

CHAPETR I: QUANTITY SURVEYING

1.1 Introduction

Quantity surveying is a term or processes used in the construction industry to take measurements of civil works, prepare specifications, and estimate the cost of works either for each trade of work or for the whole project.

The following tasks are covered in quantity surveying:

1. Preparation of specification
2. Taking measurements of civil works (Taking off quantities and preparing BOQ)
3. Preparation of approximate (preliminary) cost estimate at the very early stage of the project
4. Preparation of detail cost estimate at different stages (taking as built measurements and preparing payment certificates or approval of payment certificates prepared by taking measurements)
5. Preparation of tender documents and examining tenders
6. Preparation of schedule of prices to negotiate with pre-qualified bidders (labour rates, material supply rates, equipment rental rates)
7. Determination of values of works (executed works) and preparation of payment certificates
8. Preparation of final accounts on completion of all of the works.
9. Valuation of property

1.2 Measurement of Civil Works

Measurement of civil works includes the billing of each trade of work either from drawings or the building itself for defining the extent of works under each trade. The standard book, which is used here, is standard technical specification & method of measurement for construction of buildings by BaTCoDA, March 1991.

Specification Worksheet (BOQ form)

It is the format which is used in a bill of quantity to list (include) a short description of the specification along with its measuring unit, quantity and unit prices to determine the total cost for each trade of item.

The following tasks are part of the taking off (used to facilitate defining the quantities):

Describing the item, bracketing (relating the description to the quantity), timising, dotting on (adding to the timising factor), the ampersand (ditto), waste calculations, deduction of items, correction of dimensions (nullifying).

Project:						Bending schedule to :											
Location	Mark	Shape	Diameter	Length (m)	No.				Σ L for each diameter								
									Total								
									W/m								
									ΣW								

ALTERNATIVE BENDING SCHEDULE

Element No.	Location	Shape	Bars in a Member	No of Members	Ø	L/m	ΣL(m)	Total Weight											
								Ø6	Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø22	Ø24	Ø26	Ø28

1.2.2 Squaring:

The dimensions entered in Column 2 are squared or cubed as the case may be, multiplied by the timising factor, and the result entered in Column 3. This task is called squaring. All squared dimensions should be carefully checked by another person before abstracting, and if correct the item should be ticked with red.

1.2.3 Abstracting:

The squared dimensions are transferred to abstract sheets and all similar dimensions are collected in the same category to obtain the total quantity of each item.

1.2.4 Writing the Final Bill

After the abstract sheets have been completed and checked, the final bill of quantity is written. The dimensions are copied from the abstracts, and as each item is transferred it should be ticked by a vertical line from the abstract sheets. The description of each item in the final BoQ should be short, precise and descriptive as per the specification.

1.3 Basic Principles in Taking Off

1. Drawings shall be fully understood and clearly detailed.
2. During discrepancies in detailing, dimensioning or if missing items exist obtain clarification from the designer.
3. The BoQ shall accurately represent the works to be executed.
4. Works, which cannot be measured accurately, shall be expressed as provisional quantity (PQ) and will result in provisional sum (PS) and lump sum (LS)
5. Shall be prepared in such a way that discrepancies or mistakes in taking off will not result in excessive variation in the project cost which directly will affect the budget allocation for the project.
6. There shall be the understanding that measurements are taken to the nearest cm.
7. Built items shall generally include all possible entrants like labor, materials (including storing, loading, unloading and handling), fixing, use of plant and equipment, wastage of materials, equipment; which will result in a better process for establishing prices and profit.
8. There shall be understanding that there is a standard paper format to carry out measurements of civil works, namely take off sheet or dimension paper, bending schedule and specification worksheet.
9. Prior knowledge of the regulations is necessary (For E.g. roofing is measured in horizontal projection).
10. Measurements of civil works shall be carried out in such a way that it can be easily checked and audited.

1.4 Types of Taking Off

Mensuration – the calculation of geometric quantities such as length, area, and volume, from dimensions and angles that are already known.

Girth (perimeter) computation –linear measurement. There are various methods of taking off quantities for computation of girth.

Centre line method –suitable only when the cross sections of all walls are symmetrical. In this method centre line length is found and same is used for taking off quantities (therefore only width and depth vary).

Crossing method – lengths and breadths of walls as shown in plan are taken for working out various items and this method is useful only if the offsets of footings are symmetrical.

In- to- in and out- to-out method –some wall lengths are taken out to out and others in to in (offsets are added to out to out lengths) and same are deducted from in -to-in lengths; used for any type of measurement irrespective of condition of symmetry.

1.5 Technical Specification and Method of Measurements for the different trade of Works

1.5.1 Building Project

The following specifications and methods of measurement are provided to guide the quantity surveyor in the preparation of quantities for a building project. A typical building project will have the following work items.

	<u>A-SUB STRUCTURE</u>
1	Excavation and earth work
2	Masonry work
3	Concrete Works
	<u>B. SUPER STRUCTURE</u>
1	Concrete Works

2	Masonry Works
3	Roofing
4	Carpentry and Joinery
5	Metal Works
6	Finishing
7	Glazing
8	Painting
9	Sanitary installation
10	Electrical installation
II	Fence Work

1.5.1.1 SUBSTRUCTURE

Any structure below the ground floor slab level including the basement, retaining walls, ground slab, grade beam, and foundation is called a substructure. In most of the cases, substructure work can be categorized as follows:

1. Excavation and earthworks (mandatory)
2. Concrete works (can be neglected sometimes)
3. Masonry works (mandatory)

1. Excavation and Earthworks

What types of works are included in excavation and earthworks?

a. Site clearance

Carbonatious elements are not good in concrete, steel and timber works. In soils under structures even 5% of these elements will damage the structure. Therefore, these materials (including trees, bushes and the top 20 to 30 cm soil), termite hills, any other obstruction, too, have to be cleared. A working space of 1m is required on each side. It is sometimes necessary to prepare separate specification for obstructions (demolition works) because reusable items like doors and windows are there.

b. Excavation (bulk excavation)

Excavation to get reduced levels of every structural element below the ground level is called bulk excavation. They are subdivided as follows depending on the subsurface condition.

- Ordinary soil - with boulders and without boulders and can easily be removed by shovel.
 - Weathered rock -it can be divided easily without blasting.
 - Rock- bedded rocks that cannot be dug without blasting (requires using explosives)
- Note: - Working space for bulk excavation is 25 cm (not used for shallow masonry)
- Depth of excavation less than 30 cm – measured per m^2 , depth > 30 cm per m^3 .

c. Fill / Embankment

Shall be measured in m^3 of net volume to be filled. Fill is required because the reduced level of every structural element above the structure has to be covered. Excavation and embankment should not be added at a time in computing their volume, because their costs are different. The major consideration under embankment is compaction. Compaction is done usually at 20 cm lift thickness. The subdivisions under fill are:

Back fill: - filling by using the excavated soil but by removing coarse particles.

Borrow fill: - filling by using fill material from another place when there is shortage of fill or when better quality material is required.

d. Disposal - cleaning the building area including cart away.

e. **Sundry items** – application of termite proof solution, providing hard coring, dust blinding, expansion joints, etc are itemized as sundry items; measured in m^2 .

2. Concrete Works

a. Concrete

Cast in situ concrete – formed on site and requires formwork and reinforcement. Cast in situ concrete shall be measured by volume except in ribbed slabs and grouting.

Prefabricated concrete –fabricated (manufactured) in a factory and brought to the site and joined to make a building. It does not require formwork but needs a special care when connecting the different elements. It is fast means to construct a building, though the different elements may lack homogeneity.

Pretensioned (Post tensioned) Concrete –involves in bending up the concrete itself to make it ready for the downward bending due to load.

Concrete ancillaries- include windowsills, lintels, expansion joints, and permanent and temporary embedded materials. It is measured in ml or enumerated.

Grades of Concrete

C5 – lean concrete, to protect the structural concrete from damage

C15 – for totally supported structural elements

C20 – used for slabs; mix proportion is 1:2:4

C25 – Commonly used grade of structural Concrete; mix proportion is 1:2:3

C30 – Used for chemical stores and nuclear plants

b. Formwork – measured in m²

A temporary structural element, which supports slabs, beams in casting concrete. It shall be designed and erected to safely support, vertical and lateral loads that might be applied until such load can be supported by the concrete structure.

Period of removal (minimum):

1. Vertical formwork to columns, walls and beams: 16 hrs
2. Soffits formwork to slab: 21 days
3. props to cantilever slabs: 14 days
4. Soffits formwork to beams: 21 days
5. Props to cantilever beams: 14 days

Formwork Classification: Normal finish, Fair face Finish, and Patterned Finish.

c. Reinforcement

The reinforcement bars are tied by $\phi 6$ mm mild steel wire and measured in kg.

3. Masonry Works

Masonry works are works that are executed by laying building material units of specified dimension through a binding material such as mortar. Stone obtained from quarries shall be hard and sound, free from vents, cracks, fishers, discoloration or other defects that will adversely affect strength or

appearance. Stone chips to be produced shall not be less than 450 mm average and 380 mm in individual length. Stone for various masonry works shall be selected and shaped as follows:

- a) stone for facing works shall generally be selected for consistency in grain, color and texture, throughout the work
- b) stone for below ground work shall be chiseled from natural stone

Stone wall is measured by volume, whereas stone pavement is measured by area, specifying thickness.

1.5.1.2 SUPER STRUCTURE

1. Concrete works –

- a. **Concrete:** mostly as discussed in substructure part
- b. **Formwork:** Specify the type of material used and where to use (zigba or steel)
- c. **Reinforcement:** Differentiation is made as to the diameters and where used (sub and super structure) and Weight per unit length for $\Phi 6$ is 0.222 kg/m; for any other diameter d_2 , with weight per unit length w_2 :

$$w_2 = (d_2^2 / 6^2) * 0.222$$

2. Masonry works – measured by volume

Classification of stone masonry works:

1. Stone wall concealed from view or to be left for further finish (cheaper)

- shall be built in stone sizes of not less than 300 mm per course (one lay) and 400 mm wide per stone,
- faces of stone walls to receive further finish shall have horizontal and vertical joints raked out to form adequate key for further finish.

2. Roughly dressed stone wall (expensive)

- Shall be built in stone sizes of not less than 300 mm per course and 400 mm wide,
- The joints of the fair chiseled natural stones shall be finished slightly proud (aesthetical) and cleaned off flush at completion,
- The joints shall be raked out to a depth of 15 mm as the work proceeds and prepared for jointing.

3. Dressed stone wall facing (more expensive)

- The pattern type and size of the stone units shall be as detailed on drawings,
- The joints of dressed stone wall shall be finished good and raked out to an approximate depth of 15 mm.

Hollow and solid concrete blocks, measured by area specifying the thickness.

Blocks shall be manufactured from cement, aggregates, red ash, or pumice with no fine volcanic dust. Trial mixes shall be prepared to attain the average minimum compressive strength after casting and curing for 28 days. There are different classes of HCB:

Class A = 42 kg/ cm² (for light loads)

Class B = 35 kg /cm² (for external walls)

Class C = 20 kg/cm² (for partition walls)

Class AA=70 kg/cm² (for load bearing sub structural works)

Class A-AA= 50 kg/cm² (for load bearing super structural works)

Class AA and A-AA shall be obtained from 0.1 aggregate not from pumice or red ash. Blocks shall be uniform in texture, size, and shape and free from any cracks and defects and also the surface of blocks shall have a good key for plaster and rendering. The standard thicknesses of HCBs are 10cm, 15cm, and 20cm.

Bricks, measured by area specifying the thickness.

Bricks are fire resistant, watertight and can also resist compressive action of up to 50 MPa. Bricks can be used for external, internal, retaining and load bearing walls. Bricks shall be well made and adequately burnt, free from cracks and particles of lime. Bricks exposed to weathering shall be selected for least in absorption, high durability, uniform in color and texture. The thicknesses of bricks are 25 cm (for double layer) and 12 cm (for single layer).

Adobe walls, measured by area specifying the thickness.

It is a mixture of clay, water and straw or 'chid' with high resistance to drying shrinkage and cracking. It shall be dried gradually; ordinary type of masonry wall, and used for very low cost houses.

Stabilized soil block wall

It is a mixture of soil, water, and Portland cement, used for low cost houses.

Note: During measurement, no deduction is made for opening up to 0.25 m² in area.

3. Roofing and wall cladding**Galvanized corrugated iron sheet (CIS)**

Galvanized CIS for roof and wall cladding shall be of the required size and thickness. CIS less than G32 cannot be used for roofing and wall cladding of permanent structures but for temporary works e.g. fence works, for provisional works. Include G26, G28, G30, G32 and G35, where G26 is the thickest.

Galvanized plain steel sheet (GPSS)

GPSS is used for wall cladding, ridge cup, gutter, down pipes, flashing, coping, edge, trimmers etc; shall be to the size, thickness and galvanization required; shall not be less than G28; G24 is usually used for gutter, down pipes; Overlaps at edges shall be minimum 15 cm.

Galvanized ribbed sheets (EGA sheets)

Usually used for factory, hall etc. Shall comply with the requirements of the manual 'KASI' or other standards acceptable to the Engineer to the sizes, thickness and distance to ribs.

Aluminum corrugated sheet for roofing and cladding

The minimum thickness shall be 24 SWG (SWG = standard wire gauge), Corrugated sheets shall have uniform corrugation parallel with the sides of the sheets.

Aluminum plain sheet accessories

Used for ridge cap, gutter, down pipes, flashing, coping etc.

Roof clay tiles

Tiles shall be manufactured in wet weather and prepared from clay. Clay tiles shall show clean fracture when broken and shall not be less than 10 mm thick. Clay tiles shall be fixed to timber using roof, nails, the holes in clays shall be pierced (using embedded in clay tiles)

Fixing accessories of roofing

Fixed to timber using chiseled or diamond edge and convex head galvanized nail drawn from mild steel, Washers shall be diamond or flat pattern produced from rubber or bitumen coated fiber homogenous and free from porosity (to prevent leakage).

Hooks, bolts, nuts and screws: - Shall be fixed to steel structures; the sizes of fixing accessories shall be as recommended by the manufacturers and match with structural drawing.

Hangers and brackets; used to fix gutters and down pipes; Formed from mild steel not less than 2 mm thick and 10 mm wide; Hangers and brackets shall always be primed (coated) with anti-rust paint.

Gutter and down pipe; Gutters shall be laid to slopes as indicated on drawings not less than 0.05 percent. Gutter and down pipes shall be overlapped min 15 cm and joints welded.

Method of measurement for roofing

Roof cover, side cladding, and the like shall be measured by area (m²), flat over the projection area without addition for slopes and laps.

Ridges, flashing, down pipes etc shall be measured by length stating girth (development length) and without addition for laps, passing angles etc.

Rain water spout shall be enumerated stating the sizes and length. The same is true for most of prefabricated items.

The following shall be understood as included: perforating, sealing, nailing, bolting, screwing, battens, joists, wedges, spillers, covering lists, back supports, brackets, cutting bracing, trimming, jointing, boring, etc.

4. Carpentry and joinery works

Carpentry: – work on timber intended for structural purposes eg columns, beams, slab, truss etc

Joinery: – work on timber intended for finishing purposes eg floor finishes, wall claddings, doors and windows, ceilings etc

Carpentry – includes Truss, rafter, beams and columns. Shall be made from eucalyptus, kerero, zigba, tid, or other equivalent posts and Shall be fabricated as per the detailed drawings. Posts shall be uniform in diameter and free from cracks and shall be peeled off and allowed to season until the acceptable moisture content is achieved, i.e. 20 % (seasoning = drying up to a certain moisture

content). Eucalyptus and kerero posts to be exposed to weather or buried below ground shall be pressure impregnated. Trusses and rafter shall be tied with 6 to 8 mm diameter mild round steel.

Purlins – shall be produced from eucalyptus or zigba or other equivalent posts. Purlins shall be in the sizes shown on drawings (standard dimension 5*7cm). The splices of purlins at joints shall be minimum 60 cm and shall be securely nailed to trusses and rafter.

Joinery

A. Ceiling

Ceiling shall be built to types, size and thickness on drawings. The face of the panels to be exposed to view shall be smooth enough to receive further finish. Soffits nailed to supporting ceiling buttons.

Soffits are made of chip wood, plywood, hard board, soft board nailed to timber buttons. Minimum size of buttons is 4*5 cm and maximum spacing is 60 cm in both directions. Button shall be fixed to the truss or rafters in 4*5 cm sawn timber suspenders. The joints of ceilings to wall shall be covered with moulded corner lists not less than 50mm and joints of panels be covered with mild timber and moulded lists not less than 30 mm wide.

Suspended ceiling Soffits

Cheap wood, plywood and other ceilings suspended from supports by wire, chains and steel profiles and materials resting on the metal profile.

Milled timber Soffits

Made of zigba or kerero, Minimum thickness is 15 mm, Minimum panel width is 60 mm. Timber boards shall be grooved and tongued, Buttons shall be 50*50 mm and c/c 50 cm spacing.

Milled timber accessories

Fascia board shall have minimum thickness of 20 mm, Edges shall be chamfered. For Milled timber cladding - Use a smooth joint that is without tongue and grove, and Cladding to wall shall be to the size, shape and patterns as on the drawings.

B. Doors, Windows and Wall Panels

Doorframes

Shall be notched to receive iron mongery (hinge, lock and handle) and Lists of cover joints between frame and wall shall be milled timber not less than 50 mm wide.

- a) Glazed wooden doors - the side , top bottom and intermediate rails shall be mortised and tenoned - rails shall be single width timber
- b) Panel wooden doors - plywood or other panels are used in place of glazing
- c) Flush wooden door - Finished thickness of flush doors not less than 40mm, Face panels on either face shall not be less than 8 mm, Cover panels if tongued, boards shall not be less than 15mm.

Wall panels – Wall Panels include fully solid or partly glazed partition for buildings, Tongued and grooved milled timber boards not less than width of 80 mm and 15 mm thick, If open jointed milled timber is used, width=100mm and thickness=15mm, Block board with specified plywood exposed surface of less than 20mm thickness.

C. Cupboard and counters

Built in cupboards: – fixed cupboards on construction of the building; shall be constructed from milled timber and paneled boards. It has frames of 40x40 mm milled timber, fixed to wall, the bottom part is made up of 20mm thick edge lipped block board with exposed faces covered by plywood, and Rear, side and top part of the cupboard shall be lined with 6mm exposed face smooth finish plywood.

Drawers: – shall be built in 20 mm thick milled timber, bottom of drawer shall be block board not less than 6mm thick, shall have milled timber plastic or metal guide rails to each other.

Shelves: – 20 mm thick block board with upper face finished smooth and be supported on hardwood metal or plastic support securely screwed or nailed to the cupboard frame.

Methods of measurement for carpentry and joinery

- Structural members other than truss shall be measured by length stating size (eg columns, beams)
- Roof trusses shall be enumerated stating type and referring drawings (sometimes measured in meter length)
- Boarding, flooring, partitions, Soffits (ceiling),curtain walls are measured by area and shall be understood as including frames , corner lists and hard wares(hinge ,handle, lock)
- Fascia boards, eaves, skirting shall be measured by length stating girth
- Built in furniture and boards shall be enumerated stating sizes.

5. STEEL STRUCTURAL WORK

Steel is used for constructing:-

- Beams, columns, suspended slab, truss, rafter
- Composite structure (steel +concrete)
- Up to 15m span we can use timber trusses, but for span greater than 15m,we have to use a steel structure

Bolts and nuts

- are used to connect (fix)structural steel with concrete or other material
- welding is usually not recommended for steel structures because it does not allow movement

Steel plates (steel to steel connection)

- used for splices of joints
- used for bearing plates

Fabrication

- shall follow sequences which are suitable for assembling and erection
- cutting shall be sawing, shearing (steel cutter),copping or flame cutting (oxyacetylene cutter)
- holes shall be drilled or punched
- holes shall not be more than 3mm larger than diameter of bolts

Assembling erection

- adequate care shall be taken to ensure that components are not bent or twisted
- bolted connection shall be drawn together
- washers shall be provided where slot holes are oversize
- anchors and embedded connection shall be set and grouted before mounting

Method of measurement

- Beams, trusses, columns and purlins, bracings, rails, etc shall be measured by weight (Kg), identified by profiles and type of structures
- Connection plates, base plates, angle iron ties, brackets shall be measured by weight or enumerated stating profiles and dimensions respectively
- Anchor bolts enumerated stating size and development length

6. METAL WORKS

Includes either iron or aluminum works:

- Metal door window frames and Steel profiles produced from standard grade of steel
- Aluminum profiles: - wrought aluminum and alloys are used. Nuts, bolts, screws and fasteners are coated or produced from non-oxidizing metal.

Fabrication

- Formed accurate to required profiles and sizes

Erection

- be placed accurately in position aligned, plumbed, and leveled
- they are usually door and window frames and hence no assembling of parts except fabrication and erection

Classification

1) Casement doors and windows

- side , bottom, and top hinged
- LTZ frame (iron made)
- SECCO profile (steel)
- RHS frames (refer KASI manual)
- SECCO profile is more expensive than LTZ

2) Heavy duty sliding door

- Guide and roller trucks shall be in mild steel in the sizes specified
- Rollers shall be heavy duty and produced from stainless steel and be provided at top

3) Louver window

4) Security grills

- Produced from mild steel galvanized or precoated solid plates or hollow profiles of patterns as

shown on drawings

5) Guard rails

- fastened to support securely embedded in concrete or welded

6) Wire netting and fly screen

- netted wire produced from steel
- mesh for fly screen shall not be more than 10 mm

7) Corner protection

- not less than 30 mm
- shall be securely screwed and embedded to angle of materials for protection

Method of measurement

- Doors and windows enumerated stating sizes (the glazing work shall be measured separately)
- Curtain walls by area
- Balustrade rails, corner protection by length stating development length
- Security grills fixed to windows and doors by area
- Louvers enumerated in size stating number of blades (louver jamb sets)

The following shall be understood as included: chiseling, cutting, welding, riveting, shaping, grinding, drilling, assembling, fixing, protective treatment , decorative paint , frames, beads, lining , anchors , hardwares etc(hardwares include hinge, lock, handle).

7. FINISHING WORK

1) Plastering and Pointing works

The ingredients are:

- Cement (ordinary Portland cement), Lime
- Gypsum (such as plaster of Paris)
- Aggregate (fine or crushed aggregates), water

Surfaces to receive plaster, pointing or screed shall be thoroughly cleaned and wetted. The surface should be raked out to a minimum depth 10 mm to form proper key (if the thickness of plastering is greater than 2.5cm, it may crack) and the surface should be rubbed with cement slurry (cement +water).

A. Plastering

First coat: - mix proportion 1:2.5 (cement: aggregate by volume)

- minimum thickness of 5 mm
- spread by trowel and allowed to cure for 24 hours before applying the second coat

Second coat: - mix proportion 1:1:6 (cement: lime: aggregate by volume) or 1: 4 (cement: aggregate by volume)

- max thickness of 12 mm
- dried for 21 days

Fine finish or fine coat cement plaster: - mix proportion 1:2 (cement + fine sand)

- max thickness of 3 mm
- shall be finished truly and level, use fine sand for smooth finish as final coat

Fine coat lime plaster: - mix proportion 1:2 (lime: fine aggregate)

- max thickness of 3 mm
- further finish up to 28 days

Fine coat gypsum plaster: - mix proportion 1:3 (gypsum: lime putty)

- max thickness of 3 mm
- cured for 28 days

Render coat: - mix proportion 1:2:5 (cement: lime: fine aggregate) or mix proportion 1:3 (cement: fine aggregate)

- shall be manual or machine sprayed, wetted for 7 days

Cement pointing: - mix proportion 1:2 (cement: fine aggregate)

- can be flush or recess pointing

Method of measurement

- plaster and pointing works shall be measured by area and Internal and external works shall be measured separately

The following shall be understood as included: preparing background , hacking out joints , grouting , jointing , recessing etc

2) Floor and Wall Finish

Terrazzo tiles: -used for floor finish and skirting

- shall be pre-cast or cast in situ elements

- shall have a minimum topping of two parts of marble or granite chipping from an approved quality with one part cement
- the minimum grading of the chip shall be 5mm
- usually have a thickness of 2 cm
- shall be applied onto 3 cm thick cement screed bedding (specified thickness)

Pre-cast cement tiles: - produced from crushed aggregates (0.1 mm gravel) and sand mix

- minimum thickness shall be 20mm
- shall be applied on 3 cm cement screed bedding
- cheaper than terrazzo tile

Marble tiles

- shall be in accordance with quality, color and texture as shown (specified)
- shall be straight edged and smooth surfaced
- cement mortar backing for walls and cement screed bedding for floors

Marble chips

- flooring thickness shall not be less than 20 mm and does not exceed 50 mm
- chips shall be irregular shape and the smallest dimension shall not be less than 100mm
- the exposed surface of mortar finish to marble chip shall not exceed 1:3 proportion

Ceramic and mosaic tiles

- ceramic tiles shall be glazed type of approved color , texture and size
- ceramic tiles shall be 6mm thick for walls and not less than 15mm for floors
- mosaic tiles shall be in regular square or hexagonal sizes not exceeding 25mm in dimension of each size PVC tiles
- usually thermoplastic
- the tiles and skirting shall be resistant to household oil and acids
- the glue (adhesive) for fixing PVC tiles and skirting shall be in accordance with manufacturer's instruction
- usually 2mm thick PVC tiles and 48 mm cement screed is used

Milled timber floor: - Having a thickness not less than 20 mm and minimum width of 70mm and shall be tongued and grooved

- Width of 70mm and shall be tonged and grooved
- Nailed to sawn timber joists
- Minimum size of joists 60x100mm c/c 50 cm

- Joists shall be accurately embedded in concrete
- Skirting: - machine smooth finished with minimum thickness of 20 mm and width 80mm, Edges shall be chamfered

COPPING, CILLS, STEPS, RISERS

- can be from marble , terrazzo , concrete , stone etc and shall be laid as per the drawing

Stone and concrete pavements: - dressed or roughly dressed sand stone or precast concrete shall be laid on compacted fill of 10 mm sand or red ash bedding and joints pointed with cement

Method of measurement

The following shall be measured by area specifying material, size and thickness

- all finishes to floors and walls except skirting , coping and cills
- all finishes to risers , treads, and landings to stairs

The following shall be measured in length specifying material, size and thickness

- skirting, risers, treads, cills and copings, dividing strips in floors

The following shall be understood as included:

- preparing background, hacking , raking , grouting , bedding , jointing , rubbing and priming

8. GLAZING

Transparent glass

- Sheet glass (clear glass)
- Transparent glass shall be clear or tinted, transmitting light and capable of showing objects

Figured glass

- have sufficient imprinting of texture or pattern totally or substantially obscure vision

Opal glass

- vision from inside but not from outside

Wired glass

- shall be in wire mesh, transparent, translucent or figured

Putty

- used for fixing the glass to the frame
- shall be quick , hard setting, tropical putty specially manufactured for glazing works

Method of Measurement

- glazing shall be measured by area
- glazing to louvers and special fixing may be enumerated by stating size and thickness
- The following shall be understood as included: - Bedding, mastic, fixing, beading, cleaning etc.

9. PAINTING WORKS**Oil based priming paints: -**

- priming coat – initial or preparatory coats
- applied to surfaces readily mixed or base paints

Aluminum priming paints

- for wood work
- shall be for brush application

Metallic zinc rich priming paints

- shall be applied to iron and steel surfaces

Oil Paints

- water proof
- shall be applied in accordance with manufacturers instruction
- can be applied for walls, wood work , metals

Plaster Emulsion Paints

- normal and usual type of painting
- shall be selected for interior and exterior works

Synthetic Enamel Paints

- used for metals with manufacturers instruction

Method of Measurement

- painting shall be measured by area
- special application to edges shall be measured in length stating the girth
- internal and external surfaces shall be measured separately

The following shall be understood as included: Trimming, cutting, matching patterns, cleaning, and priming.

10. SANITARY WORKS

It includes all works on building in connection with supply of potable water and removal of solid and liquid wastes.

CLASSIFICATION OF SANITARY INSTALLATIONS

Pipes

- Galvanized steel pipes –used for distribution of water (pipes for cold and hot potable water) internally and externally installed having plain or threaded ends.
- Pipes are measured by length stating diameter taken along the centerline over all fittings

Valves:

- Flanges used to connect pipes and for controlling
- Check valves, gate valve, service valves
- shall be in specified material and size at positions indicated in drawings
- Enumerated stating diameter

UPVC (unplasticised PVC) – rigid thermoplastic conduit

- can be used for cold water distribution
- usually used for solid waste and surface drainage with vent pipe in horizontal and vertical stacks
- shall be measured in length stating diameter and understood to include accessory joint fitting like Y,T, joints

Pre-cast concrete pipes – for solid waste and surface drainage

Solid pipes –surface drainage and sewage

Perforated pipes – subsurface drainage

Manholes: - Manholes are used for inspection, reduction of number of pipes, change of directions at angles and shall be in pre-cast concrete C 20 quality or Class A hollow brick as indicated and detailed in the drawings.

- shall be laid on a minimum concrete bed of 150mm
- enumerated stating size and depth including all related earthwork

Concrete pipes shall be measured in length, stating the diameter and understood as including: setting out, trench excavation, pipe laying, jointing, bedding and backfills

Septic Tanks, Soakaway Pits and Percolation Ditch

Solid and liquid waste (concrete) pipe and Manhole or septic tank

- Measurement shall be done in accordance with the method of measurement for each item of works

- May be specified on lump sum for costing

Sanitary Fixtures

- Shall be manufactured of standards acceptable for the intended purpose
- Appliances shall be supplied with mounting and plugging devices, valves, chains, waste plug, traps, handles, flexible pipes, bolts, nuts screws, hinges etc.

II. ELECTRICAL INSTALLATION

It includes supply, erection, installation, testing and commissioning of electrical wires as generally shown on electrical drawings. Materials shall be fully in accordance with qualities, tolerances, tests, recommendations, method of workmanship as described on specification and all accessories shall be fixed at the following heights above finished floor level unless specified on the BOQ or drawings.

1) Underground cable ducts

- made of pre-cast concrete pipes or galvanized steel pipes
- for protection of power and telephone outlet cable
- it shall be the responsibility of the contractor to ensure that the underground duct is installed correctly according to each party's requirement
- pre-cast concrete , galvanized steel UPVC are used (similarly as given for sanitary installation)
- Manholes – similar to the requirements for sanitary installation

2) Distribution boards (DB)

Main distribution boards (MDB) and sub distribution board (SDB)

- The contractor shall supply and install medium voltage MD panel as shown on the drawings. Arrangement of the panel shall be as to permit the ready incoming and outgoing cables.
 - Sub distribution board (SDB) shall be surface flush mounted and DB shall be of the type fully enclosed sheet steel cabinet and hinged cover
 - DBs shall be enumerated stating the power and voltage supply including all related works
- ### **3) PVC cables**
- underground cables shall be pvc insulated steel wire and pvc served overall and all cables shall have copper conductors

- measured in meter linear

4) Light points, power and socket outlets

- outlets are either of bell, fan , telephone , TV or antenna
- outlets shall be enumerated and understood as including all related works

Light points

- Fed through specified size pvc insulated conductors of thermoplastic conduits of 13.5 mm diameter for surface installation including junction boxes with cover and insulating caps
- Ditto as above but in steel conduits of 15 mm diameter

Socket outlets – same as light points

Bell points - fed through PVC insulated conductor of 2mm by 0.8 mm² inside thermoplastic conduits including junction boxes with covers.

Measurement: - enumerated and understood to include related works

5) **Electrical fixtures**

- Light fixtures –shall be enumerated stating type of fixtures
- Air conditioners
- Fans, Bell systems
- Shall be enumerated stating type of fixture

C. EXTERNAL WORKS, SERVICES

Includes pavements, parking, landscaping and gardening, fencing and Excavation and earthworks for slope stabilization or drainage ditches

Example: - Find out quantities of excavation and earthwork and concrete for the single isolated footing.

1.5.2 Road Project

The following specifications and methods of measurement have been summarized from the Technical Specification for Road Projects by the Ethiopian Road Authority (ERA, 2002).

The preparation of quantities is based on high way design and is assumed to have been discussed in Highway Engineering courses.

Group Name	Group Description of Works
Group I – General / Site Works	Living quarters, Offices, Laboratories, Vehicles with operating costs
Group II – Earth Works	Clearing & grubbing, Common earth work, rock and borrow excavation, Overhaul, sub -grade preparation, and capping layers.
Group III – Pavement Works	Sub – base, base , surface coatings and asphalt concrete works
Group IV – Major / Minor Drainage Works	Culvers, Structures (bridge), pipes, drainage works
Group V – Miscellaneous / Incidental Works	Road furniture: guide post, curbs, sign and retaining walls
Group IV – Day Work Provisions	Provisions made for different day work rates

CHAPETR II: SPECIFICATION

2.1. Introduction

Specification is defined as the designation or statement by which written instructions are given distinguishing and/or limiting and describing the particular trade of work to be executed. In short specification is a statement of particular instructions of how to execute some task. Specification is one of the contract documents.

Specifications are written based on the prepared design, drawings, general and scientific trends of workmanship, quality expected, equipment involved and materials to be used for the particular trade of work. The specifications should clearly specify: -

- 1) Design and drawing
- 2) Labor employment
- 3) Materials to be used
- 4) Construction method
- 5) Equipments used

Specifications should be clear, concise, and brief descriptions of what is required to execute the proposed trade of work. The information that is needed for construction is usually conveyed by two basic communication lines. They are Drawings (pictorial) and Specifications (written).

In so doing the methods of communication should complement each other and neither should overlap or duplicate the other. Specifications are devices for organizing the information depicted on the drawings and they are written descriptions of the legal and technical requirements forming the contract documents. Their difference is that the drawings should generally show the following:

- 1) Dimensions, extents, size, shape, and location of component parts
- 2) Location of materials, machineries, and fixtures
- 3) Interaction of furniture, equipments and space
- 4) Schedules of finishes, windows and doors

Specifications generally describe the following: -

1. Type and quality of materials, equipments, labor or workmanship
2. Methods of fabrication, installation and erection

3. Standards, codes and tests
4. Allowance, submittals and substitutions
5. Cost included, insurance and bonds
6. Project records and site facilities.

2.2. Purposes of specifications

The purpose of specifications generally includes:

1. Guide the bidder at the time of tendering to arrive at a reasonable cost for the work
2. Provide guidance for execution and supervision of works.
3. Guide the contractor for the purchase of materials
4. Serve as a part of contract document to limit and describe the rights and obligations of each contracting parties.
5. Guide the bidder to identify his capacity to execute the work.
6. Serve as fabrication and installation guide for temporary and permanent works.
7. Guide the contractor for the purchase and/or hiring of equipments.
8. Serve for the owner to know what he/she is entitled to receive
9. Serve for the manufacturers of construction materials, equipments, tools etc to grade, classify, and improve qualities of their produces.
10. Indirectly, the specifications are very much related to the legal considerations, insurance considerations, bidding requirements, alternates and options, rights, obligations and remedial measures for the contracting parties.

Note: In the events of conflicts between specification and drawings, the specification governs.

2.3. Types of Specifications

In general, specifications can be broadly classified into four categories as follows:

1. **Manufacturer's specification:** Manufacturers prepare specification of their product for the guidance of their users, which may include property description and installation guide lines.
2. **Guide Specification :** Specifications prepared by an individual or group of individuals based on manufacturer's specifications, established trends of workmanship, service and laboratory tests and research findings to be used as guide lines for preparation of contract specifications.

3. **Standard Specification:** Specifications which are intended to be used as a reference standard in the construction of a project. The guide specification which has been standardized by a recognized authority is considered as standard specification.

4. **Contract (Project) Specification:** the specification prepared for a particular project to accompany the drawings and other contract documents.

The specifications described above can be prepared following the format which has general and specific parts (general specification and specific specification).

In the general part of the standard specifications the following items are included:-

- Administrative and Procedural Requirements
- Scope, definitions
- Reference organizations and Standards
- Project description, site facilities
- Submittals and quality assurance
- Delivery, storage and handling
- Project records, Insurances, Other general requirements

In the specific part of the standard specifications, detailed description of the quality of items to be used is given. In addition to this, preparatory actions and methods of incorporating the items into the project are indicated.

“Technical Specification and Methods of Measurement for Construction of Buildings”, of March 1991 is the standard specification which has been in use for many years as one of the contract documents in our country. This material has the general requirement part and the specific part.

In the general requirement part the following items, which may be applied to any project and any trade of work are described in general terms:

011 - General 012 - Site Description 013 - Quality Assurance

014 - Project Records 015 - Site Facilities 016 - Cleaning up

In the specific part the different trades of works (excavation and earthworks, concrete works, etc.) are described in details and the method of measurements are given.

Specifications could be written in several ways, with the prime emphasis given to either the producer company's brand or the performance capacity of the material and so on.

Accordingly, there are the following types of technical specifications.

1. **Proprietary Specifications:** These specifications call for desired materials, producers, systems, and equipments by their trade names and model numbers. For detailed descriptions reference should be made to manufacturer's specifications. They are of two types; closed (sole) source and open or equal source.
2. **Performance Specifications:** specifications which define products based on desired end results which are performance oriented; most appropriate when new or unusual products or systems are required or when innovation is necessary. Describing the problems or conditions under which the products or systems must operate, and the parameters for the acceptable solutions is difficult and challenging. Testing methods and evaluation procedures for defining the required performances must be explicitly specified.
3. **Reference Specifications:** Specifications which refer to levels of quality established by recognized testing authority or standards set by quality control authorities. These specifications are also used in conjunction with other types of specifications.
4. **Descriptive Specifications :** Specifications which describe all components of products, their arrangements and methods of assembly, physical and chemical properties, arrangement and relationship of parts and numerous other details. The specifier shall take total responsibility for the function and performance of the product.
5. **Cash Allowance Specifications:** Specifications meant to direct bidders to set aside a specified amount of money to be applied to the construction work at the direction of the specifier.

2.4. Specification writing

Basically specifications are not to be created; they are prepared based on existing standards, codes, guidelines, and laws.

Specification writing embodies certain methods of presenting information and instructions. When specifications are to be written, the following shall be taken into consideration:-

a) Specification writing require

1. Visualization (having clear picture of the system)
2. Research (to know the legal impact correctly)
3. Clear thinking (understanding things directly without misleading)
4. Organizing (organizing what we know to write the specification)

b) Specification writing require professional ability to read drawings

- c) **Specification writing require** wide knowledge of the construction materials, various levels of workmanship, different construction equipments and method of construction to be employed
- d) **Specifications use simple and clear language** such that it can readily be understood.
- e) **Specifications shall be brief and short** as much as possible (avoid long sentences without punctuations)
- f) **Specifications shall include all items affecting the cost of the work**
- g) **Specifications shall be fair** and do not attempt to throw all risks and responsibilities on one of the parties signing the contract, the employer or the contractor.
- h) **Specifications shall avoid repetition of information** shown on drawings to avoid mistakes and duplications within the specifications and drawings
- i) Specifications shall not include inapplicable text and do not specify the impossible or anything not intended to be enforced.

2.4.1. What are the useful references in specification writing?

The following are useful references in Specification Writing: -

1. Codes and ordinances of governments, cities, or municipalities. For example, Ethiopian Building Code of Standards (EBCS)
2. Standards prepared by distinct societies and government agents. For example, ACI standards, ASTM standards, BS, ES.
3. Standards or model specifications prepared by manufacturers, professional societies, and government bodies.
4. Master specifications and previously written specifications.
5. Information or experience acquired by personal observation and contact with trained or experienced people in the construction industry.

2.4.2. Specification language

The specification writer should present his instructions regarding the particular work under consideration in such a manner that: -

1. The drawings are more clearly interpreted, not duplicated.
2. Rights, obligations, and remedial measures shall be designated without ambiguity or prejudice.

3. Clearly express the extent of works under consideration; therefore, the phraseology used in regard shall be: -

- i) Judged by its quality not its length
- ii) Should be concise and short and written with commonly used words
- iii) Punctuations are important but their usage shall be limited to few
- iv) Capitalizing the first letters is mandatory for the following expressions: -
 - a) Parties to the contract; e.g. Employer/Client /Contractor/ Engineer
 - b) Space within the building; e.g. Bed Room, Toilet, Living Room
 - c) Contract documents; e.g. Bill of Quantity, Working Drawing, Specification
 - v) Minimize pronouns, better to repeat nouns
 - vi) Minimize the use of symbols
 - vii) Do not use foot notes, do not underline within a sentence for emphasis
 - vi) Words shall be used as follows:-
 - a) shall in place of must; use “shall” for the duties of the contractor or the consultant to represent the word “must”
 - b) “will” is used for the duties of the employer to represent the word “must”
 - c) “must” –avoid the use of the word “must” and substitute by the word shall to prevent the inference of different degrees of obligation
 - d) Avoid the use of words which have indefinite meanings or limitless and ambiguous in their meanings. For example, any, either, same, similar, etc.

CHAPETR III: PROJECT COST ESTIMATION

3.1. Project Cost Estimation

General

Project Cost estimation is the process of valuing on monetary expression, including the cost of all possible entrants necessary for the planning, implementing and monitoring stages of the proposed project under consideration. The possible entrants are:

- Preliminary investigation (project appraisal costs)
- design and supervision (consultancy cost)
- construction works (contractor's cost)
- land owning cost, and
- monitoring costs

Cost due to construction is given special attention here; it includes cost due to material, cost due to labor, cost due to equipment, overhead costs and contractor's profit. In order to facilitate estimation of cost due to material, it is important to know the quantities of various elements involved in construction of various parts of the building work i.e. material break down is essential. As an example material break down for 1m³ of plain cement concrete of C- 25 (1:2:3 mix) grade is given below:

Materials required for 1:2:3 cement concrete mix – a commonly used grade of concrete for structural works.

Wet (fresh) concrete mix= 1m³

e) Quantity for dry base analysis...= 1.55m³

f) Volume of cement.....= $1/6 * 1.55 = 0.258\text{m}^3 = 0.258\text{m}^3 / 0.035\text{m}^3 \text{ per bag} = 7.4 \text{ bags of cement}$

g) Sands= $2/6 * 1.55 = 0.517\text{m}^3 \text{ of sand}$

h) Coarse aggregate.....= $3/6 * 1.55 = 0.775\text{m}^3 \text{ of coarse aggregate}$

i) Water= 0.16 m³ (assuming w/c 0.62)

Note: - 1.5 to 1.6 times dry volume of the materials is required to get 1m³ of compact dense fresh concrete mix.

Exercise: Do similarly for C 20 and C 30 concretes

Purposes of Cost Estimation

The main purpose of costing or estimating are to:

- know the volume of work in reference to the fund available
- determine actual cost per unit of item
- identifying engineering estimate of the work for bidding purpose
- work out economical use of materials , labor and equipments
- in cases of variations to determine the extra cost to be incurred
- when changes in cost due to legislation happens, to work out the escalation in cost

The following information is required to define cost per unit of work

1. Correct information of the market price of the materials at the time of need to be used as a basic price
2. Correct information of the rates of various categories of skilled and unskilled laborers as wage rates to be used for daily work rate
3. Output of laborers per day for various types of items (productivity)
4. Correct information of the rates of various categories of equipments and tools as rental rates to be used for major items of rates
5. Up-to-date knowledge of the construction methods.

Factors affecting cost estimation

- 1) Type and documentation of the project
- 2) Construction scheduling
- 3) Bidding environment
- 4) Quality and availability of material and labor (given in specification)
- 5) Construction facilities /tools and method of construction
- 6) Location of the site: Transportation charges
- 7) Proper management
- 8) Land charges (lease)
- 9) Nature of subsurface condition

3.2 Types of Costing or Estimation

Estimation can be broadly classified as preliminary (approximate) and detailed.

Preliminary /approximate costing

This type of cost estimation is required to know the financial position of the client before costly detailed designs are carried out. Such estimates are based on practical knowledge and cost of similar previous works. Examples of approximate cost estimations are as follows:

A. Cost per functional unit

Hospital = cost per bed, Dormitory = cost per student, Cinema or theatre = cost per seat, residential buildings = cost per area, road works = cost per kilometer length, culverts or bridges = cost per meter span, water supply or sewerage projects = cost per head of population.

B. Plinth area method – cost per m²

This estimate is prepared on the basis of plinth area of the building. The rate per meter square is deduced from the cost of similar building projects in the locality. The plinth area shall be calculated based on the roof area, by taking external dimensions of the building at the plinth level. Courtyard and other open area shall not be included in the plinth area.

C. Cubical Content method – cost per m³

The estimate is based on cubical contents of various buildings, i.e. plinth area of the building x height x cubic content rate. Height should be taken from the top of flat roof (or halfway of the sloped roof) to the top of concrete in foundation.

Detailed cost estimate(based on item rate)

This is the most reliable and accurate type of estimate. The quantities of items are carefully prepared from the drawings and the total cost worked out from up to date market rates. A detail cost estimate thus requires quantity surveying and analysis of the different rates for the quantities prepared.

Rate Analysis

Rate Analysis is the process of fixing cost per unit of measurement for the different item of works. Cost due to construction (contractor's cost) is given special attention here. Total cost per unit of work (TC) may be grouped into two components; direct cost and indirect cost.

The direct cost (DC) includes cost due to material, cost due to labor, cost due to equipment, whereas the indirect (IC) cost covers overhead costs, and contractor's profit. Overhead costs are expenses for general office facility, rents, taxes, electrical light, water, and other miscellaneous items.

In order to facilitate estimation of cost due to material, it is important to know the quantities of various materials involved in construction of various parts of the building or construction work i.e. material break down is essential as shown above. Different formats, Excel sheets and softwares (like CONMIS) are used for rate analysis; a typical format is shown below.

Example: - Calculate the Unit price for C -25 concrete per m³ of work (formwork and reinforcement rated separately). Assume 15% overhead and 20 % profit.

Solution: -

Total cost (TC) = Direct Cost (DC) + Indirect Cost(IC)

IC = (15% + 20%) of DC = 35 % of DC

Direct Cost (DC) = Material Cost (MC) + Labour Cost (LC) + Equipment Cost (EC)

Material cost (MC) – using the material breakdown shown above:

Materials required for 1:2:3 cement concrete mix – a commonly used grade of concrete for structural works.

Wet (fresh) concrete mix= 1m³

A. Quantity for dry base analysis...= 1.55m³

B. Volume of cement.....= $1/6 \times 1.55 = 0.258\text{m}^3 = 0.258\text{m}^3 / 0.035\text{m}^3 \text{ per bag} = 7.4 \text{ bags of cement}$

C. Sands= $2/6 \times 1.55 = 0.517\text{m}^3 \text{ of sand}$

D. Coarse aggregate.....= $3/6 \times 1.55 = 0.775\text{m}^3 \text{ of coarse aggregate}$

E. Water= 0.16 m³ (assuming w/c 0.62)

Cement	= 7.4 Bags/ m ³ * 180/2 Birr/Bags	= 666.00 Birr/ m ³
Sand	= 0.517 m ³ * 120 Birr/ m ³	= 62.04 Birr / m ³
Aggregate	= 0.775 m ³ * 100 Birr/ m ³	= 77.50 Birr/ m ³
Water	= 0.16 m ³ * 0.25 Birr / m ³	= 0.04 Birr/ m ³
	Total	= 681.50 Birr/ m³

PROJECT NAME	ACTIVITY DESCRIPTION	
BOQ REFERENCE		
ACTIVITY CODE		
UNIT OF MEASURE		

DIRECT MATERIAL COST				DIRECT LABOR HOURLY COST				DIRECT EQUIPMENT HOURLY COST			
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	
A – TOTAL DIRECT MATERIAL COST					B – TOTAL DIRECT LABOR HOURLY COST					C – TOTAL EQUIPMENT HOURLY COST	

D – Hourly crew productivity	Data
E – Direct material cost	A
F – Direct labor cost	B/D
G – Direct equipment cost	C/D
H – DIRECT UNIT COST	E + F + G
I – Site overhead costs	K1 * H
J – Head office overhead costs	K2 * H
K – INDIRECT UNIT COST	I + J

L – RISK ALLOWANCE	$R1 * E + R2 * F + R3 * G + R4 * I + R5 * J$
M – GROSS PROFIT	$P \% / 0.7 * (H + K + L)$
N – TOTAL UNIT PRICE WITHOUT VAT	H + K + L + M
O – VALUE ADDED TAX (VAT)	$0.15 * N$
P – TOTAL UNIT PRICE WITH VAT	
N + O	
REMARK	

Labour cost (LC)

Assuming the crew consists of a site engineer, foreman, mason, and four daily laborers and a productivity of 0.50 m^3 per hr:

Personnel	Salary per hr	Utilization Factor (UF)	LC/ hr
Site Engineer	= 4,000 Birr/ Month / (22 days * 8 hrs/day) = 22.73 Birr/hr	= $1/10 = 0.1$ (Assuming 10 foreman under Site Engineer)	2.27
Foreman	= 60 Birr/Day * $1/8$ Day/ hr = 7.50 Birr/ hr	= $1/4 = 0.25$ (Assuming 4 crew under foreman)	1.88
Mason	= 45 Birr/Day * $1/8$ Day/ hr = 5.63 Birr/ hr	= 1	5.63
Daily laborers(4)	= 4 * 20 Birr/Day * $1/8$ Day/ hr = 10.00 Birr/hr	= 1	10.00
Mixer Operator	= 32 Birr/Day * $1/8$ Day/ hr = 4.00 Birr/ hr	= 1	4.00
Total LC (Birr/ hr) (i.e. 0.5 m^3)			= 23.78
Total LC (Birr/ m^3)			= $23.78 \text{ Birr} / \text{hr} / (0.5 \text{ m}^3 / \text{hr}) = 47.56$

Equipment Cost (EC)

Assuming a mixer with an hourly rate of 20.00 Birr / Hr and productivity of 0.5 m^3 per hour:

Mixer	= 20 Birr/hr * $1/0.5 \text{ m}^3/\text{hr}$	= 40.00 Birr / m^3
Total EC		= 40.00 Birr/ m^3

$$\text{DC} = \text{MC} + \text{LC} + \text{EC}$$

$$\text{DC} = 681.50 + 47.56 + 40.00 = 769.06 \text{ Birr}/\text{m}^3$$

$$\text{IC} = 35/100 * 769.06 = 269.17 \text{ Birr}/\text{m}^3$$

$$\text{TC} = (769.06 + 269.17) \text{ Birr}/\text{m}^3 = 1,038.23 \cong 1,040.00 \text{ Birr}/\text{m}^3$$

CHAPTER IV: PROJECT VALUATION

Valuation is the art of determining present value of a property such as a building, a factory or other engineering structure. By valuation the present value of property is fixed. The present value of property can be determined on the basis of rent, or income it may fetch. It is determined or decided by its selling price. The value of property depends on its structure, life, maintenance, location, etc.

4.1 Purpose of Valuation

1. **For rent valuation** – valuation of a property is done to fix the rent. Rent is fixed on the basis of certain percentage of the valuation. It is generally 6% to 10% per annum.
2. **For buying or selling** – every seller or buyer is willing to sell or purchase the property up to certain limiting price and that is only arrived at by valuation
3. **For Security of loans or mortgage** – when it is required to have loan against the security of any property or when the property is to be used for collateral for security like performance or advance payment bond, valuation is necessary.
4. **Acquisition** – when a property is compulsorily acquired by government, compensation is given to the owner for the valuation is necessary.
5. **For Tax assessment** – to determine the property tax. House tax, etc., valuation is necessary.

Important Definitions

The following terms need to be understood in property valuation: Market Value, Taxes, Scarp Value, Salvage Value, Book Value, Assessed Value, Obsolescence, Gross Income, Net Income, Annuity, Capital Cost, Capitalized Value, and Depreciation.

4.2 Valuation of Building

Valuations of a building depends upon, the type of building, its structure, shape, size, locality, the quality of material used and present day prices of the materials. This also depends upon the height of the building and plinth area. Building in market area will have higher value than building in residential area. The valuation of a building can be determined after knowing the contents of each

item of work, specifications and physical condition of the building. It can also be calculated on its cost of construction at present day rate after deducting a suitable depreciation.

The following are the different methods of valuation:

1. **Rent Return Method:** based on the net rent value, capitalized for the future life of the building.
2. **Valuation on land and building basis:** in this method the cost of land is added on the depreciated cost of the building.
3. **Valuation on profit basis:** suitable for commercial buildings like hotels, cinemas, etc. In such cases the net profit is calculated after deducting all outgoings and interest of capital invested. The net profit is multiplies by future life of the building.
4. **Valuation on cost basis:** in this method the actual cost incurred in construction of property with due consideration of depreciation, is taken as the basis to determine the value of the property.
5. **Development method of valuation:** this method is used for properties that are underdeveloped or partly developed or if the building require renovations by alteration. The anticipated future net income is renovated and multiplied with the future life of the property to get the value.
6. **Depreciation method of valuation:** the property value is determined based on the book value for the year by deducting the deprecation.