00 per bag	5280.00
2. Sand	1.1 cu m	350.00 per cu m	385.00
3. C. aggregate	2.2 cu m	800.00 per cu m	1760.00
4. Water proof compound	25 kg	25.00 per kg	625.00
Labour Charges			
1. Head Mason	/ Nos.	450.00 per day	225.00
2. Mason	08Nos.	350.00 per day	2800.00
3. Mazdoor	08Nos.	220.00 per day	1760.00
4. Bhisti	01 Nos.	220.0 per day	220.00
T&P, Sundries, etc.	LS	500.00 LS	100.00
Total Materials and Labour			13155.00
Add 1.5% water charges			197.33
Add 10% Contractors profit			1315.50
Grand Total			14667.83
Rate per sq m			Rs. 146.70

3.5.8. Random Rubble Masonry in cement mortar (1:6) in foundation and plinth.**a) Estimation of Materials**

11.7 cu m of undressed stone and 0.80 cu m of through stone (header) is required for 10 cu m of RR masonry. Further, 4.2 cum of dry mortar materials (cement and sand) are required for same volume of RR masonry work.

b) Rate Analysis

Assume, volume of RR masonry = 10 cu m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	17 bags	320.00 per bag	5440.00
2. Sand	3.6 cu m	350.00 per cu m	1260.00
3. Undressed Stone	11.7 cu m	200.00 per cu m	2340.00
4. Through Stone	0.8 cu m	250.00 per cu m	200.00
Labour Charges			
1. Head Mason	/ Nos.	450.00 per day	225.00
2. Mason	10 Nos.	350.00 per day	3500.00
3. Mazdoor	17 Nos.	220.00 per day	3740.00
4. Bhisti	2 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
Total Materials and Labour			17345.00
Add 1.5% water charges			260.17
Add 10% Contractors profit			1734.50
Grand Total			19339.67
Rate per cu m			Rs. 1934.00

3.5.9 Rule pointing in cement mortar (1:3) on brickwork on wall.

a) Estimation of Materials

An empirical quantity of 0.63 cu m (dry) mortar is required for 100 sq. m of Rule and Tuck pointing. In case of Flush pointing 75% of above quantity is required.

b) Rate Analysis

Assume, area of Rule pointing = 100 sq m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	4.8 bags	320.00 per bag	1536.00
2. Sand	0.48 cu m	350.00 per cu m	168.00
Labour Charges			
5. Head Mason	/ Nos.	450.00 per day	225.00
6. Mason	10 Nos.	350.00 per day	3500.00
7. Mazdoor	09 Nos.	220.00 per day	1980.00
8. Bhisti	1 Nos.	220.0 per day	220.00
T&P, Sundries, etc.	LS	120.00 LS	120.00
Scaffolding	LS	360.00 LS	360.00
Total Materials and Labour			8109.00
Add 1.5% water charges			121.64
Add 10% Contractors profit			810.90
Grand Total			9041.54
Rate per sq m			Rs. 90.42