

ESTIMATION COSTING

AND

SPECIFICATIONS

For all Engineering works it is required to know beforehand the probable cost of construction known as the estimated cost. If estimated cost is greater than the money available, then attempts are made to reduce the cost by changing the specifications or reducing the work.

Specification:

Specification specifies or describes the nature and class of work, materials to be used in the work, workmanship etc., and is very important for execution of work. Cost of a work depends much on specifications. Drawings and Specifications completely define a structure. Drawings and Specifications form important parts of contract document.

Specifications depend on the nature of work, purpose of work, strength of materials, availability of materials, quantity of materials etc,

Specifications are of two types.

1. General Specifications or Brief Specification
2. Detailed Specification.

General or Brief Specification: General Specification gives the nature and class of work and materials in general terms to be used in various parts of work.

General Specifications

	First class Building	Second class building	Third class building	Fourth class building
1. Foundation and plinth	Shall be of I class bricks in lime mortar or 1:6 cement mortar over lime concrete or 1:4:8 cement concrete	Shall be of I-class brickwork with lime mortar over lime concrete	Shall be of 2nd class brickwork in lime mortar over lime concrete	Shall be of Sundried or Kutchra bricks in mud mortar.
2. Damp proof course	Shall be 2.5cm (1") thick cement concrete 1:1 1/2:3 mixed with one kg of Impermo per bag of cement or other water proof agents with two coats of bitumen.	Shall be 2cm (3/4") thick cement concrete 1:2 mixed with 1kg of Impermo per bag of cement or other water proof agents	Shall be 2cm thick cement mortar 1:2 mixed with standard water proofing compound	inside and outside shall be waterproof mud plastered
3. Super structure	Shall be I-class brick work with lime mortar or 1:6 cement mortar. Lintels over doors & windows shall be of R.C.	Shall be 2nd class brick work in lime mortar. Lintels over doors & windows shall be of Reinforced brick.	Shall be of 2nd class brick work in mud mortar. Door and window opening shall be of 2nd class brickwork in lime mortar	Door and window openings shall be provided with arches of 2nd class brickwork in lime mortar or with wooden planks.

General Specifications

	First class building	Second class building	Third class building	Fourth class building
4 Roofing	Roof shall be of RCC Slab with insulation layer, and lime concrete terracing above, supported by RS Joints or beams. Height of rooms shall not be less than 3.7m	Shall be of RB slab with 7.5 cm lime concrete terracing above, supported by wooden battens and beams or Jack arch roof. Verandah roof may be of A.C sheet or allahabad tiles	Shall be of mud over tiles or bricks or planks over wooden beams or of tile or GI sheet or A.C. sheet sloping roof	Shall be of tile over bamboo and wooden supports.
5 Flooring	Drawing room, dining room, Bathroom, K.C. Floors and dado shall be of mosaic (terrazzo). Floors of bedrooms shall be coloured and polished of 2.5cm (1") cement concrete over 7.5cm lime concrete.	Shall be 2.5cm (1") cement concrete over 7.5cm lime concrete. Verandah floor may be of brick tile or flag stone over lime concrete, finished Gment Painted	Shall be of brick on edge floor over well rammed earth	Shall be kutcha or earthen floor finished with "gobri" washing (crowdung lapping)

		General Specifications	
	First class building	Second class building.	Third class building
	Inside and outside walls shall be of 12 mm cement lime plastered @ 1:6. Drawing, dining, bedrooms and - inside distempered and others white washed 3 coats. Outside walls shall be snowcum washed two coats over one coat white wash.	Inside & outside walls shall be 12mm cement mortar Plasted 1:6. ceiling shall be of 1:3. Inside shall be 3 times white washed. Colour washed 2 times over one coat of white wash.	Inside and outside walls shall be Plastered with lime mortar and white washed three coats.
6	Finishing		-
	Doors and windows	Chaukats shall be of RCC or well seasoned sal wood, shutters of shisham wood or deodar wood 4cm thick with iron fitting. Doors and windows shall be painted two coats over one coat of priming	Chaukat shall be of sal wood, shutters of chir mango or other country wood. They shall be painted twice with ordinary paint over a coat of priming.
7	Doors and windows	Doors and windows shall be teak wood. All fittings shall be of brass. Doors and windows shall be varnished or coated 2 times with enamel paint over one coat of priming. Windows shall be provided with iron gratings or grills.	Doors & windows shall be of chir or mango wood or country wood.
			Fourth class building

General Specifications

Miscellaneous	<p>First class building</p> <p>Rain water pipes of cast iron or asbestos cement shall be provided, finished and painted. Building shall be provided with 1st class Sanitary, water fittings and electric installations. A metre wide 7.5cm thick cc 1:3:6 apron shall be provided all round the building.</p>	<p>Second Class building</p> <p>Rain water pipes shall be of cast iron finished painted. Electrification, sanitary and water fittings may be provided if required.</p>	Third class building	Fourth class building.
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Detailed Specifications

Detailed specification of an item of work specifies the qualities and quantities of materials, the proportion of mortar, workmanship, method of preparation, execution and the methods of measurement. This gives information about what works to be done and how they shall be executed.

Detailed specification of various works such as Earthwork in excavation in foundation, lime concrete in foundation and roof terracing, CC, RCC, Damp Proof course (DPC), Brickwork (I class, II class, III & IV class), flooring, painting, doors and windows etc., are available and some of them are given below.

1. Earthwork in excavation in foundation:

Excavation: Foundation trenches shall be dug out exact width of foundation concrete and sides shall be vertical. If soil is not good, the sides shall be sloped back or protected with timber shoring. Excavated earth shall not be placed within 1m of edge of trench.

Finishing: All the sides of foundation shall be levelled perfectly so that concrete is placed at exact width of design. The bed of trench shall be lightly watered and well rammed. Excessive digging if done through

mistake shall be filled at the expense of contractor.
Foundation concrete shall not be laid before the inspection and approval of trench by Engineers-in-charge.

Finds: Any treasures and valuables found during the digging, shall be property of the Government.

Water in foundation: water if any accumulates in the trench, shall be pumped out without any extra payment. Precaution should be taken to prevent surface water from entering the trench.

Trench filling: After the concrete has been laid masonry^{or} has been completed, the remaining portion of trenches shall be filled up with earth in layers of 15cm and well rammed.

Measurement: Measurement of earthwork shall be taken in cu.m or cu.ft. Rate shall be for complete work for 30m lead and 1.5m lift, including all tools required for completion of work. For every extra lead of 30m and extra lift of 1.5m separate extra rate is provided.

Excavation in saturated soil: Excavation in saturated soil or below subsoil water level shall be treated as separate item and remaining works remain same as above.

Pumping and removal of slush shall be included in item whereas timbering to the sides of trenches shall be taken under separate item.

2. Reinforced cement concrete: (R.C.C.) -

Steel-steel reinforcing bars shall be of mild steel or deformed steel and shall be ^{free} from corrosion, loose rust scales, oil, grease paint etc. The bars shall be round, can be bent and hooked and can be bound together by 20 SWG steel wire at point of intersection. Joints in the bar should be avoided as far as possible, when joints have to be made 40 times diameter of overlap shall be provided. Bigger diameter bars are connected by welding.

While concreting steel bars shall be given a cover of 4cm to 5cm in beam and 10cm to 20cm for slab. During laying and compacting the concrete, the bars should be in their positions and not disturbed.

Centering and shuttering - centering and shuttering shall be made with timber or steel plate close & tight to prevent leakage of mortar with necessary props. A coating of oil is applied to shuttering or paper is spreaded over for smooth finished surface & to prevent adherence of concrete. A camber of 1cm in 2.5m with a maximum of 4cm is provided in centering sheets. Centering and shuttering should not be removed before 14 in general. [4 days for R.C.C. columns, 10 days for roof slab, 14 days for beams].

Proportion of cement concrete: concrete mix shall be of 1:2:4 for slabs, beams and lintels and 1:1½:3.

Proportion for columns or unless otherwise specified.

Materials for concrete

Cement shall be fresh portland cement of standard I.S.I specifications, and shall have required compressive and tensile stresses and fineness.

Water shall be clean and free from alkaline and acid matters and suitable for drinking purposes.

Fine aggregate shall be coarse sand having hard, sharp, angular grains and shall pass through screen of 5mm square mesh. It should be free from dust, dirt organic matters. Sea sand shall not be used.

Coarse aggregate shall be hard broken stone of granite free from dust, dirt or other foreign matters. The coarse aggregate shall pass through 20mm mesh and retained on 5mm mesh and should not have voids greater than 42%. For building works 20mm gauge and for road & mass work 40 to 60mm gauge is employed. While placed in ribs of main beams, the maximum size is restricted to 5mm less than the minimum clear distance between main bars or 5mm less than minimum cover to Rft. when bars are widely

Spaced, limitations to size of aggregate is not so important.

Mixing:

Hand mixing: Mixing shall be done in masonry platform or sheet iron tray. For concrete 1:2:4 proportion, first two boxes of sand and one bag of cement shall be mixed dry thoroughly and this dry mix is placed over a stack of 4 boxes of stone aggregate and the whole mixed dry turning at least three times to have uniform mix. water shall be added around 25 to 30 litres per bag of cement, to give plastic mix.

Machine mixing: Stone ballast sand and cement shall be put into the cement concrete mixer. For concrete of 1:2:4 proportion, first four boxes of stone ballast then two boxes of sand and then one bag of cement shall be put into cc mixer. Mixer, the machine shall be revolved to mix materials dry and then water shall be added gradually. It requires $1\frac{1}{2}$ to 2 minutes rotation for thorough mixing. output of concrete mixer is 15 to 20 mix per hour.

Laying: Before laying the concrete, the shuttering shall be clean, free from dust, dirt and other foreign matters. concrete shall be deposited not dropped in its final position. Time between mixing and placing of concrete shall not exceed 20 minutes.

concreting shall not be done if temperature falls below 4°C . completion shall be completed within 30 minutes of addition of water to mix. If laying of concrete is suspended for rest of day, then the end should be sloped at angle of 30° and made rough.

Structures exceeding 45m in length shall be divided by one or more expansion joints. Structures in which plan dimension changes abruptly shall be provided with expansion joints at section where change occurs.

Curing: After two hours of laying, when concrete becomes to harden, it shall be kept damp by covering with wet gunny bags etc., and then cured by flooding with water making mud walls of 7.5cm high and kept damp for continuously 15 days.

Finishing: The surface shall be plastered by 1:3 cement sand mortar immediately after removing centering sheets. Before applying plastering, the surface is wetted and neat cement wash is done.

Measurement: Measurement shall be taken in cu m or cu ft . No deduction shall be made for volume of steel. Steel is considered as separate item in quintal. plastering is not included in measurement. RCC work rate shall be for complete work excluding steel including centering shuttering and all tools and plants.

3. Damp proof course 2.5 cm (1") c.c 1:1½:3:-

Materials: Damp proof course shall consists of cement, coarse sand and stone aggregate of 1:1½:3 with 2% of impermo or cem-seal or any water proofing agent on weight of cement (1 kg per bag of cement) or as specified by manufacturer. This mix is applied as layer of 2.5 cm thickness at plinth level.

Mixing: cement is mixed first with water proofing agent and then mixed dry with sand of proportion 1:1½. It is then mixed with stone aggregate. Clean water is then added to get a homogenous mix.

Laying: The top of walls at DPC will be laid with frogs of bricks downward. Damp proof course shall be laid within one day without joints. Joints or breaks if unavoidable shall be given at sills of doors or openings. Shuttering may be removed after three days.

Curing: DPC shall be cured by watering for 7 days. Surface shall be cleaned and wetted before masonry is started.

Painting with asphalt: Two coats of asphalt painting shall be applied to DPC. First coat of hot asphalt at 1.5 kg per sq.m and after concrete is dry it is blinded with coarse sand and tamped lightly. Second coat is applied at 1 kg sq.m and immediately

blinded with coarse sand and tamped lightly.

2 cm Damp proof course: DPC is of 2cm thick layer of 1:2 cement & coarse sand mortar with water proofing agent at the rate of 1kg per bag of cement.

Mixing, laying, curing is as mentioned above.

4. Brickwork I class:

Bricks: All bricks shall be of first class of standard specification without any irregularities in shape, should be sharp and clearing ^{ringing} sound when struck each other. Brick shall be well burnt and free from any lumps, chips, cracks and flaws and shall be in cherry red or copper colour. Bricks shall not absorb water more than $\frac{1}{6}$ of their weight and shall have a minimum compressive strength of 105 kg/cm^2 .

Mortar:

For cement mortar cement shall be fresh portland cement of standard specification. sand shall be sharp coarse or medium sand for rich mortar and local sand can be used for lean mixes. Mortar for one hour's work only shall be mixed with water so that mortar may be used before it starts setting.

lime surkhi mortar can be used where lime shall be fresh and slaked and screened at site of work.

Fresh mixed mortar of 24 hrs can be used, old & stale mortar should not be used. proportion lime surkhi mortar may be 1:2 to 1:3 as specified

Soaking of brick: Bricks shall be fully submerged in a tank for 12 hours until air bubbling is ceased.

Laying: Bricks shall be well bonded and laid in English bond unless otherwise specified. Vertical joints in alternate course shall come directly one over other.

No damaged or broken bricks shall be used. closers shall be of clean cut bricks and shall be placed near

the ends of walls but not at other edge. selected best shaped bricks shall be used for face work. Brickwork

shall not be carried more than 1m at a time in height.

Curing: Brickwork shall be kept for curing for a period of 10 days. At the end of days work the top surface

shall be flooded with water making small weak mortar edging to contain atleast 2.5cm deep water.

Protection: Brickwork shall be protected from the effect of sun, rain, frost etc., during construction.

Scaffolding: Necessary suitable sound and strong

Scaffolding to withstand all loads likely to come upon shall be provided.

Measurement: Brickwork shall be measured in ~~square~~ cu.m & cu-ft. Different kinds of bricks with different mortar shall be taken as separate items. Thickness of wall shall be taken as multiple of half brick.

[half brick = 10cm, full brick = 20cm and $1\frac{1}{2}$ brick 30cm].

Rate shall be for complete work including scaffolding and all tools and plants.

Brickwork in arch: rough arch or axed arch or gauged arch as the case may and the centering required may be specified.

5. Brickwork II class and III class:

For II class brick work, second class bricks can be used with kankar or white lime of 1:2 to 1:3 proportion. Mortar joints shall not exceed 10mm in thickness. Bricks shall be soaked in water for at least three hours immediately before use.

For III - class brickwork bricks shall be III class if not specified. Mortar joints shall not exceed 12mm in thickness. Bricks shall be dipped in tub of water before use.

6. 2.5cm (1") cement concrete floor:

Cement concrete shall be of proportion 1:2:4 or 1:1½:3 or as specified.

Cement shall be fresh portland cement and coarse aggregate shall be hard and tough of 20mm gauge. Sand shall be coarse of 5mm maximum size. Aggregate shall be well graded, clean and free from dust, dirt and organic matters.

Floor shall be levelled and divided into panels of not exceeding 1m in its smaller dimension and 2m in its longer dimensions. Glass or aluminium strips of 3mm thick and depth equal to thickness of floor shall be fixed on base with cement mortar. Required camber shall be given in floor for draining wash water.

Mixing of concrete is done either by hand mixing or machine mixing. Quantity of water shall not exceed 30lit per bag of cement. Concrete required for one panel shall be mixed in one lot. Alternate panels shall be laid on alternate days. The flooring shall be laid on 2 layers. The lower layer being 22mm thick and upper layer 3mm thick.

concrete shall be placed gently and compacted by wooden thapias and surface shall be tamped with wooden tampers. Surface shall be smoothed with removal of unevenness by adding 1:2 cement sand mortar. whole operation shall be completed in 30min. After laying the surface shall be undisturbed for 2 hours and then covered with wet bags and after 24 hours cured by flooding with water for 7 days. Junctions of floor with wall plaster, dado and skirting shall be rounded off neatly.

Coloured floor - use of coloured cement or a mixture of opc and coloured pigment in a ratio of 3 of cement to one of colour (or 4:1 or 5:1). For coloured floor the thickness of two layers shall be 19mm and 6mm. For polished floor, the thickness of surface cement finishing shall be 2.5cm.

Base - in ground floor the cc floor is to be laid on 7.5cm base of lime concrete or cement concrete. In case of cement concrete it shall be allowed to set for about 7 days. In case the base is of weak cement concrete, the flooring shall commence within 48 hours of laying the base.

In first floor or upper floor, the surface of Rcc slab is made rough with wire brushes while

concrete is green. Before laying of c.c floor, the surface is cleaned and neat cement wash is applied to attain good bond.

7. Sand:

Sand shall be hard, durable, angular, sharp and gritty to touch and free from mica, salts, alkalies organic and vegetable matters. It should not contain more than 5% of clay. Sand should be perfectly dry before measuring. In case of any dampness compensation shall be made for bulking by providing extra or additional sand upto extent of bulking. sand shall be natural river sand or pit sand of approved quality.

For concrete coarse sand shall be of 5mm maximum in size. All sand shall pass through a sieve of 5mm sq mesh and 60% retained on I.S sieve 60. Fineness modulus of coarse sand shall not be less than 2.5 and fine sand shall not be less than 1.0.

$$\text{Percentage of silt content} = \frac{h}{H} \times 100$$

where,

'h' is height of silt layer above sand in measuring jar when soaked in water.

'H' is height of sand.

If percentage is above allowable percentage of silt, the sand should be washed to remove silt.

Determination of bulking of damp sand:

$$\text{Percentage of bulking} = \frac{V-v}{v} \times 100$$

V = original volume of sand

v = Volume of damp sand.

ESTIMATE

Estimate:

An estimate is the anticipated or probable cost of work and is usually prepared before the construction work is taken up.

Data for estimate:

To make out an estimate for a work the following data are necessary.

1. Drawing (Plan, Section etc.,)
2. Specifications
3. Rates

Different types of estimate -

The following are the different types of estimate:-

1. Preliminary estimate or Approximate or Abstract or Rough cost estimate.
2. Plinth Area estimate
3. cube rate estimate or cubical content estimate
4. Approximate quantity method estimate
5. Detailed estimate & Item rate estimate
6. Revised estimate
7. Supplementary estimate
8. Supplementary and revised estimate
9. Annual repair or Maintenance estimate (A.R. or A.M. estimate)

1. Preliminary or Approximate or Abstract estimate:

This deals with preliminary studies of various aspects of work to decide financial position and policy for administrative sanction by competent administrative authority

Approximate estimate is prepared from the practical knowledge and cost of the similar work. The estimate is prepared showing separately

the approximate cost of all important items of work as cost of land, cost of each building, cost of roads, water supply and sanitary works etc. A percentage of about 5% to 10% is added as contingencies.

The preliminary estimate may be prepared for various works in various ways.

a) Buildings:

Per unit basis - per student for schools and hostels, per class room for school, per bed for hospitals, per seat for cinema theatres, per bay for factories, barracks etc.

b) Roads and highways -

Per kilometre basis depending on nature of road, width and thickness of metalling etc.

c) Irrigation channels -

Per km basis depending on capacity of channel. Area of land commanded i.e., per hectare basis.

d) Bridges and culverts -

Per running metre of span depending on the roadway, nature and depth of foundation, type of structure, etc.,

e) Sewerage project and water supply project -
on the basis of per head of population served. on the basis of area covered.

f) overhead water tank -
on the basis of capacity, per litre of tank depending on the type of structure height of tank.

2. Plinth Area ~~Estimate~~ Estimate for building (P.A. estimate):

This is prepared on the basis of plinth area of building, the rate being derived from the cost of similar specification, heights and construction, in the locality.

This estimate is calculated by finding the plinth area and multiplying with plinth area rate.

Courtyard and other open area should not be included in plinth area.

If the plan of building is not ready or available, a proposal is prepared, floor area of rooms is determined and 30 to 40% of this area may be added for walls, circulation and waste to get the approximate cost of building.

3. Cube rate estimate or Cubical content Estimate:

Cube rate estimate is a preliminary estimate and is prepared on basis of cubical contents of building. Cube rate is found out from the cost of similar building with similar specification. Cubical content is found by length \times breadth \times height of building. It is then multiplied by cube rate to find cost of building.

Height should be taken from floor level to top of roof. For storeyed building, height is taken from floor level of one storey to top of next higher floor. Foundation, plinth level and parapet wall is not considered in calculation of cubical content.

Cubical content method is most accurate compared to plinth area method as height of building is also considered in this method.

4. Approximate quantity method estimate:

In this method approximate total length of walls is found in running metre and this total length is multiplied by the rate per running metre of wall which gives fairly accurate cost.

In this method, the structure is divided into two parts i) foundation including plinth and ii) Super structure.

5. Detailed estimate or Item rate Estimate:

It is an accurate estimate and consists of ~~work~~ finding the quantities of each item of work and the cost of them. Dimensions, length, breadth and height of each item are taken from drawing and items are calculated and abstraction and billing are done.

Detailed estimate is done is carried in two stages.

i) Details of measurement and calculation of quantities:-

Measurements of each item are taken from Plan and quantities under each item are calculated in a tabular form named as "Details of measurement form."

Details of Measurement form

Item NO	Description or Particulars	No.	Breadth Length	Breadth	Height or depth	Content or quantity

ii) Abstract of Estimated cost:

Cost of each item of work is calculated based on the quantity of each item. Total cost is worked out in "Abstract of estimate form"

A percentage of 3% of estimated cost is added to allow any contingencies and 2% is provided for workcharged establishment.

6. Revised estimate:-

It is a detailed estimate and is prepared under any one of the circumstances:

- i) when the original sanctioned estimate is exceeded or likely to exceed by more than ~~10%~~ 5%.
- ii) when the expenditure on a work exceeds the amount of administrative sanction by more than 10%.
- iii) when there is a material deviation from the original Proposal, even though the cost may be met from the Sanctioned amount.

Revised estimate should be accompanied by a comparative statement showing the variations of each item of work, cost and quantity, & the reason for variation.

7. Supplementary Estimate:-

It is a detailed estimate prepared when additional works are required or when further development is required during the progress of work. This is a fresh detailed estimate of additional works in addition to original estimate.

8. Supplementary and revised estimate:-

When a work is partially abandoned and the estimated cost of remaining work is less than 95% of original work, or when there are material deviations and changes in design which may cause substantial saving in the estimate, then the original estimate is revised by competent authority. A supplementary and revised estimate is prepared and new technical sanction is obtained from competent authority.

9. Annual Repair or Maintenance estimate (A.R or A.M. estimate)

It is a detailed estimate and is prepared to maintain the structure in proper order and safe condition. For a building it includes white washing, colour washing, painting, minor repairs etc., For

road works A.R. estimate provides for patch repairing, renewals, repairs of bridges and culverts etc.,

CONTINGENCIES:-

The term contingencies indicates the incidental expenses for miscellaneous petty items which cannot be classified under any sub-head or item, yet pertain to work as a whole. In any estimate 3% to 5% of total estimated cost is taken as contingencies.

CONTRACT SYSTEM

Work is got done through contractors who arrange all material required and employ the workers required for the completion of project in contract system. The contractor and Department are bound by the conditions of contract agreement.

Contract agreement stipulates the quantities of work, rates, detailed specifications, time limit to complete the work and various other conditions. contracts are usually arranged by inviting sealed tenders and entrusting the work to lowest tender usually.

Types of contracts:

1. Lump sum contract
2. lump sum and schedule contract
3. schedule contract or item rate contract
4. Labour contract
5. Target contract
6. Materials Supply contract
7. cost plus percentage contract
7. piece-work agreement
8. cost Reimbursement contracts
 - a) cost plus fixed fee contract
 - b) cost plus percentage contract
 - c) cost plus fluctuating fee contract
 - d) Percentage contract.

Price based contracts

cost based contracts

1. Lump sum contract

In lump sum contract, the contractor undertakes the execution of certain work along with the contingencies within a specified time for a fixed amount.

Details or detailed specifications of all items of works pertaining to whole work, plans, detailed drawing, deposit of 10% security money, penalty, progress etc., are included in the contract agreement.

Schedule of different items of work are not provided. Contractor has to complete the work within the specified time and sum irrespective of qualities of materials.

2. Lump sum and schedule contract:

This is similar to lump sum contract whereas schedule of rates is also provided in contract agreement. Contractor has to complete the work within the specified time and sum and with the specified plans and detailed specifications and conditions.

3. Schedule contract or Item rate contract:

In schedule contract, the contractor undertakes the construction work on the item rate basis. The amount the contractor receive depends upon the quantities of various items of work actually done. The contract agreement includes quantities, rates and amounts of different works, total amount of contract, plans detailed drawings, specifications and deposit of 10% security money, penalty, progress, date of completion and other conditions of contract. It is also called unit price contract.

4. Labour contract:

All the materials for the construction

are arranged and supplied at the site of work by department or owner.

2. The labour contractor engages the labour and gets the work done according to specifications.
3. The contract is on item rate basis for labour portion only.
4. The contractor is paid for quantities of work done on measurement of different items of work at stipulated rate as in agreement.
5. Contractor uses his own tools for working where machines and plants are to be arranged by department.
6. This contract is not generally adopted in government works but preferred for private works.

5. Target contract:

Target cost contracts base their pricing that aptly or approximately known as target cost. Number is negotiated by both contractor and client before signing the contract.

If final cost of project is below target cost, both the contractor and client divide the savings in equal halves. If final cost exceeds target cost both parties are responsible for paying extra.

6. Materials supply contract:

In this form of contract, the contractors have to offer their rates for supply of required quantity of materials, inclusive of all local taxes, carriage and delivery charges of materials to the specified site within the time fixed in the tender.

7. Piece - work Agreement:

In this contract or agreement, a rate is agreed upon without reference to total quantity of work to be done or the quantity of work to be done within a given period.

8. Cost plus percentage contract:

Contractor is given certain percentage over the actual cost of construction as his profit. Contractor arranges materials and labour at his cost and keeps proper account.

Cost plus fixed fee contract:

In this type of contract, the contractor is paid by the owner an agreed lump-sum amount over and above the actual cost of work.

Cost plus fluctuating fee contract:

The contractor is paid by the owner

the actual cost of construction plus an amount of fee inversely variable according to the increase or decrease of the estimated cost agreed first by both the parties.

TURNKEY PROJECTS

1. It is a contract under which a firm agrees to fully design, construct and equip a manufacturing/business service facility and turn the project over to the purchaser when it is ready for operation.
2. It refers to something that is ready for immediate use, generally used in sale of or supply of goods and services.
3. A turnkey contract is one under which contractor is responsible for both the design and construction of a facility.

Advantages:

1. Great way to earn economic returns from the asset.
2. contractor's responsibility to get good result.
3. contractor has a fixed price.
4. Eliminates extra expenses.

Dis-advantages:

1. High in price
2. No client interference
3. Difficulty in finding skilled profession for particular project in turnkey projects.

Essentials of contract (or) Contract Document

Before the work is given out on a contract, an agreement & bond is prepared. The following documents should be duly endorsed and sealed along with the agreement. Each page must bear the signature of contractor and accepting authority.

1. **Title page:** having the name of work, contract bond number, etc.
2. **Index page:** having the contents of the agreement with page references.
3. **Tender notice:** giving brief descriptions of work, estimated cost of work, date and time of tender, amount of earnest money and security money, time of completion, ~~Progress~~ etc., Earnest money usually 2% of estimated cost, is deposited along with tender.

4. **Tender form**: giving the bill of quantities, contractor's rates, and total cost of works, and time for completion, progress of works, security money, penalty clause etc.

5. **Bill of quantities or schedule of quantities**: giving quantities and rates of each item of work and cost of each item of work and total cost of the whole work.

6. **Schedule of issue of materials**: giving list of materials to be issued to the contractor with rates and place of issue.

7. **General Specifications**: Specifying the class and type of works in general.

8. **Detailed Specifications**: of each item of work, and of each material to be used in the work.

9. **Drawings**: complete set of drawings including plans, elevations, sections, detailed drawing, etc. and site plan fully dimensioned.

CONDITIONS OF CONTRACT

It contains the terms and conditions of contract in detail. The conditions specify

the following:

- i) Rates inclusive of materials, transport, labour T. and P. all other agreements necessary for completion of work.
- ii) Amount of the security money
- iii) Time for completion of the work
- iv) Progress to be maintained.
- v) Penalty for unsatisfactory and bad work, for failure in maintaining progress, for delay in completion.
- vi) Mode of payment, running account payment, final Payment, Security money refund
- vii) Extension of time limit of contract.
- viii) Rules for employment of debitable agency, termination of contract
- ix) Minimum wages to labour, compensation to labour.
- x) Authority deciding extra items and contractors, claims etc.,

General conditions of contract are as follows:

1. contractor shall deposit 10% of estimated cost as Security money, or this amount may be collected gradually from running account bill of contractor.
2. contractor shall have to complete the work by a specified date and have to maintain a monthly progress.

3. If he fails in maintaining the progress or completing the work in time he is liable for compensation or penalty and part or whole of the Security money may be forfeited.

4. Time may be extended by the competent authority on written application of contractor on valid reason.

5. Running account payment has to be made to the contractor from time to time as the work progress.

6. The cost of materials issued to the contractor shall be deducted from first running bill.

7. If progress of work is not satisfactory, a separate debitable agency may be engaged chargeable to the original contract.

8. Contract may be terminated for bad work, unsatisfactory progress etc., and part or full security money may be forfeited.

9. Contractor has to execute the work as per altered specifications and design if such alterations are done by competent authority.

10. Compensation to the workman shall be paid by the contractor for any accident or damage.

11. For any claim or dispute the decision of Superintending Engineer is final.

Schedule of rates: (SOR)

1. SOR is the list of rates of various items of work.
2. To facilitate the preparation of estimates, and also to serve as guide in setting rates in connection with contract agreements.
3. SOR is prepared by central public works Department (CPWD) which is premier construction organization of Government of India.
4. SOR consists of about 2500-3000 items under different subheadings like
 - Part-I Irrigation & CAD works
 - Part-II Road & bridge works
 - Part-III Building works
 - Part-IV Public health works.
5. Labour costs depends upon the cost class of labour - skilled (1st class), skilled (2nd class), unskilled.

Standard data & Rate Analysis:

The determination of rate per unit of a Particular Item of work, from the cost of materials, the cost of labourers and other petty expenses required for its completion is known as Analysis of rate.

Rates of Particular item depends upon the following:

i) Specification of works and materials, quality of materials, proportion of mortar, method of construction & operation etc.,

ii) quantities of materials and their rates, number of different types of labourer and their rates.

iii) Location of the site, its distance from source materials, transportation cost, availability of water etc.,

iv) profits and miscellaneous and overhead expenses of contractor.

overhead costs: these include general office expenses, rents, taxes, supervision and other costs which are indirect and non productive expenses of the job.

They may be of two types

1) General overheads: These includes cost for

Establishment (office staff), ii) Stationary, Printing, Postages etc., iii) Travelling expenses iv) Telephone v) Rent and taxes.

2) Job overheads: - i) Supervision, ii) handling of materials iii) Repairs, carriage and depreciation of T and P (Tools and plants) iv) Amenities & labour v) workmens compensation, insurance etc.,

Analysis of rate is usually worked out for the unit of payment of particular item of work under two

heads. i) Materials and

ii) Labour.

Following points are to be considered during rate analysis.

1) Materials and labour costs are added to find cost of item of work.

2) cost of materials are taken as delivered at site inclusive of transport, local taxes & other charges.

3) For T & P (Tools and plants) which cannot be accounted in details, lump-sum provision is made.

4) A provision for water charges $1\frac{1}{2}$ % of total cost is made.

5) Adding 10% to this cost as contractors profit, the rate per unit item of work is calculated.

6) If transport of materials is done for more than 8 km, Analysis for transportation cost have to be calculated.

Task or turn-out work: capacity of doing work by an artisan or skilled labour in the form of quantity of work per day is task work or ^{out-}turn of labour.

Numericals:

Materials required for different proportion of Cement concrete: - (10 cu m)

In practice volume of finished concrete over the sum total volume of ingredient materials is taken as 50 - 55%. For 100 cu.m of finished concrete the sum total volume of dry ingredient materials is 152 cu.m.

For 1:4:8 proportion.

$$\text{Cement} = \frac{15.2}{1+4+8} = 1.17 \text{ say } 1.15 \text{ cu.m.}$$

$$\text{Sand} = 4 \times 1.15 = 4.60 \text{ cu.m}$$

$$\text{ballast} = 8 \times 1.15 = 9.20 \text{ cu.m}$$

Mix	Proportion	cement (cu.m)	Sand (cu.m)	ballast (cu.m)	concrete (cum)
M20	1: 1 1/2 : 3	2.8	4.2	8.4	10
M15	1: 2 : 4	2.2	4.4	8.8	10
M10	1: 3 : 6	1.5	4.5	9.0	10
M7.5	1: 4 : 8	1.15	4.6	9.2	10
M5	1: 5 : 10	0.95	4.75	9.5	10
	1: 6 : 12	0.8	4.8	9.6	10

1 cum of concrete = 30 bags of cement.

Q) Calculate the cost for cement concrete 1:5:10 in foundation or floor with brick ballast 40mm (1 1/2") thick for 10 cum of concrete. Also calculate for 1 cum of concrete. (Cement concrete)

For 1:5:10 concrete mix

calculate the proportions of cement, sand, ballast in cum. as in table above.

Particulars	Quantity of No.s	Rate		Cost
		RS	P	RS
Materials -				
Cement	0.95 cum (28 1/2 bags)	7650	Per cum	7267.50
Sand	4.75 cum	700	Per cum	3325.00
brick ballast	9.5 cu m	650	Per cum	6175.00
		Total :		16767.50
labour -				
Mistri	1/2 no.	350	Per day	175.00
Mason	1 1/2 no	300	Per day	450.00
Mazdoor	12 no.s	220	Per day	2640.00
Boy or woman coolie	18 no.s	200	Per day	3600.00
Bhisti	4 no.s	200	Per day	800.00
Sundries, T&P	Lumpsum	120	L.S	120.00
		Total :		7785.00
Total materials & labour				24552.50
Add	1 1/2% water charges			368.00
Add	10% Contractors Profit			2455.25
Grand total :				27375.75
				per 10 cum

$$\text{Rate per cum} = 27375.75/10 = \text{RS. } 2737.50.$$

Q2) Calculate & perform Rate analysis for cement concrete 1:2:4 ratio. for 10 cum. Also find for 1 cum of cement concrete.

The following rates may be considered.

Cement : RS ~~255~~²⁵⁵ Per bag

Sand : RS 1500 per cum

Stone ballast : RS 1800 per cum

Mistri : RS 350 per day

Mason : RS 300 per day

Mazdoor : RS 220 per day

Boy or women coolie : RS 200 per day

Bhisti : RS 200 per day

Forms if required : RS 1300.00 Lumpsum.

Cost of cement: RS ~~255~~²⁵⁵ Per bag

Cost of 30 cement bags = $30 \times \text{RS } 255 = \text{RS } 7650$

\therefore Cost of 1 cum of cement = RS 7650/-

Particulars	Quantity no.s	Rate	Cost
Materials -			
Cement	2.2 8.18 cum (66 bags)	7650 Per cum	16830.00
Sand	4.4 cum	1500 Per cum	6600.00
Stone ballast	8.8 cum	1800.00 per cum	15840.00
Total :			39270.00
Labour -			
Mistri	1/3 no	350 per day	116.70
Mason	2 no.s	300 per day	600.00
Mazdoor	12 nos.	220 per day	2640.00
Boy & woman coolie	20 nos.	200 Per day	4000.00
Sundries T&P	Lump Sum	150.00	150.00
Forms	Lump Sum	1300.00	1300.00
Bishti	6 nos.	200 per day	1200.00

Total : 10006.70

Total materials & labour : 49276.70

Add 1 1/2 % water charges : 739.00

Add 10% contractors profit : 4927.67

Grand Total : 54943.47

for 10 cum

Rate per cum of cement concrete = $54943.47 / 10$

= RS 5494.34

Q3) Find the rate of R.C.C work in beams, slabs etc., of 1:2:4 for 10 cum of RCC and also for 1 cum of RCC. The following rates may be considered.

Cement : RS ~~285~~³⁷⁰ per bag

Sand : RS 1500 per cum

Stone ballast : RS 1800 per cum

steel :

Timber planks and ballies : 1500 L.S.

Nails : 200 L.S.

Binding wire : 65 per kg

Mistri : RS 350 per day

Mason : RS 300 per day

Mazdoor : RS 220 "

Boy & woman coolie : RS 200 per day

Bhistiti : RS 200 per day

Blacksmith (II class) : RS 280 per day

Carpenter : RS 280 per day

Cost of 1 bag of Cement = RS 370

Cost of 30 bags of Cement = $370 \times 30 = \text{RS } 11100/-$

Cost of 1 cum of Cement = RS 11100/-

Particulars	Quantity Nos.	Rate Rs	Cost
Materials —			
Cement	2.2 Cum	11100 71610/100 per cum	24420.00 168810.00
Sand	4.4 Cum	1500 Per cum	6600.00
stone	8.8 cum	1800 per cum	15840.00
Steel . @ 1% = 1 Cum = 7.85 q	7.85 q	4400 per q	34540.00
Binding wire	1.5 kg	65 per kg	97.5
		Total: 81497.5	
Labour —			
Mistri	1/2 no.	350 per day	175
Mason	3 nos.	300 per day	900
Mazdoor	12 nos.	220 per day	2640
Boy or woman coolie	20 nos.	200 per day	4000
Bhishti	6 nos.	200 per day	1200
Sundries, T & P	Lumpsum	140	140
		Total: 9055.00	
Bending, cranking and binding steel bars in position —			
Blacksmith (II class)	8 nos.	280 per day	2240.00
Mazdoor (Beldoor)	8 nos	220 per day	1760.00

Particulars	Quantity NOS.	Rate Rs	Cost Rs
T and p	Lump Sum	90	90
Centering and Shuttering —			
Timber planks and ballies	Lump Sum	1500 L.S.	1500
Carpenter (II class)	10 nos.	280 per day	2800
Mazdoor	10 nos.	220 per day	2200
Nails	Lump Sum	200 L.S.	200
T and P	Lump Sum	70 L.S.	70
		Total :	4090.00
		Total :	Rs 6770.00

Total of materials and labour: Rs 10141.50
 Add 1/2 % for water charges : 1521.18
 10% for contractor's profit: 10141.25

Grand Total = Rs 113074.93
 for 10 cum of RCC

Rate for 1 cum of RCC = $\frac{113074.93}{10}$
 = Rs 11307.49
 = Rs 11308.00

Q4) Find the rate for RCC work in column 1:1 1/2:3

Following rates may be used

Cement: RS 255 per bag

Sand : RS 1500 per cum

Stone aggregate : RS 1800 per cum

Cost of labour can be used as in before solved

Problem

Cost of 1 cum of cement = $255 \times 30 = \text{RS } 7650$

Particulars	Quantity NOS.	Rate (Rs)	Cost (Rs)
Materials—			
cement	2.8 cum (84 bags)	7650 per cum	210420.00
Sand	4.2 cum	1500 per cum	6300.00
Stone aggregate	8.4 cum	1800 per cum	15120.00
mild steel @ 2% = 0.2 cum	2 x 7.85 = 15.7 q	4400 per q	69080.00
Binding wire	2 Kg	65 per kg	130
			Total : 112050.00
Labour —			
Same as Previous		Problem	
			Total : 9055.00
Bending & binding of steel bars —			
Blacksmith	12 Nos.	280 per day	3360.00
Mazdoor	12 Nos.	220 per day	2640.00
Tand p	Lump sum	70.00	70.00
			Total : 6070.00

Centering and Shuttering -

Same as previous problem

Total : 6770.00

Total of materials & labour : RS 133945.00

Add 1 1/2 % for water charges : RS 2009.00

Add 10 % for contractors profit : RS 13394.50

Grand total: 149348.50
for 10 cum of RCC

Rate for 1 cum of RCC = $\frac{149348.50}{10}$ = RS 14934.85

Q5) Find the rate of lime concrete in foundation with 40mm gauge brick ballast for 10 cum and 1 cum. Take lime and Surkhi of proportion. Following rates may be employed.

white slaked lime : RS 800 ^{per} cum

Surkhi : RS 500 per cum

brick ballast : RS 650 per cum

Mistri : RS 350 per day

Mason : RS 300 per day

Mazdoori : RS 220 per day

Boy or woman coolie, Bhishti : RS 200 per day

A) Calculation of materials:

Proportion = 1:2:6 [consider]

$$\text{lime} = \frac{15.2}{1+2+6} = 1.6 \text{ cum}$$

$$\text{Surkhi} = 2 \times 1.6 = 3.2 \text{ cum}$$

$$\text{brick ballast} = 6 \times 1.6 = 9.6 \text{ cum} \approx 10 \text{ cum}$$

Particulars	Quantity or Nos.	Rate (RS)	Cost (RS)
Materials—			
Brick ballast I class 40mm guage	10 cum	650.00 Per cum	6500.00
white lime slaked	1.6 cum	800 per cum	1280.00
surkhi	3.2 cum	500 per cum	1600.00
Total:			9380.00
Labour—			
Mistri	1/2 no.	350.00 per day	175
Mason	1 no.	300.00 per day	300
Mazdoor	12 nos.	220.00 per day	2640
Boy or woman coolie	12 nos.	200.00 per day	2400
Bhishti	2 nos.	200.00 per day	400
Sundries, T & P	Lump sum	100.00 per L.S.	100
Total:			6015.00
Total of materials & labour:			15395
Add 1/2% water charges:			231.00
Add 10% contractor's profit:			1539.50
Total:			17165.50
			for 10 cum

$$\text{Rate per cum} = \frac{17165.50}{10} = 1716.55$$

Q6) Find rate of Lime concrete in Roof terracing with 20mm gauge stone ballast, white lime and sand proportion 1:2:4. Following data may be used.

Stone ballast : RS 1800 per cum

Sand : RS 700 per cum

White lime slaked : RS 800 per cum

Labour costs may be taken as in previous question.

Particulars	Quantity or NOS.	Rate (RS.)	Cost (RS)
Materials —			
Stone ballast (20mm)	8.8 cum	1800 Per cum	15840.00
Sand (local)	4.4 cum	700 per cum	3080.00
White lime slaked	2.2 cum	800 per cum	1760.00
			20680.00
Labour-			
Mistri	1/2 no.	350.00 per day	175
Mason	2 no.	300 per day	600
Mazdoor	10 nos.	220 per day	2200
Boy or woman coolie	25 nos.	200 per day	5000
Bhishti	3 nos.	200 per day	600
Sundries, T&P	Lump Sum	100 L.S.	100

Total : 8675

Total materials & labour: 19345.00

Add 1 1/2 % water charges : 290

Add 10 % contractors profit : 1934.50

Grand total for 10 cum = 21569.50

Rate per cum = 2156.90

* For 10 cum of brickwork 5000 bricks are required.

* For 10 cum of brickwork, 3.2 cum to 3.5 cum dry volume of mortar is used.

Q7) Find the rate of I-class brickwork in super structure with 20x10x10 cm brick with 1:6 cement sand mortar. Following data may be used.

Cement: RS 255 per bag.

Sand: RS 700 per cum

Brick I-class: RS 4500 per 1000 NO.S.

Labour required cost may be taken as previous problem.

Particulars	Quantity or NO.S.	Rate (Rs.)	Cost (Rs.)
Materials -			
Brick I-class	5000 NO.S.	45000 per 1000 nos.	22500.00
Cement	0.45 cum	7650 per cum	3442.50
Sand	2.7 cum	700 per cum	1890
		<u>Total:</u>	<u>27832.50</u>
Labour -			
Mistri	1/2 no.	350 per day	175
Mason	7 Nos.	300 per day	2100
Hazdoor	7 Nos.	220 per day	1540
Boy or woman coolie	7 Nos.	200 per day	1400
Bhishti	2 nos.	200 per day	400
Sundries, T&P	Lump Sum	90 Lumpsum	90
		<u>total:</u>	<u>5705</u>
		Total of materials & labour:	33537.50

Add 1 1/2% water charges : 530.00

Add 10% contractors profit: 3531.75

39379.25. for 10 cum

Rate per cum = $39379.25 / 10 = \text{Rs } 3938.00$

Q8)

Find the rate of half brick wall (10cm thick partition wall) with 1:3 cement mortar - Take 100sqm.

Coarse sand: Rs 1500 per cum

All the remaining data can be taken same as in previous

Problem.

100 sq.m of 10cm thick wall = 10 cum. Hence quantity of materials can be calculated as usual.

Particulars	Quantity & Nos.	Rate (Rs)	Cost (Rs)
Materials —			
Brick I class	5000 Nos.	4500 per 1000 nos.	22500.00
Cement	0.75 cum	7650 per cum	5737.50
Sand	2.25 cum	1500 per cum	3375.00
Labour —		Total: 316	12.50
Mistri	1/2 no.	Rs 350 per day	175
Mason	12 nos.	300	3600
Hazdoor	8 nos.	220	176000
Boy & woman coolie	10 nos.	200	2000
Bhishti	2 nos.	200	400
Scaffolding	Lump sum	325	325
Sundries, T&P	Lump sum	90	90
		<u>Total: 8350.00</u>	

Particulars	Quantity	Rate	cost
	Total materials & labour		RS 39962.50
Add 1 1/2% of water charges			599.40
Add 10% of contractors profit			3996.25
Total			44558.00
for 100sq.m			
Rate per sq.m =			$44558/100 = 445.58$

Q9) Find the rate of 12mm plastering 1:6 for 100sq.m and 1sq.m.

Sand: RS 700 per cum

Remaining required data can be taken from previous problem.

* Dry volume of materials required for 100sq.m of plastering = 2 cum

$$\text{Cement} = \frac{2}{1+6} = 0.3 \text{ cum}$$

$$\text{Sand} = 6 \times 0.3 = 1.8 \text{ cum}$$

Particulars	Quantity	Rate (Rs)	cost (Rs)
Materials —			
Cement	0.3 cum	7650 per cum	2295.00
Sand	1.8 cum	Rs 700 per cum	1260.00
		<u>Total :</u>	<u>3555.00</u>
Labour —			
Mistri	1/3 no.	350 per day	116.70
Mason	10 NOS.	300 "	3000
Mazdoor	15 NOS.	220 "	3300
Bhishti	3/4 nos	200 "	150
Scaffolding, Sundries etc.	Lump sum	200 L.S.	200
		<u>Total :</u>	<u>6766.70</u>

Total of materials and labour : 10321.70
 Add 1 1/2 % of water charges : 154.80
 Add 10 % contractors profit : 1032.17

Grand total : 11508.67
 for 100 sqm

$$\text{Rate per sqm} - 11508.67 / 100 = \text{RS } 115$$

* In cement concrete floor: For ¹⁰⁰ cum of dry cement concrete the total volume of materials is 125 i.e., approximately 50% more.

For 2.5cm thick cc floor: (consider 0.25cm extra thickness for finishing purpose)

$2.75 + 50\%$ of $2.75 =$ Total dry volume of materials for 1000 m^2 sqm of cc floor.

$= 2.75 + 1.375 = 4.125 \text{ cum}$ [1:2:4 Proportion]

Cement = $\frac{4.125}{1+2+4} = 0.59 \approx 0.6 \text{ cum}$

For 2cm thick cc floor of 1:1 1/2:3:

Dry volume of materials required = $2.25 + \frac{2.25}{2} = 4.125$

Cement = $\frac{4.125}{1+1.5+3} = 0.75 \text{ cum}$

Sand = $1.5 \times 0.75 = 1.125 \text{ cum}$.

Rate analysis of 2.5cm cc floor 1:2:4.

Particulars	Quantity Nos.	Rate (Rs)	Cost (Rs)
Materials —			
stone ballast	2.4 cum	1800 per cum	4320
Sand	1.2 cum	1500 / cum	1800
Cement	0.6 cum	7650 / cum	4590
Cement for surface finishing	0.2 cum	7650 / cum	1530
		Total:	12240.00
Labour —			
Mistri	3/4 no.	350 per day	262.50
Mason	10 NOS.	300 "	3000
Haz door	5 nos	220 "	1100
coolie	5 nos	200 "	1000
bhishti	2 nos	200 "	400
Side forms	Lump sum	200 L.S.	200
Sundries, I & P	Lump sum	90 L.S.	90

Total materials and labour = 1829.50

Add 1 1/2 % water charges = 274.00

Add 10% contractors profit = 1829.25

20395.75 for 100sqm

Rate per sqm = $20395.75 / 100 = \text{Rs } 204.00$

Bill of quantities:

1. It is a statement of the various items of work giving the description, quantities and unit of rates.
2. It is prepared in a tabular form similar to the 'Abstract of estimated cost' of detailed estimate, but the rate and amount columns are left blank.
3. It is primarily meant for inviting tender and supplied to the contractor to fill up the rates and amounts columns.
4. On receipt of the tenders the rates and amounts are compared and decision about entrusting the work is finalised.