

LECTURE NOTES

ON

Estimation Specifications and Contracts
(for theory)

IV B.TECH II Sem

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UNIT - I

GENERAL ITEMS OF BUILDING

TECHNICAL TERMS

Estimate

An estimate is the anticipated or probable cost of work and is usually prepared before the construction is taken up. It is indeed calculations or computations of various items of an engineering work.

Quantity survey

It is the schedule of all items of work in a building. These quantities are calculated from the drawing of the building. Thus quantity survey gives quantities of work done in case of each items, when priced gives the total cost. In short, quantity survey means calculations of quantities of materials required to complete the work concerned.

Specifications

Detailed specifications gives the nature, quality and class of work, materials to be used in the various parts of work, quality of the material, their proportions, method of preparation, workmanship and description of execution of work are required.

Rates

The rates of various items of works, materials to be used in the construction and the wages of different categories of labor (skilled and unskilled) should be available for preparing an estimate. The cost of transportation charges should also be known. As far as possible sanctioned "Schedule of Rates" shall be followed or the rates may be worked out by the "Analysis of Rates" method.

Site plan

It is the plan drawn for a particular construction showing its position with respect to approaching roads, main bazars, markets and other permanent features in a populated area. It shows the location of the area under construction with respect to the other areas and on it generally the names of the owners of areas or property holders adjoining to it are also denoted. North line is also clearly marked on it.

Line plan

Line plan can be defined as the plan of a particular construction simply showing main features with the help of the single lines of different portions of the constructions. Details of constructions are not generally shown on this plan. This inside and outside dimensions shown on this plan should necessarily be corresponding to actual dimensions.

Index plan

This is the plan of a particular colony showing the positions of different houses in single lines their number if any position of roads, schools, market, hospitals and other features etc. this plan is generally fixed on the entrance, or at exit or in the central place of the colony, for the guidance of the inhabitants and outsiders.

Detailed plan

This plan indicates a plan of a construction drawn to a definite scale, showing all detailed information required for its execution. Various sections and elevations are clearly drawn on this plan.

Centre line plan

This is actually a layout plan drawn to facilitate the laying out of foundation lines and other features. It is generally fixed on the entrance or at exit in the central place of the colony for the guidance of the inhabitants and outsiders.

Supplementary estimate

When some additions are done in the original work, a fresh detailed estimate is prepared to supplement the original work. This estimate is called supplementary estimate. It is also accompanied by all the papers as required in the detailed estimate.

Administrative approval

For any project required by the department an approval or sanction of the competent authority with respect to the cost and work is necessary at the first instance. Thus administrative approval denotes the formal acceptance by the administrative department concerned of the proposals for incurring expenditure.

Technical sanction

It means the sanction and order by the competent authority of the department for the detailed estimate design calculations quantities of work rates and cost of work..after the technical sanction of the estimate is received the work is then taken up for construction.

Competent authority

An officer or any other authority in the department to whom relevant powers are delegated by the government (Financial Department).

Ordinary measurement book

It is a measurement book in which entries regarding the work done or supplies made and services performed are recorded for the purpose of making payments to the contractors or the labor. Entries in the M.B are generally recorded by the sectional officers or by any other officers deputed for the purpose

Lumpsum items

Sometimes while preparing estimate for the certain small items like front architecture or decoration work of a building it is not possible to workout detailed quantities so far such lump sum items a lump sum rate is provided.

Plinth area

The built up covered area of a building measured at floor level of any storey is called plinth area.

Circulation area

The total cost of construction including all expenditures incurred plus the cost of external services up to the end of the completion of the work is called capital cost. It also includes the cost of preliminary works, miscellaneous items and supervision charges etc.

General

Estimating is the technique of calculating or computing the various quantities and the expected Expenditure to be incurred on a particular work or project. In case the funds available are less than the estimated cost the work is done in part or by reducing it or specifications are altered, the following requirements are necessary for preparing an estimate.

1. Drawings like plan, elevation and sections of important points.
2. Detailed specifications about workmanship & properties of materials etc.
3. Standard schedule of rates of the current year.

Units of measurements

The units of measurements are mainly categorized for their nature, shape and size and for making payments to the contractor and also. The principle of units of measurements normally consists the following:

- a) Single units work like doors, windows, trusses etc., is expressed in numbers.
- b) Works consists linear measurements involve length like cornice, fencing, hand rail, bands of specified width etc., are expressed in running meters (RM)
- c) Works consists areal surface measurements involve area like plastering, white washing, partitions of specified thickness etc., and are expressed in square meters (m²)
- d) Works consists cubical contents which involve volume like earth work, cement concrete, Masonry etc are expressed in Cubic metres.

Rules for measurement

The rules for measurement of each item are invariably described in IS- 1200.

However some of the general rules are listed below.

1. Measurement shall be made for finished item of work and description of each item shall include materials, transport, labor, fabrication tools and plant and all types of overheads for finishing the work in required shape, size and specification.
2. In booking, the order shall be in sequence of length, breadth and height or thickness.
3. All works shall be measured subject to the following tolerances.
 - a). linear measurement shall be measured to the nearest 0.01 m.
 - b). Areas shall be measured to the nearest 0.01 sq.m
 - c). Cubic contents shall be worked-out to the nearest 0.01 cum

Same type of work under different conditions and nature shall be measured separately under separate items.

The bill of quantities shall fully describe the materials, proportions, workmanships and accurately represent the work to be executed.

In case of masonry (stone or brick) or structural concrete, the categories shall be measured separately and the heights shall be described:

- a) From foundation to plinth level.
- b) From plinth level to first floor level.
- c) From First floor to second floor level and so on.

Requirements of estimation and costing

- a) Estimate gives an idea of the cost of the work and hence its feasibility can be determined i.e. whether the project could be taken up with in the funds available or not.
- b) Estimate gives an idea of time required for the completion of the work.
- c) Estimate is required to invite the tenders and Quotations and to arrange contract.
- d) Estimate is also required to control the expenditure during the execution of work.
- e) Estimate decides whether the proposed plan matches the funds available or not.

Procedure of estimating or method of estimating.

Estimating involves the following operations

Preparing detailed Estimate.

Calculating the rate of each unit of work

Preparing abstract of estimate

Data required to prepare an estimate

Drawings i.e. plans, elevations, sections etc.

Specifications.

Rates.

Drawings

If the drawings are not clear and without complete dimensions the preparation of estimation become very difficult. So, it is very essential before preparing an estimate.

Specifications

General Specifications: This gives the nature, quality, class and work and materials in general terms to be used in various parts of work. It helps to form a general idea of building.

Detailed Specifications: These give the detailed description of the various items of work laying down the Quantities and qualities of materials, their proportions, the method of preparation workmanship and execution of work.

Rates

For preparing the estimate the unit rates of each item of work are required.

for arriving at the unit rates of each item.

The rates of various materials to be used in the construction.

The cost of transport materials.

The wages of labor, skilled or unskilled of masons, carpenters, Amador, etc.,

Complete estimate

Most of people think that the estimate of a structure includes cost of land, cost of materials and labor, but many other direct and indirect costs included and are shown below.

The following are some of L.S. Items in the estimate.

Water supply and sanitary arrangements.

Electrical installations like meter, motor, etc.,

Architectural features.

Contingencies and unforeseen items.

In general, certain percentage on the cost of estimation is allotted for the above L.S. Items. Even if sub estimates prepared or at the end of execution of work, the actual cost should not exceed the L.S. amounts provided in the main estimate.

Work charged establishment

During the construction of a project considerable number of skilled supervisors, work assistance, watch men etc., are employed on temporary basis. The salaries of these persons are drawn from the L.S. amount allotted towards the work charged establishment. That is, establishment which is charged directly to work. An L.S. amount of 1½ to 2% of the estimated cost is provided towards the work charged establishment.

Methods of taking out quantities

The quantities like earth work, foundation concrete, brickwork in plinth and super structure etc., can be worked out by any of following two methods:

Long wall - short wall method

Centre line method.

Partly centre line and short wall method.

Long wall-short wall method

In this method, the wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall. To get the length of long wall or short wall, calculate first the centre line lengths of individual walls. Then the length of long wall, (out to

out) may be calculated after adding half breadth at each end to its centre line length. Thus the length of short wall.

Measured into in and may be found by deducting half breadth from its centre line length at each end. The length of long wall usually decreases from earth work to brick work in super structure while the short wall increases. These lengths are multiplied by breadth and depth to get quantities.

Centre line method

This method is suitable for walls of similar cross sections. Here the total centre line length is multiplied by breadth and depth of respective item to get the total quantity at a time.

When cross walls or partitions or verandah walls join with main wall, the centre line length gets reduced by half of breadth for each junction. Such junction or joints are studied carefully while calculating total centre line length. The estimates prepared by this method are most accurate and quick.

Partly centre line and partly cross wall method

This method is adopted when external (i.e., around the building) wall is of one thickness and the internal walls having different thicknesses. In such cases, centre line method is applied to external walls and long wall-short wall method is used to internal walls. This method suits for different thicknesses walls and different level of foundations. Because of this reason, all Engineering departments are practicing this method.

Detailed estimate

The preparation of detailed estimate consists of working out quantities of various items of work and then determines the cost of each item. This is prepared in two stages.

Details of measurements and calculation of quantities

The complete work is divided into various items of work such as earth work concreting, brick work, R.C.C. Plastering etc., The details of measurements are taken from drawings and entered in respective columns of prescribed preformed. The quantities are calculated by multiplying the values that are in numbers column to Depth column as shown below:

Details of measurements form

S.No	Description of Item	No	Length (L) m	Breadth (B) m	Depth/Height (D/H)m	Quantity	Explanatory Notes

Abstract of Estimated Cost

The cost of each item of work is worked out from the quantities that already computed in the details measurement form at workable rate. But the total cost is worked out in the prescribed form is known as abstract of estimated form. 4% of estimated Cost is allowed for Petty Supervision, contingencies and Unforeseen items.

Types of Estimates

Abstract of estimate form

Item No.	Description/Particulars	Quantity	Unit	Rate	Per (Unit)	Amount

The detailed estimate should accompanied with

- i) Report
- ii) Specification
- iii) Drawings (plans, elevation, sections)
- iv) Design charts and calculations
- v) Standard schedule of rates.

Factors to be considered while preparing detailed Estimate

i) Quantity and transportation of materials:

For bigger project, the requirement of materials is more. such bulk volume of materials will be purchased and transported definitely at cheaper rate.

ii) Location of site:

The site of work is selected, such that it should reduce damage or in transit during loading, unloading, stocking of materials.

iii) Local labor charges:

The skill, suitability and wages of local labors are considered while preparing the detailed estimate.

Data

The process of working out the cost or rate per unit of each item is called as Data. In preparation of Data, the rates of materials and labor are obtained from current standard scheduled of rates and while the quantities of materials and labor required for one unit of item are taken from Standard Data Book.

Fixing of rate per unit of an item

The rate per unit of an item includes the following:

Quantity of materials & cost

The requirement of materials is taken strictly in accordance with standard data book(S.D.B). The cost of these includes first cost, freight, insurance and transportation charges.

Cost of labour

The exact number of labourers required for unit of work and the multiplied by the wages/ day to get of labour for unit item work.

Cost of equipment (T&P)

Some works need special type of equipment, tools and plant. In such case, an amount of 1 to 2% of estimated cost is provided.

Overhead charges:

To meet expenses of office rent, depreciation of equipment salaries of staff postage, lighting an amount of 4% of estimate cost is allocated.

Methods of preparation of approximate estimate

Preliminary or approximate estimate is required for studies of various aspects of work of project and for its administrative approval. It can decide, in case of commercial projects, whether the net income earned justifies the amount invested or not. The approximate estimate is prepared from the practical knowledge and cost of similar works. The estimate is accompanied by a report duly explaining necessity and utility of the project and with a site or layout plan. A percentage 5 to 10% is allowed for contingencies. The following are the methods used for preparation of approximate estimates.

- a) Plinth area method
- b) Cubical contents methods
- c) Unit base method.

Plinth area method

The cost of construction is determined by multiplying plinth area with plinth area rate. The area is obtained by multiplying length and breadth (outer dimensions of building). In fixing the plinth area rate, careful observation and necessary enquiries are made in respect of quality and quantity aspect of materials and labour, type of foundation, height of building, roof, wood work, fixtures, number of storey's etc., As per IS 3861-1966, the following areas include while calculating the plinth area of building.

Types of Estimates

Area of walls at floor level.

Internal shafts of sanitary installations not exceeding 2.0m², lifts, air-conditioning ducts
etc.,

Area of barsati at terrace level: Barsati means any covered space open on one side constructed on one side constructed on terraced roof which is used as shelter during rainy season.

Arches of non cantilever type. Areas which are not to include

Area of lofts.

Unenclosed balconies.

Architectural bands, cornices etc.,

Domes, towers projecting above terrace level.

Box louvers and vertical sunbreakers.

Cubical Contents Method

This method is generally used for multistoreyed buildings. It is more accurate than the other two methods viz., plinth area method and unit base method. The cost of a structure is calculated approximately as the total cubical contents (Volume of buildings) multiplied by Local Cubic Rate. The volume of building is obtained by Length x breadth x depth or height. The length and breadth are measured out to out of walls excluding the plinth offset. The cost of string course, cornice, corbelling etc., is neglected. The cost of building = volume of buildings x rate / unit volume.

Problems

Estimation of different foundations, steps and boundary walls. Example : 1 From the Drawing given below determine (a) Earth work excavation CC (1:5:10) Bed (c) R.R.Masonry in C.M. (1:6) (d) Brick Work in C.M.(1:6).

Single Roomed Building (Load Bearing type structure)

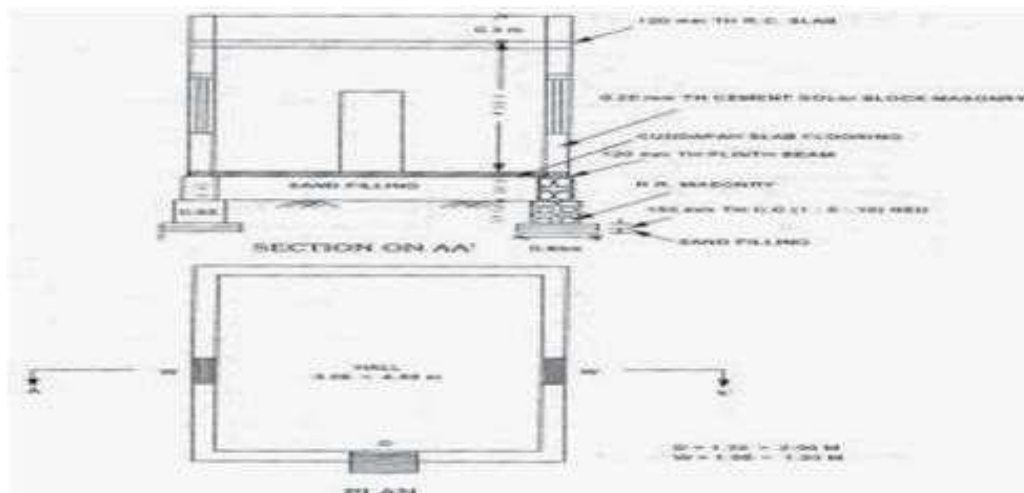
From the Drawing given below determine (a) Earth work excavation

(b) CC (1:5:10) Bed (c) R.R.Masonry in C.M. (1:6) (d) Brick Work in

C.M.(1:6). by

longwall - short wall method

Centre line Method



Technical Terms

Retaining wall

It is a structure designed and constructed to resist the lateral pressure of soil when there is a desired change in ground elevation that exceeds the angle of repose of the soil.

Aqueduct

It is a water supply or navigable channel (conduit) constructed to convey water. In modern engineering, the term is used for any system of pipes, ditches, canals, tunnels, and other structures used for this purpose.

Arch

It is a structure that spans a space while supporting weight.

Pitched roof

It is a roof structure where the roof leans to one side of the house

Flat roof

It is a type of covering of a building. In contrast to the sloped form of a roof, a flat roof is horizontal or nearly horizontal.

Culvert

It is device used to channel water. It may be used to allow water to pass underneath a road, railway, or embankment

Formwork

It is the term given to either temporary or permanent moulds into which concrete or similar materials are poured. In the context of concrete construction, the false work supports the shuttering moulds.

Load bearing

It is one in which a wall of a structure bears the weight and force resting upon it, conducting the vertical load from the upper structure to the foundation.

Handrail

It is a rail that is designed to be grasped by the hand so as to provide stability or support.

Tread

It means horizontal upper portion of a step.

Riser

This is the vertical portion of a step. It means the vertical distance between the horizontal surfaces of two consecutive steps.

Landing

This is a horizontal platform provided at the head of a series of step.

Nosing

This is the outer projecting edge of a tread.

Flight

This is consists of series of steps provided between the landings.

Flatslab

A flat slab is reinforced concrete slab supported directly over the columns without beams. Generally used when head room is limited. Such as in cellars and warehouses.

Panel

Panel is that the part of the slab bounded on each of its four sides by the centre line of columns or center lines of adjacent spans.

Drop

The drop panel is formed by increasing the thickness of slab in vicinity of supporting column.

Column head

The column head or capital located by flaring of the column at the top is primarily intended to increase the punching shear of the slab.

Brick masonry

Masonry structures are built using masonry units and mortar.

Masonry wall

Masonry walls are constructed using bricks and mortar.

Mortar

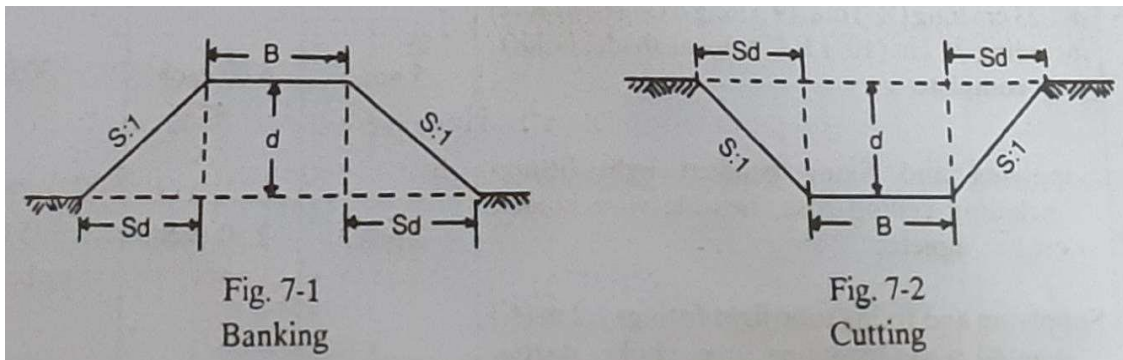
Masonry units are bonded together using mortars.

UNIT-II

EARTH WORK

All the civil engineering structures such as buildings , roads, canals, railway lines, culverts and dams earth work will there.

Cross-section of earth work of road in banking or in cutting is usually in the form of trapezium.



Sectional area= Area of central rectangular portion+ Area of two side triangular portions. =

$$Bd + 2\left(\frac{1}{2}sdxd\right) = Bd + sd^2$$

S:1 is the ratio of side slopes as horizontal :vertical.

For 1 vertical , horizontal is s, for d vertical , horizontal is sd.

$$\text{Quantity} = (Bd + sd^2) \times L$$

$$\text{Mean height} = \frac{d_1 + d_2}{2} = dm$$

Sectional area is taken out from mean height = $Bdm + sd^2m$

$$\text{Qty} = (Bdm + sd^2m) \times$$

Lead and Lift

Earth work is estimated for 30m lead for distance and 1.5m lift for height or depth and this distance of 30m and height of 1.5m are known as normal lead and lift.

For greater lead or lift the rates will be different for every unit of 30m lead & for every unit of 1.5m lift.

Longitudinal section is usually plotted with horizontal scale of 1cm=10m to 1cm = 30m lead & a vertical scale of 1cm=1m to 1cm=5m.

Mid-Sectional area method

Quantity = Area of mid-section area x length.

Let d_1 & d_2 be the height of bank at two ends portion of embankment, L the length of the section B

the formation width & S:1(horizontal :vertical).

Area of mid-section = Area of rectangular portion +area of two triangular portion.

$$\text{Area} = Bdm + 1/2Sdm^2 + 1/2Sdm^2 = Bdm + Sdm^2$$

Quantity of earth work = $(Bdm + Sdm^2) \times L$.

General Q = $(Bd + Sd^2) \times L$ where d stands for mean height or depth.

Area of side sloping surface

The area of sides which may require turfing or pitching , may be found by multiplying the mean

sloping by length

Mean sectional area method

Quantity = Mean sectional area x length.

Sectional area at one end $A_1 = Bd_1 + sd_1^2$

Sectional area at other end $A_2 = Bd_2 + sd_2^2$, d_1 and d_2 are the heights or depths at the two ends

Prismoidal formula method

Quantity or Volume = $\frac{1}{6}[A_1 + A_2 + 4A_m]$, where A_1 and A_2 are the cross-sectional areas at the two ends of a portion of embankment of a road of length L and A_m is the mid-sectional area.

UNIT – II

RATE ANALYSIS

Reinforced concrete and allied works

Scope

This specification covers the general requirements for concrete jobs, using on-site production facilities including requirements in regard to the quantity, handling, storage of ingredients, proportioning, batching, mixing and testing of concrete and also requirements in regard to the quality. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, consolidation, curing, protecting, repairing and finishing of concrete. After award of the work, if so desired by the contractor, he / they may be allowed by the Engineer-in-charge till the designed mix is obtained, to carry out the reinforced concrete work in foundation and plinth as per equivalent nominal mix against the specified design mix concrete as per IS Codes. However, all other specification for design mix shall govern for nominal mix also and nothing extra shall be paid for use of extra cement on this account whether the cement is supplied by the Department or procured by the contractor.

Cement Concrete (Plain and Reinforced)

The quality of materials and method and control of manufacture and transportation of all concrete work in respect of mix, where reinforced or otherwise, shall conform to the applicable portions of these specifications. The Engineer-in-charge shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipments and the quality control system. Such an inspection shall be arranged by the contractor and the Engineer-in-charge's approval shall be obtained prior to starting the concrete work.

Materials for Standard Concrete

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement, clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for as per drawings or schedule of quantities.

Cement

Unless otherwise specified or called for by the Engineer-in-charge, cement shall be ordinary Portland cement in 50 kg bags. The use of bulk cement will be permitted only with the approval of the Engineer-in-charge. Changing of brands or type of cement within the same structure will not be permitted. Ordinary Portland cement (OPC) 43 grade manufactured as per I.S. specifications of reputed brands like ACC / Ultratech / Zuari / Coramendel or any other brands as approved by the Engineer-in-charge from time to time shall be procured and used on the work. Joint account of cement consumed at site for every day for items of work carried shall be maintained by the Contractor for verification to ensure effective control on quality of cement used in the work.

A certified report attesting to the conformity of the cement to IS specifications by the cement manufacturer's chemist shall be furnished to the Engineer-in-charge, if demanded. In case the cement is required to be arranged by the Contractor, the Contractor will have to make his own arrangement for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos which will provide complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be got approved by the Engineer-in-charge. Consignments in cement shall be stored as received and shall be consumed in the order of their delivery. Contractor shall establish cement/concrete/soil testing laboratories at site of work with qualified person to handle the laboratory. Every consignment of cement procured shall accompany test certificate from the company indicating lot No etc.

Sample shall be taken for each lot and sent to Standard Approved Material Testing Laboratory for physical and chemical analysis. The cost of testing shall be borne by the Contractor.

Cement held in store for a period of 90 (ninety) days or longer shall be retested before use in work. Should at any time the Engineer-in-charge have reasons to consider that any cement is defective, then irrespective of its origin and / or manufacturers test certificate, such cement shall be tested immediately at a National Test Laboratory / Departmental Laboratory or such approved laboratory, and until the results of such tests are found satisfactory, it shall not be used in any work.

Aggregates

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete. "Fine Aggregate" is aggregate most of which passes through 4.75 mm I.S. sieve. "Coarse Aggregate" is aggregate most of which is retained on 4.75 mm I.S. sieve. All fine and coarse aggregates proposed for use in the work shall be subject to the Engineer-in-charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-charge. Aggregate shall, except as noted above, consist of natural sand, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, curable against weathering, of limited porosity and free from deleterious materials that may cause corrosion to the reinforcement or may impair the strength and / or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete and shall be based on the "mix design" and preliminary test on concrete specified hereinafter.

Sampling and Testing

Sampling of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Record of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer-in-charge in advance of the work or use, in determining suitability of the proposed aggregate.

Storage of aggregates

All coarse and fine aggregates shall be stacked separately in stock pile in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials

shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but also at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregate from bins or stock piles. Coarse aggregate shall be piled in layers not exceeding 1.00 meters in height to prevent conning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected materials after remixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

Specific Gravity

Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Engineer-in-charge.

Fine Aggregate

Fine aggregate except as noted above, and for other than light weight concrete shall consist of natural or crushed sand conforming to IS 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter mica, salt or other deleterious substances which can be injurious to the setting qualities / strength / durability of concrete.

Screening and Washing

Sand shall be prepared for use by such screening or washing or both as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions. Sand with silt content more than 3 percent will not be permitted to be used unless same is washed and silt content is brought within 3% by weight.

Gradation

Unless otherwise directed or approved, the grading of sand shall be within the limit indicated here under:-Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron (IS) sieve by not more than 5% it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron (IS) sieve or to percentage passing any other sieve size on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to Grading zone IV shall not be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

Fineness Modulus

The sand shall have a fineness modulus of not less than 2.2 or more than 3.2 the fineness modulus is determined by adding the cumulative. Percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

Coarse Aggregate

Coarse aggregate for concrete except as noted above and for other than light weight concrete shall conform to IS 383. This shall consist of natural or crushed stone and gravel, and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, sag, alkali, mica, organic matter or other deleterious matter. The coarse aggregate and fine aggregate shall be tested from time to time as required by the Engineer-in-charge to ascertain its suitability for use in construction and the charges for testing aggregate shall be born by the contractor as specified herein after.

Screening and Washing

Crushed rock shall be screened and / or washed for the removal of dirt or dust coating, if so demanded by Engineer-in-charge.

Grading

Coarse aggregates shall be either in single or graded in both the cases. The grading shall be within the following limits:

Foreign Material Limitations

The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following.

IS Sieve designation	Percentage passing for single sized aggregates						Percentage passing for graded aggregates of nominal size			
	63mm	40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
75mm	100	-	-	-	-	-	-	-	-	-
63mm	85-100	100	-	-	-	-	100	-	-	-
37.5mm	0-30	85-100	100	-	-	-	95-100	100	-	-
19mm	0.5	0.20	85-100	100	-	-	30-70	95-100	100	100
16mm	-	-	-	85-100	100	-	-	-	90-100	-
11.2mm	-	-	-	-	85-100	100	-	-	-	90-100
9.5mm	-	0.5	0.20	0.30	0-45	85-100	10-35	25-55	30-70	40-85
4.75mm	-	0.5	0-5	0-10	0-20	0-20	0-5	0-10	0-10	0-10
2.36mm	-	-	-	-	0-5	0-5	-	-	-	-

Sl. No.	Substances	Percent by weight	
		Uncrushed	Crushed
I	Material finer than 75 micron IS Sieve	3.00	3.00
II	Coal and Lignite	1.00	1.00
III	Clay lumps	1.00	1.00
IV	Soft fragments	3.00	-
V	Total of all the above substances	5.00	5.00

Water

Water used for both mixing and curing shall be free from injurious amount of deleterious materials; potable waters are generally satisfactory for mixing and curing concrete. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The samples shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water. Average 28 days compressive strength of at least three 150mm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The initial setting time of test block made with the appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than (+) 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS 4031. Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.

Limits of acidity

To neutralize 200ml sample of water, using phenolphthalein as an indicator, it should not require more than 2ml of 0.1 normal NaOH. The details of test shall be as given in IS 3025. **Limits of alkalinity**

To neutralize 200ml sample of water, using methyl orange as an indicator, it should not require more than 10ml of 0.1 normal HCL. The details of test shall be as given in IS 3025.

Design Mix Concrete

All reinforced concrete in the works shall be "Design Mix Concrete" as defined in I.S.456-2000. All "Design Mix Concrete" work to be carried out under these specifications shall be in grades designated as per table below:

Grades of Concrete

Grade Designation	Specified Characteristic compressive strength at 28 days(N/mm ²)
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40

Mix Design

This is to investigate the grading of aggregates, water cement ratio, workability and the quantity of cement required to give works cubes of the characteristic strength specified. The proportion of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Mix proportioning shall be carried out according to the ACI standard designation ACI-613 or Design of concrete mixes –Road research Note No. 4, Department of Scientific and Industrial Research U.K. or I.S.10262-1982.

Selection of Water Cement Ratio

Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water cement ratio should preferably be established for the materials actually to be used. In the absence of such data, the preliminary free water cement ratio (by mass) corresponding to the target strength of 28 days may be selected from the relationship shown in Fig. 1 of IS. 10262- page 7.

Alternately, the preliminary freewater ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig2-IS 10262-1982, Page 8 using the curve

corresponding to the 28 days cement strength to be used for the purpose. Other relevant items to be used with design of mix should strictly conform to the relevant clauses and appendices of IS 10262 – 1982.

Mode of Measurement for concrete work

General

Concrete as actually done shall be measured for payment, subject to the following tolerances, unless otherwise stated hereinafter. Any work done extra over the specified dimensions shall not be measured for payment.

- a. Linear dimensions shall be measured in full centimeters except for the thickness of slab which shall be measured to the nearest half centimeter.
- b. Areas shall be worked out to the nearest 0.01 sqm.
- c. Cubic contents shall be worked out to the nearest 0.001 cum.
- d. The concrete shall be measured for its length, breadth and height/depth limiting dimensions to those specified on drawings or as directed by the Engineer-in-charge.

Note: The sizes of RCC members as assumed in to estimate are based on preliminary drawings and are likely to be changed. The contractor is not entitled to any extra claim due to such changes.

Deductions

No deduction shall be made for the following:

- a. Ends of dissimilar materials e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc. up to 500 sq.cm in cross section.
- b. Opening up to 0.1 sqm. (1000 sq.cm).
- c. Volume occupied by reinforcement.
- d. Volume occupied by pipes, conduits, sheathing etc. not exceeding 25sq.cm. each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

Column Footing

R.C.C. in foundation and footings shall be measured for its length, breadth and depths limiting dimensions to those specified in drawing or as ordered in writing by the Engineer-in-charge. In case of tapering portions of column footings, the quantities shall be calculated by Prismoidal Formula.

Column

Column shall be measured from top footings to the plinth level and from plinth level to the structural slab level and to the subsequent structural slab levels. Measurements for higher grade concrete in column at its junction with lower grade concrete beams shall be restricted total column section supporting the beam in question.

Wall

All walls shall be measured from top of the wall footing to the plinth level and from plinth level to the top of structural first floor and to subsequent floors.

Beam and Lintel

Beam shall be measured from face to face of the columns, walls, cross beams including haunches if any. The depth of the beams shall be measured from the top of the slab to the bottom of the beam except in the case of inverted beam where it shall be measured from top of slab to top beams. The beams and lintels with narrow width even though acting as fascia in elevation in some cases will be measured as beams and lintels only.

Slab

The length and breadth of slab laid to correct thickness as shown in the detailed drawing for as ordered by the Engineer-in-charge shall be measured between beams, walls and columns.

Chajjas, Facias, Fins and Mullions

- a. Chajjas shall be measured net from supporting faces upto the edges of chajjas without any fascia.
- b. Facia shall be measured full excluding chajja thickness.
- c. End fins shall be measured full.
- d. Intermediate fins, mullions shall be measured between chajjs or

other supporting structural members.

e. Parapets shall be measured from top of slab / chajja.

Staircase

The concrete in all members of staircase like waist slabs, steps, cantilever steps, stringer beams etc. shall be measured for their length, breadth and depth, limiting dimensions to those specified on drawings. No deductions shall be made for embedded plugs, pockets.

Rates

The rate for PCC / RCC shall include the cost of all materials, labour, transport, tools and plants and all the operations mentioned hitherto, including or excluding the cost of form work and / or reinforcement as mentioned in the schedule for quantities. The rates also shall include the cost of testing material, mix design; cube test and allied incidental expenses. The reinforcement steel used in the works shall be measured and paid for separately under relevant item.

Form work

General

The form work shall consist of shores, bracings, sides of beams and columns, bottom of slabs etc, including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the work. The false work shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustment and dismantling of form work.

Design of Form Work

The design and engineering of form work as well as its construction shall be the responsibility of Contractor. The drawings and calculations for the design of the form work shall be submitted well in advance to the Engineer-in-charge for approval before proceeding with work, at no extra cost to the Department. Engineer-in-charge's approval shall not however, relieve Contractor of the full responsibility for the design and construction for the form work. The design shall take

into account all the loads vertical as well as lateral that the forms will be carrying including live and vibration loadings.

Tolerances

Tolerances are specified permissible variation from lines, grade or dimensions given in drawings. No tolerances specified for horizontal or vertical buildings lines or footings. Unless otherwise specified, the following tolerances will be permitted.

Steel reinforcement

Steel reinforcement bars, if supplied or arranged by contractor, shall be either plain round mild steel bars grade as per IS 432 (part-I) or medium tensile steel bars as per IS 452 (part-I) or hot rolled mild steel and medium tensile steel deformed bars as per IS 1139 or cold twisted steel bars and hot weld strength deformed bars as per IS 1786, as shown and specified on the drawings. Wire mesh or fabric shall be in accordance with IS 1566. Substitution of reinforcement will not be permitted except upon written approval from Engineer-in-charge.

Storage

The reinforcement steel shall not be kept in direct contact with ground but stacked on top of an arrangement of timber sleepers or the like. Reinforcement steel shall be with cement wash before stacking to prevent scale and rust. Fabricated reinforcement shall be carefully stock to prevent damage, distortion, corrosion and deteriorations.

Quality

All steel shall be grade I quality unless specifically permitted by the Engineer-in-charge. No rolled material will be accepted. If demanded by the Engineer-in-charge. Contractor shall submit the manufacturers test certificate for steel. Random tests on steel supplied by contractor may be performed by Department as per relevant Indian Standards. All costs incidental to such tests shall be at contractors expense. Steel not conforming to specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt loose mill, scale dust, bituminous materials or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-charge. If welding is approved, the work shall be

carried as per 2751, according to best modern practices and as directed by the Engineer-in-charge in all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. Special specifications, as specified by the Engineer-in-charge, shall be adhered to in the welding of cold worked reinforcing bars and bars other than mild steel.

Laps

Laps and splices for reinforcement shall be shown in the drawings. Splices, in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawing shall be approved by the Engineer-in-charge. The bars shall not be lapped unless the length required exceeds the maximum available length of bars at site.

Bending

All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawings/ bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebent in a manner that will injure the materials. Bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25mm in diameter which may be bent hot if specifically approved by the Engineer-in-charge. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 645°C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and rebending be such as shall not, in the opinion of the Engineer-in-charge injure the material. NO reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having links or bends other than those required by design shall not be used.

Bending at Construction Joints

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

Fixing / Placing and Tolerance on Placing

Reinforcement shall be accurately fixed by any approved means maintain in the correct position as shown in the drawings by the use of blocks, spacer and chairs as per IS 2502 to prevent

displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

Tolerance on placing of reinforcement

Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances:

Tolerance in spacing

- a) For effective depth, 200 mm or less + 10 mm
- b) For effective depth, more than 200 mm + 15 mm

Painting

Painting should be strictly according to IS. 1477-1971 (Part-I-Pretreatment) and IS 1477-1971 (part-II painting). Painting should be carried out on dry surfaces free from dust, scale etc. The paint shall be approved by the Engineer-in-charge. One coat of shop paint (red lead) shall be applied on steel, except where it is to be encased in concrete or where surfaces are to be field welded.