Course Title: Quantity Surveying and Contracts Management

As per Choice Based Credit System (CBCS) scheme

SEMESTER:VIII

Subject Code	15CV81	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
	CREDITS –04	**Total Marks- 100**	

Course objectives: This course will enable students to;

1. Estimate the quantities of work, develop the bill of quantities and arrive at the Cost of civil engineering Project
2. Understand and apply the concept of Valuation for Properties
3. Understand, Apply and Create the Tender and Contract document.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Quantity Estimation for Building; study of various drawing attached with estimates, important terms, units of measurements, abstract, Types of estimates - Approximate, detailed, supplementary and revised, Estimation of building - Short wall and long wall method - centre line method. Estimate of R.C.C structures including Slab, beam, column , footings, with bar bending schedule.	10 hours	L2,L3
Module -2		
Estimate of Steel truss, manhole and septic tanks. Quantity Estimation for Roads: Road estimation, earthwork fully in banking, cutting, partly cutting and partly Filling, Detailed estimate and cost analysis for roads.	10 Hours	L1,L2,L3
Module -3		
Specification for Civil Engineering Works: Objective of writing specifications essentials in specifications, general and detail specifications of different items of works in buildings, **Analysis of Rates :** Factors Affecting Cost of Civil Works , Concept of Direct Cost , Indirect Cost and Project Cost Rate analysis and preparation of bills, Data analysis of rates for various items of Works, Sub-structure components, Rate analysis for R.C.C. slabs, columns and beams.	10 Hours	L1,L2,L3
Module-4		
Contract Management-Tender and its Process: Invitation to tender, Prequalification, administrative approval & Technical sanction. Bid submission and Evaluation process. Contract Formulation: covering Award of contract, letter of intent, letter of acceptance and notice to proceed. Features / elements of standard Tender document (source: PWD / CPWD / International Competitive Bidding – NHAI / NHEPC / NPC). Law of Contract as per Indian Contract act 1872 , Types of Contract, Entire contract, Lump sum contract, Item rate, % rate, Cost plus with Target, Labour, EPC and BOT, Sub Contracting. Contract Forms : FIDIC contract Forms , CPWD , NHAI , NTPC , NHEPC	10 Hours	L1,L2,L3
Module -5		
Contract Management-Post award : Basic understanding on definitions, Performance security, Mobilization and equipment advances, Secured Advance, Suspension of work, Time limit for completion, Liquidated damages and bonus, measurement and payment, additions and alterations or variations and deviations, breach of contract, Escalation, settlement of account or final payment, claims, Delay's and Compensation, Disputes & its resolution mechanism, Contract management and administration **Valuation:** Definitions of terms used in valuation process, Cost, Estimate, Value and its relationship, Capitalized value. Concept of supply and demand in respect to properties (land , building , facilities'), freehold and lease hold , Sinking fund, depreciation–methods of estimating depreciation, Outgoings, Processand methods of valuation : Rent fixation, valuation for mortgage, valuation of land.	10 Hours	L1,L2,L3

Course outcomes: After studying this course, students will be able to:

1. Prepare detailed and abstract estimates for roads and building.
2. Prepare valuation reports of buildings.
3. Interpret Contract document's of domestic and international construction works

Program Objectives:

Engineering knowledge
Problem analysis
Interpretation of data

Question paper pattern:

The question paper will have 5 modules comprising of ten questions. Each full question carrying 16 marks
There will be two full questions (with a maximum of three subdivisions, if necessary) from each module.
Each full question shall cover the topics as a module

The students shall answer five full questions, selecting one full question from each module. If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Datta B.N., "Estimating and costing", UBSPD Publishing House, New Delhi
2. B.S. Patil, " Civil Engineering Contracts and Estimates", Universities Press
3. M. Chakraborthi; "Estimation, Costing and Specifications", Laxmi Publications
4. MORTH Specification for Roads and Bridge Works – IRC New Delhi

Reference Books:

1. Kohli D.D and Kohli R.C, " Estimating and Costing",12 th Edition, S.Chand Publishers, 2014.
2. Vazirani V.N and Chandola S.P, " Estimating and costing", Khanna Publishers, 2015.
3. Rangwala, C. "Estimating, Costing and Valuation", Charotar Publishing House Pvt. Ltd., 2015.
4. Duncan Cartlidge , "Quantity Surveyor's Pocket Book", Routledge Publishers, 2012.
5. Martin Brook, "Estimating and Tendering for Construction Work", A Butterworth-Heinemann publishers, 2008.
6. Robert L Peurifoy , Garold D. Oberlender , " Estimating Construction Costs" – 5ed , Tata McGraw-Hill , New Delhi
7. David Pratt , " Fundamentals of Construction Estimating" – 3ed ,
8. PWD Data Book ,CPWD Schedule of Rates (SoR). and NH SoR – Karnataka
9. FIDIC Contract forms
10. B.S. Ramaswamy " Contracts and their Management" 3ed , Lexis Nexis (a division of Reed Elsevier India Pvt Ltd)

Quantity Surveying & Contracts Management

01/02/2019

M-1 — (1)

Module – 1:- Quantity Estimation for Building; study of various drawing attached with estimates, important terms, units of measurements, abstract, Types of estimates – Approximate, detailed, supplementary & revised. Estimation of building Short & Long Wall method - Centre line method.
Estimate of R.C.C. structures including Slab, beam, column, footings with bar bending schedule. – 10 hrs. L2, L3.

Introduction:- (1) Several items of work will contribute for the completion of a construction activity. The items may include, E.W. in excavation for foundation, P.C.C, SSM, columns (footings), plinth, BBM, lintels, beams, slabs, staircase, plastering, painting, Doors, windows, Ventilators etc.,

(2) Arriving @ the approximate amount of items/materials required for a particular work is referred as Quantity Estimation.

Estimation:- (2) (3) It may be defined as the process of calculating the quantities and costs of the various items required for executing a work. It is prepared by calculating the quantities from the dimensions of the executed approved drawings. Hence, plan, elevation & sections are the (necessary) drawings for the Quantity estimation. The purpose of estimations are as follows

a) To ascertain the necessary funds (money) required by the owner to the work.
b) —"— Quantity of materials required inorder to procure them.
c) To decide the different categories workers to employ. (Helper, Mason, Mistry, plumber, Electrician, Carpenter, Bar bender, painter)
d) To asses the requirement of Tools, plants & equipments required, (Crow bar, pick axe, head pan, mixer, RMC etc.)
e) To fix up the time limit for the completion of different items of work.
f) To justify the investment from benefit cost ratio [>1].
g) To invite tenders and prepare bills for payment.

1) Datta B.N. 2) B.S. Patil. 3) M. Chakraborthi 4) MoRTH - IRC - New Delhi

Units of measurements:- Following are the units adopted for different items work. 02/02/2019

1) Earth work excavation/Filling.	L×B×D	m^3 or Cum or cmtr
2) P.C.C.	L×B×D	—"—
3) SSM	—"—	—"— / Nos
4) plinth / DPC.	L×B.	m^2 or smtr.
5) B.B.M.	L×B×D	m^3 or cum or cmtr.
6) BBM – partition wall – ½ brick wall or 100mm thick wall.	L×D.	— m^2 or Smtr.
6) Cornice. String courses	– rmtr – (Expansion joints)	plastering – Smtr. – m^2
7) Concrete & RCC works	L×B×D	m^3
8) Formwork.	L×B.	m^2
9) Reinforcement	Kg/MT.	m^2
10) Stone work in facing	Smtr.	
11) Asbestos sheet / water proofing	Smtr.	
12) Pavig / Flooring	— Smtr.	
13) Wood work. – Frames	— cmtr.	
– shutters	— smtr.	
Hand rails	— rmtr.	
14) Steel – channels, L's, bars, Trusses	— MTs.	
15) White washing / painting / coloring	— Smtr.	

(5) **ACTUAL COST:-** The actual cost of a work is known @ the completion of work. The actual cost should not differ much from the estimated cost worked out in the beginning.

Estimation & Estimated cost:- (*) (2) Procedure of arriving @ probable or expected cost before the commencement of a construction activity is known as estimation & this arrived amount is referred as Estimated cost.

a) Clearing of shrubs, & small trees – L×B – m^2
b) cutting of trees – Number

Pick axe, spade, digging bar, Trowels, Rhombus mixers or saw, chisel, Hammer, Hoe, Head pan, – SOR

a) Collapsible gate / Rolling shutters – m^2
b) wire Fencing – rmtr. Hoe – SOR, Pick axe, Digging bar – SOR, measuring box, rubber broth, ladder, gloves, Mason's square, spirit level, vibrator, Smoothing

Head of C.E.D

Lal bagh / Hyacinth Bean – G.O.

Abstract:- Types of Estimates:- Following are the different types of estimates
1) Detailed Estimate 2) Approximate/preliminary/Rough Estimate 3) Quantity Estimate
4) Revised Estimate 5) Supplementary Estimate 6) Complete Estimate 7) Annual maintenance
& Repair Estimate (A.M. of A.R.)

1) Detailed Estimate:- This includes the detailed particulars for the quantities, rates & cost of all the items of project. This is supported with prepared by a) Report b) specifications c) detailed drawings & plans, sections & index. d) Design data e) Rates adopted.

The procedure for the preparation of a detailed estimate are.
a) Details of measurement & calculation of quantities. b) Abstract of Estimated cost.
All the items that are involved in complete work are noted from the drawing and entered in the respective columns of a Standard Measurement Form as shown & Quantities are calculated.

Item no.	Description/Particulars	no.	Length	Breadth	Height/Depth	Content	Quantity

In case of abstract of estimate, the cost of individual item of work is calculated by multiplying the qty with the specified rate.

Sl.No	Description/particular	Quantity	unit	Rate Rs-Ps	Amount Rs-Ps	Rem

The main purpose of Abstract of estimate will help in 1) Total Ec. of each individual item and that of total construction can be known 2) This will help in deciding the tenders on percentage basis 3) This will be the basis on which bills are prepared 4) comparative cost of different works can be
2) Approximate/Preliminary Estimate:- In this approximate cost can be calculated in a short time to consider the financial aspect of work. This method is adopted
a) To decide feasibility.. b) To save time & money c) Adjustments for variations in planning d) To obtain administrative approval. e) For Insurance & Tax schedule. . Following common methods are used for approximate estimation.
1) Plinth Area method. 2) Cubic rate or meter method 3) Approximate qty with bill method
4) Unit rate method 5) Bay method 6) Cost-comparison method 7) Cost from materials & labor.

(2) Floor Area = plinth Area − Area of walls : Carpet area, Covered area, Rentable area, 05/02/19
circulation area & face space area.

(1) Plinth area: is the builtup cover area measured @ the floor level of the basement & Can be calculated by taking external dimensions of the building excluding plinth offsets.
∴ Estimated cost on plinth Area basis = Area @ floor level − plinth offsets

(3) Carpet area:- Carpet area = Floor area − corridor/passage − porch − staircase − Bath room & W.C. − store − Canteen − Lift well − Pantry

(4) Covered area:- The ground area covered by the building immediately above plinth level

Rentable area:- For residential bldgs the R.A will be same as Carpet area

Rates of plinth area depends on a) specification b) price of level c) shape of building. d) location.

a) Cubic Rate method:- This method gives more accurate estimated cost than plinth area method as cubic content of proposed bldg is worked out & multiplied by the rate of 1m³ bldg in the same locality. It may be a) determination of total vol by cubic meter. b) L×B×D (L×B - plinth area) D = ht. of bldg measured from half the depth of the b) determination of the rate per cubic meter. (plinth area method) Comparing with previously constructed bldgs

3) Approximate Qty's with bill method:- This is not accurate as earlier two methods. It requires plan, sections, rates of items & knowledge of estimation. that are

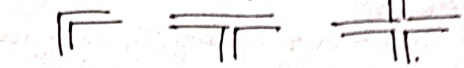
4) Unit rate method:- In this method all cost of a unit quantity such as per ton for lighting, per class room of school bldg, per bed of a hospital, per litre of water tank are considered in the beginning & applied for the complete construction. [Central Building Research Institute]

5) Bay method:- E.c. = Nos of bays in the str × Cost of one such bay. Bays are. components or similar portion of a str. 6) Cost Comparison method: prototype of bldgs (staff quarters of Railway, PSU, Police etc.) are prepared by comparing with previous cost & with present rates. 7) Material: Material & labour reqd for entire plinth area are multiplied with total bldg. plinth area as per CBRI Roorkee &

METHODS OF BUILDING ESTIMATE

All the dimensions like; length, breadth & height or depth are to be carefully taken out from the drawings (plan, elevation, & section). By looking @ the drawing the building is to be imagined / pictured in the mind to take out the dimensions correctly.

NOTE: Junctions of wall @ the corners or @ the meeting points of walls require special attention.



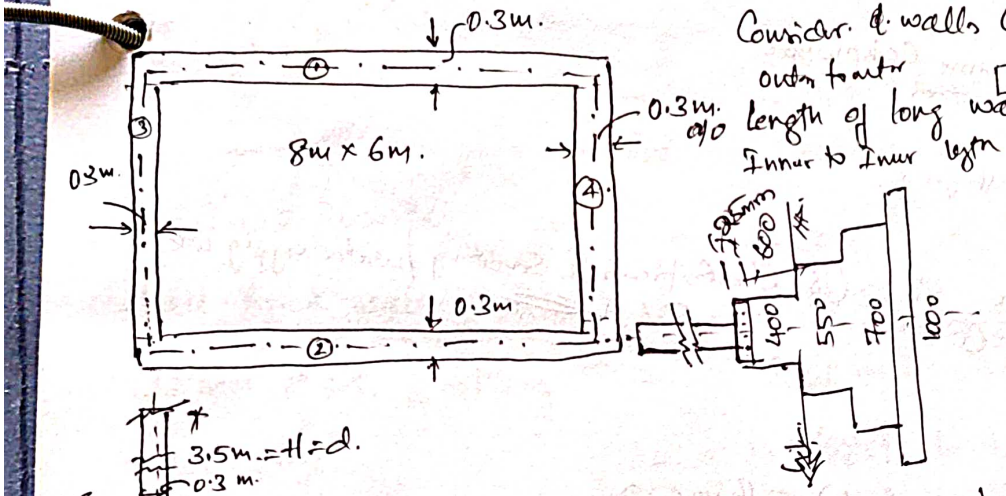
(OR, Cross.)

METHOD I:- Seperate OR Individual wall method [Long & Short wall method]

METHOD II:- CENTRE LINE METHOD.

Individual wall Method:- The wall which is taken first is treated as long wall. (preferably longer dimension) & the other wall be treated as short wall. (shorter dimension)

① Estimate the quantities of a) Earth work in excavation for foundation b) Concrete in foundation c) SSM in foundation & plinth. d) BBM in superstructure. e) Plinth concrete.



Consider ④ walls ①, ② as long walls & ③ & ⑤ as short walls.

outer to outer
c/o length of long walls = L + 0.3 + 0.3 = 8.6m. ~~= 6.6m~~

Inner to Inner length of short wall = L - 0.3 - 0.3 = ~~6.0 - 0.3 - 0.3~~ ~~= 5.4m~~. 6m.

C/c length of long wall.

= clear length + $\frac{\text{width on left}}{2}$ + $\frac{\text{width on right}}{2}$

= 8.0 + $\frac{0.3}{2}$ + $\frac{0.3}{2}$ = 8.3 m.

C/c length of short wall.

= clear left + $\frac{\text{width on Top}}{2}$ + $\frac{\text{width on bottom}}{2}$

= 6 + $\frac{0.3}{2}$ + $\frac{0.3}{2}$ = 6.3 m.

L.L.W @ Fn: S.W / PCC

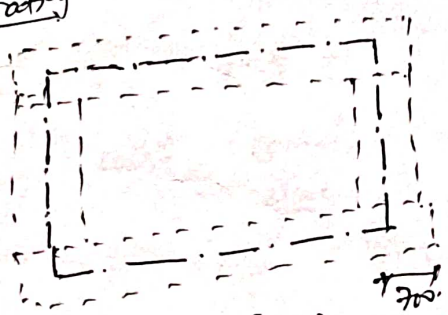
= C/c L + $\frac{1000}{2}$ + $\frac{1000}{2}$ = 9.3 m.

LSW @ Fn: SW/PCC

= C/c L - $\frac{1000}{2}$ - $\frac{600}{2}$ = 5.3 m.

@ Foundation level.

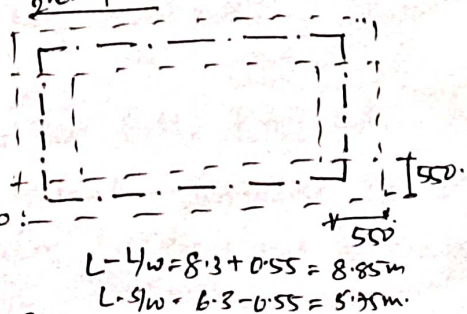
1st Footing



L → L/W = C/c L + $\frac{0.7}{2}$ + $\frac{0.7}{2}$ = 8.3 + 0.35 + 0.35 = 9.0 m.

L → S/W = C/c L + $\frac{0.7}{2}$ - $\frac{0.7}{2}$ = 6.3 - 0.7 = 5.6 m.

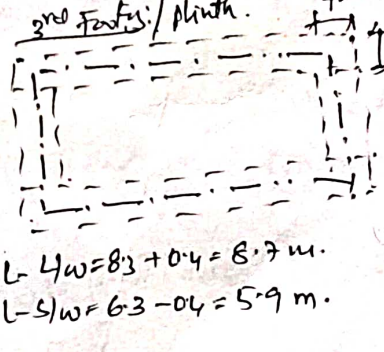
2nd Footing



L - L/W = 8.3 + 0.55 = 8.85 m

L - S/W = 6.3 - 0.55 = 5.75 m.

3rd Footing / plinth.



L - L/W = 8.3 + 0.4 = 8.7 m.

L - S/W = 6.3 - 0.4 = 5.9 m.

E. V. - (2).

Main Items of work.

(1) Earth work. 1×b×d — m³

(2) Concrete in foundation (P.C.C.) 1:3:6 / 1:4:8 / 1:5:10. 1×b×d. — m³

(1a) Soling. (Soft or Bad soil) 1×b. — m²

(4) Damp proof Course (DPC) 25mm. with rich concrete/water proof material — plinth level. m²

(3) Masonry — (a) SSM — Foundation + Basement (plinth) (Sub str) (Sup str) } Concr. with deductions for D.W.V,
(b) Brickwork BBM.

(5) Arch masonry. (6) Lintels over opening (120mm, min) m³ 4½".

(7) R.C.C. & RB work — slabs, beams, Lintels, column, foundation (footing), etc. m³ 7860 kg/m³ 7.86T/m³
0.7 to 1%. 1/2%. 0.7 to 1%. 1 to 5%. 0.5 to 0.8%. Steel.

Form work [Centering & shuttering] — m²

(8) Flooring & Roofing — Tiles, mosaic, marble, C.C., stone m²
m² m²

(9) Plastering & Painting — 12mm — m² — Single / double coat

(10) Cornice / — Ornamental purpose — Roof.

(11) pillars — m³ — Area × ht.

(12) Doors & windows — m³ — Frame (chowkat), m² — shutters

(13) Steel work (Bar bending) MT.

(14) white washing / color washing / Distempering.

(15) Painting.

(16) Lump sum — Fascia decoration site clearing, dressing etc.

(17) other item other than (16) item

(18) Electrification & Sanitary / water supply work. 8% ~~to 8%~~

Nomenclature — Type of work, material, proportion,

Rates — PWD Schedule of Rates (SR-Book) — Shimoga.

07/02/19
M-1-(2).

Task of out-turn work:

The capacity of doing work by a skilled labour in the form of Quantity of work per day is known as Task.

Item	Qty.	Perday.
E.W. In ordinary soil	$3.0\,m^3$	per labour / Beldar.
— " — Hard soil	$2.0\,m^3$	— " — (Bel-hoe-Pickone. Dar-having/using)
C.C 1:2:4 / 1:4:8 in ft	$5/8\,m^3$	— " — mason.
RR SSM — Coursed Rubble Masonry	$0.8\,m^3$	— " — Masm.
— Random — " —	$1.0\,m^3$	— " —
— Ashlar Masonry	$0.4\,m^3$	— " —
BBM — in ft	$1.25\,m^3$	— " —
— in Superstructure	$1.00\,m^3$	— " —
R.C.C. works	$3.00\,m^3$	— " —
Half Brick wall (partition)	5.00 Sqm	— " —
12mm C.M. plastering	$8.00\,m^2$	— " —
Painting	$10.00\,m^2$	per painter.

Material Requirement for Different Items of works.

① Bricks [20×10×10] $= 2\times10^{-3}\,m^3$ ∴ No of Bricks = 500 Nos/m^3.
= 85 Nos/m^3

② Size Stone $9"\times9"\times9" = 0.010645\,m^3$

RRM → 42%	for $10\,m^3$	$4.2\,m^3$
CRM → 40%		$4.0\,m^3$
AM → 25%		$2.5\,m^3$

③ Cement (IS 455) $1\,m^3$ of cement = 1440 kg. 1 Bag = 50 kg.

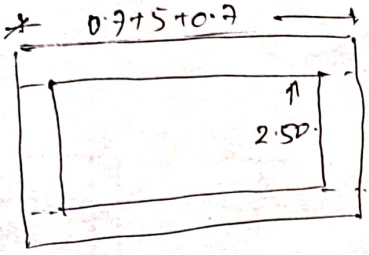
∴ for $1\,m^3$ of Cement = $\frac{1440}{50}$ = 28 bags ≒ 30 bags.

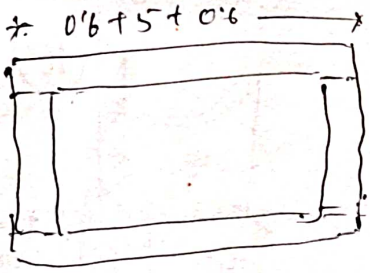
④ Dry Mortar for Brick work = 30%.

⑤ Cement Concrete $x:y:z$ = BM : FA : CA. Consider $10\,m^3$ finished Concrete.
∴ Dry Material required — Increase by 52%.
∴ Dry material required for $10\,m^3$ finished Concrete = $15.2\,m^3$

Item No	Particulars of Item of work	No.	L	B	D	Qty	Remarks
1.	E.W. in Excavation						L = 2.00+0.80+0.10 = 2.8 m
	a) Septic Tank	1	2.8	1.7	1.95 2.00		B = 0.70+0.64/2 = 1.7 m.
	b) Soak pit						
	i) bottom	1	$\frac{\pi}{4}(2.0)^2$	—	3.0		Septic tank & Soak pit
	ii) Lower portion	1	$\frac{\pi}{4}(1.4)^2$	—	0.2		
2	C.C. 1:3:6 Floor/foundation						working chamber, annular shaft.
	a) Septic tank	1	2.8	1.7	0.2		
		1	2.0	0.7	0.05		Φ - Sewer line (150Φ)
3.	BBM 1:4. CM.						6" - 9" / 150mm to 225mm - 45 cm
	Septic tank 1st step 1 leg wall.	2	2.6	0.3	0.6		9" - 8" / 250 to 400 - 75 cm (300Φ)
	2 Short walls	2	0.9	0.3	0.6		>15" / 400mm - 90 cm (375Φ)

Man hole





	No.	L	B	D	Qty	Remarks
E.W.:	1	2.8	1.9	2.90		70+10+90+20 = 190 cm
C.C.: 1:3:6	1	2.8	1.9	0.20		
Bench	1	1.8	0.9	0.40		
Deduct upper portion of man chamber	1	1.8	$\frac{0.9+0.3}{2}$	0.15		
upper portion of bench chamber	1	0.3	0.2	0.15		
BBM						
leg wall 1st step	2	2.6	0.4	0.9		No deduction for pipe.
2nd leg	2	2.4	0.3	1.0		
3rd step	2	1.0	0.2	0.70		
Short wall 1st step	2	0.9	0.4	0.9		
2nd leg	2	0.9	0.3	1.0		
3rd st	2	0.9	0.2	0.7		
Cover slabs						
leg wall	2	1.8	~~1.9~~	1.5		
(upto Rcc slab)						
S.W. upto Rcc slab	2	0.9	—	1.5		
SW left face	1	0.9	—	0.82		
SW Rt face	1	0.9	—	0.70		
Lenning for (in L.W.)	2	0.6	—	0.82		
Cover slab for Man hole & channels.	1	1.80	1.2	—		Φ.9 + 0.3 = 1.2
Rcc slab.	1	1.35	1.2	0.12		1.8 − 0.6 = 1.2 + 0.15 = 1.35
working chamber shaft	1	0.8	1.1	0.10		0.9+0.15+0.15 = 1.2.
						0.6+0.2/2+0.2/2 = 0.8

S: 1.
200 : 1.
200 − 1
30 − ?. 30/200 = 0.15

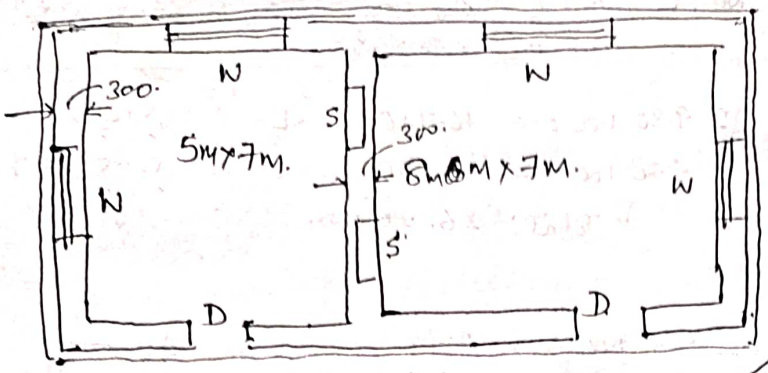
Deduct for Man hole cover
1 $\frac{\pi}{4}(0.45)^2$ = 0.1

Details of Measurements & Calculation of Quantities. Ex: 1

ESV-03

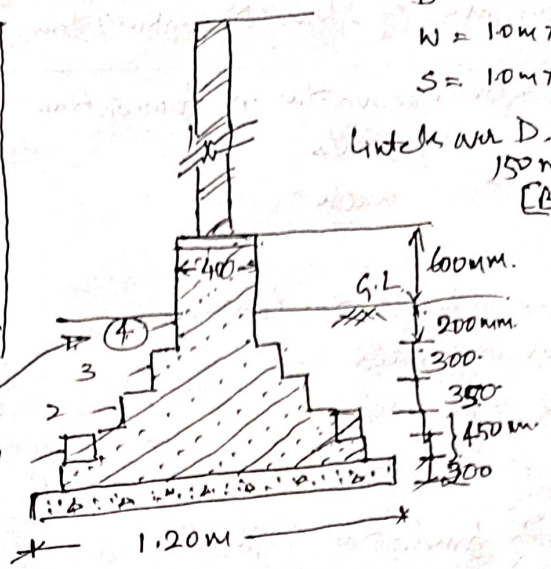
Item No.	Particulars of Item / Description of items	NO	L m	B m	D or H.m	Quantity with unit.	Explanatory Note.
1.	Earth work excavation in foundation.						
	a) Long walls	02	9.30	1.00	0.90	16.740	→ L = c/c + 0.5/2 + 0.5/2 = 9.30 (8.3)
	b) Short walls	02	5.30	1.00	0.90	9.540	→ L = c/c − 0.5/2 − 0.5/2 = 5.3 (6.3)
				Total:		26.28 cmtr.	
2.	Concrete in foundation (P.C.C.)						
	a) long walls	02	9.30	1.00	0.15	2.79	—do—
	b) Short walls	02	5.30	1.00	0.15	1.59	
				Total:		4.38 cmtr	
3.	S.S.M. in foundation & plinth.						
	a) long walls.						
	i) 1st Footing	02	9.0	0.7	0.45	5.67	L = c/c + 0.7/2 + 0.7/2 = 9.0m.
	ii) 2nd Footing	02	8.85	0.55	0.30	2.92	L = c/c + 0.55/2 + 0.55/2 = 8.85m
	iii) plinth /or	02	8.70	0.40	0.60	4.176	L = c/c + 0.4/2 + 0.4/2 = 8.7m
	b) Short walls						
	i) 1st Footing	02	5.60	0.7	0.45	3.528	L = c/c − 0.7/2 + 0.7/2 = 5.60 m
	ii) 2nd Footing	02	5.75	0.55	0.30	1.897	L = c/c − 0.55/2 − 0.55/2 = 5.75m
	iii) 3rd ~~Footing~~ Plinth.	02	5.90	0.40	0.60	2.832	L = c/c − 0.4/2 − 0.4/2 = 5.9m
				Total:		21.023 cmtr.	
4)	plinth Concrete:						
	a) long wall	02	8.7	0.4	~~0.025~~	~~0.696~~ 6.96 ~~0.174~~	L = c/c + 0.4/2 + 0.4/2 = 8.7m
	b) Short wall	02	5.9	0.4	~~0.025~~	0.4724.72	L = c/c − 0.4/2 − 0.4/2 = 5.9m.
						~~11.68~~ 11.68 Smtr	
	BBM in Super Structure						
	a) long wall.	02	8.6m	0.3	3.5	18.06	L = c/c + 0.3/2 + 0.3/2 = 8.6m
	b) Short wall	02	6.0	0.3	3.5	12.60	L = c/c − 0.3/2 − 0.3/2 = 6.0m
				Total:		30.66 cmtr.	

2) Estimate the quantities of following items of a two roomed building referring to following drawings.



D = 1.20m × 2.10m.
W = 1.0m × 1.50m.
S = 1.0m × 1.50m.

Lintels over D, W & S is 150 mm thick. [Bearing]



1) Earth work in foundation.
2) 1:3:6 PCC ~~for~~ in —"—
3) SSM in ~~fn~~ in plinth. Plinth wall above 3rd floor
4) 25mm DPC with C.C.
5) BBM in superstructure.

Deduction for BBM:

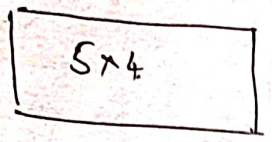
a) openings.

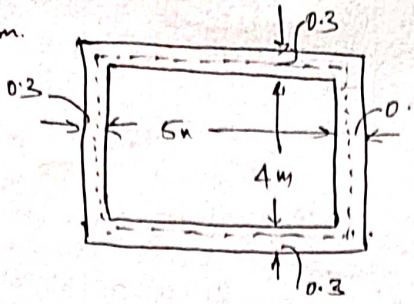
i) Doors ~~D~~ ~~S~~	02	1.2	0.3	2.1
ii) Windows	04	1.0	0.3	1.5
iii) Shelves	02	1.0	0.2	1.5 [Back of shelves 100mm wall]

b) Lintels ~~in Lintels~~.

D	02	1.5	0.3	0.15
W	04	1.3	0.3	0.15
S	02	1.3	0.3	0.15

Wall thickness 300mm.

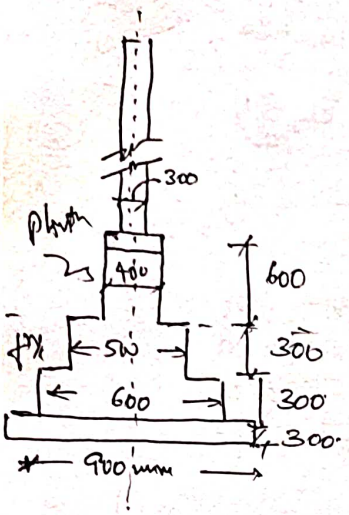




L.W = 5.6m S.W = 4.6m.

C/c L.W = 5.6 + 0.3/2 + 0.3/2 = 5.3m.

C/c S.W = 4 + 0.3/2 + 0.3/2 = 4.3m.



E.W:
① Long walls. L = C/c + 0.9/2 + 0.9/2 = 5.3 + 0.9 = 6.2. D = 0.3 B = 0.9.
② S.W L = ℄ + 0.9/2 − 0.9/2 = 4.3 − 0.9 = 3.4m

PCC
①
②
L.W

Foundation:
① 1st Footing L = C/c + 0.6/2 + 0.6/2 = 5.3 + 0.6 = 5.9m.
② 2nd " = C/c + 0.5/2 + 0.5/2 = 5.3 + 0.5 = 5.8m
③ 3rd Footing plug = 5.3 + 0.4 = 5.7m.
S.W

① 1st Footing = C/c − 0.6/2 − 0.6/2 = 4.3 − 0.6 = 3.7m
② 2nd " C/c − 0.5/2 − 0.5/2 = 4.3 − 0.5 = 3.8m.
③ 3rd footing C/c − 0.4/2 − 0.4/2 = 4.3 − 0.4 = 3.9m.

Plinth wall L.W = C/c + 0.4/2 + 0.4/2 =

3) Quantity Estimate or Quantity Survey:- The quantity of each individual item of work is worked out from respective dimensions on the drawing. To find the cost of an item its quantity is multiplied by the rate per unit for that item. The purpose of Bill of Quantities (B.O.Q.) is to provide a complete list of quantities necessary for the completion of any project.

4) Revised Estimate:- A revised estimate is a detailed estimate for the revised quantities and rates of items of works originally provided in the estimate approved for the project. It is executed when a) A sanctioned estimate is likely to exceed by more than 5%. b) Material deviation from the original proposal c) when sanctioned estimate is more than actual requirement

ESTIMATION OF BUILDING.

All the (measurements) dimensions like: length, breadth & height/depth are to be carefully read and taken out from the drawings (plan, elevation & section). By looking @ the drawing the building is to be imagined or pictured in the mind to take out the dimensions correctly.

NOTE: Junctions of wall @ the corners or @ the meeting points of walls require special attention. ⊢ ⊤ ⊣

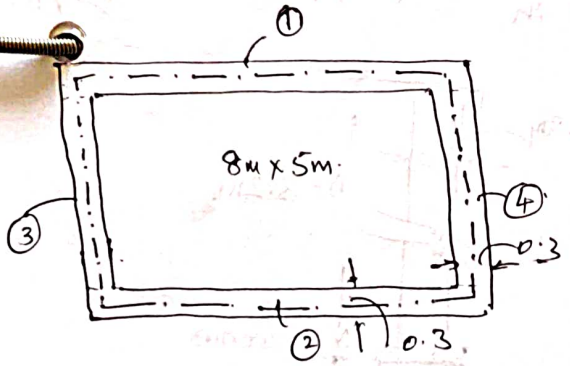
Following are the two methods of Building Estimation.

1) Method-I: Separate or Individual Method [Long & short or Cross wall method]
2) Method-II: Centre line method.

Method-I: Separate or long & short wall method.

The wall which is taken first is treated as long wall (preferably longer dimension) and the other wall be treated as short wall (shorter dimension).

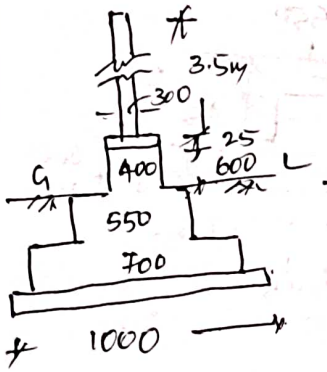
1) Estimate the quantities of a) Earth work in excavation b) Concrete in foundation c) SSM in the & plinth. d) plinth concrete. f) BBM in super structure

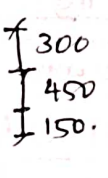


Walls ① & ② are long walls
∴ ℄ length of long walls = clear dimn + ½ wall thickness from ③ + ④
= 8 + 0.3/2 + 0.3/2 = 8.3 m.

walls ③ & ④ are short walls
∴ ℄ length of short walls = clear dimn + ½ wall thickness of ① + ②
= 5 + 0.3/2 + 0.3/2 = 5.3 m.

① for level: Length of Long wall = ℄ of LW + b/2 + b/2 = 8.3 + ½ + ½ = 9.3 m.
Length of short wall = ℄ of S.W − b/2 − b/2 = 5.3 − ½ − ½ = 4.3 m





P.C.C. 1st footing:
Long wall = 8.3 + 0.3/2 + 0.3/2 = 9.3 m. → 2 × 9.3 × 0.3 × 0.15
Short wall = 5.3 − ½ − ½ = 4.3 → 2 × 4.3 × 1.0 × 0.15
Long wall = 8.3 + 0.7/2 + 0.7/2 = 9.0 → 2 × 8.3 × 0.7 × 0.45
Short wall = 5.3 − 0.7/2 − 0.7/2 = 4.6 → 2 × 4.6 × 0.7 × 0.45

2nd & Basement :- follow same above with 0.55/2 & 0.4/2

Head of C.E.D

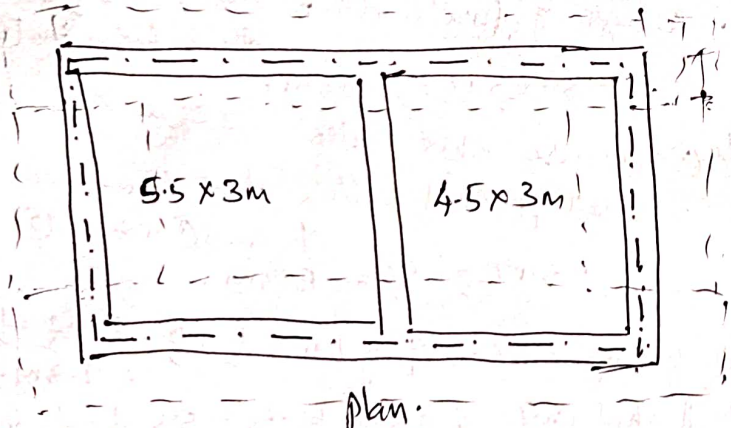
DPC: L.W = 8.3 + 0.4/2 + 0.4/2 = 8.7 ⇒ 2 × 8.7 × 0.4 = Smtr
S.F = 5.3 − 0.4/2 − 0.4/2 = 4.9 ⇒ 2 × 4.9 × 0.4 = Smtr.

BBM: L.W = 8.3 ⇒ 2 × 8.3 × 0.3 × 3.2 cmtr
S.W = 5.3 ⇒ 2 × 5.3 × 0.3 × 3.2 cmtr.

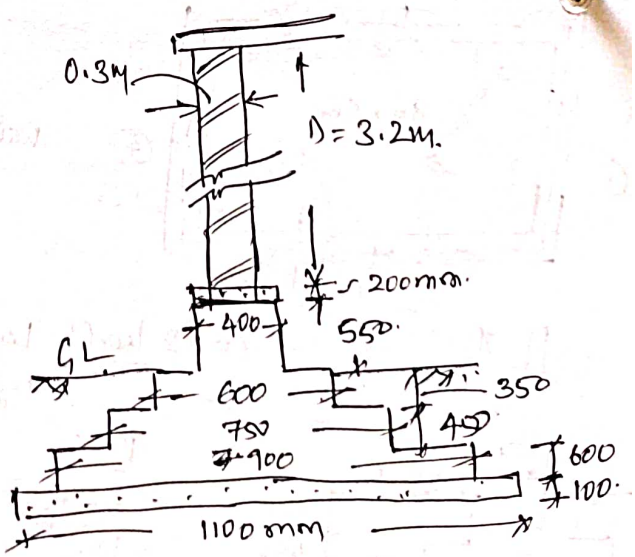
Details of Measurement & Calculation of Quantities

Sl. No.	Item	Particulars	No	L	B	Depth or Height	Quantity	Explanatory note.
1.		E.W in excavation for FD						
		a) long walls	02	-	-	-	-	-
		b) Short walls	02	-	-	-	-	
2.		Concrete in foundation PCC						
		a) long walls	02	-	-	-		
		b) Short	02					
3.		SSM in FD						
		a) long walls						
		i) 1st footing						
		ii) 2nd footing						
		iii) plinth wall / Basement						
		b) Short wall						
		i)						
		ii)						
		iii)						
4.		DPC.						
		i) long wall.						
		ii) Short						
5.		BBM.						

Prob 2) Calculate the Quantities of following items for the drawing shown by separate wall method. a) E.W. b) PCC c) SSM in FD & plinth d) DPC/PC e) BBM in



Plan.



FD details

C/L length of LW = 0.3/2 + 5.5 + 0.3 + 4.5 + 0.3/2 = 10.6M
No. of LW = (02)

C/L length of SW = 0.3/2 + 3 + 0.3/2 = 3.3M.
No. of S.W. = (03)

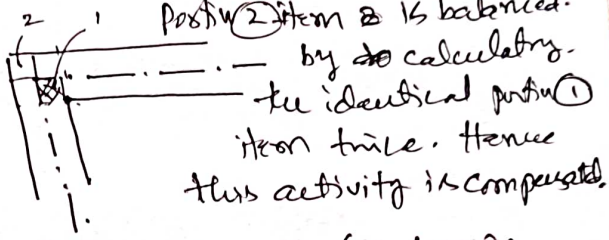
15/02/2019
M-1-(3)

METHOD - II - Centre-Line METHOD

In this method, the total centre line length of same type of wall (both long & short wall) having same type of foundations & footings is calculated. When this total centre line length is multiplied by breadth & height of respective items, we get required quantities.

NOTE: 1) If there is cross wall OR partition wall, for every junction special consideration OR care should be given to find correct quantity. For each junction or joints half breadth OR ~~depth~~ width of respective item is to be deducted from the actual length i.e. $L - n(B/2)$.

2) No deductions are made for a junction where two walls are meeting @ a corner in a building.



Portion (2) item is balanced by calculating the identical portion (1) item twice. Hence this activity is compensated.

3) If a building is having different types of walls (i.e. varying thickness like 200/250/300), then each should be dealt seperately. N=2

Ex: (3) Solve example 2 by adopting centreline method.

$L_{EW} = \text{℄} - 2(b/2)$
$L_{PCL} = \text{℄} - 2(b/2)$
$L_{SSH} = \text{℄} - 2(b/2) \ldots$

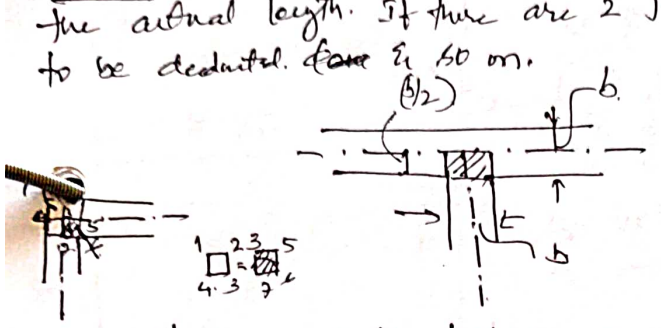
Head of C.E.D

METHOD - II: [Centre Line - Method]

M-(I)-(4) E.S.V-04

In this method find Total length of centre lines of walls of same type, long & short having same type of foundations and footings, If gives total centre line length is multiplied by breadth & height of respective items, we get quantities. In this, the length remains same for excavation of foundations, for concrete in fn, for all footings and for superstructure. (with changes where there are, cross walls or junctions)

NOTE: 1) If there is a cross wall or partition walls, for every junction special consideration or care should be taken to find the correct quantity. For each junction half breadth or width of respective item is to be deducted from the actual length. If there are 2 junctions $2 \times (b/2) = b$; one breadth or width has to be deducted. & so on.



2) Corners of the building where Two walls are meeting no substraction 200/230/300/250 - then each should be dealt seperately

3) If a building is having different types of walls: ~~each type~~ c/l of all [Type-①, ②, ③]

walls of 1st type, 2nd type, 3rd type & so on.

Find Total c/l length = ... m.

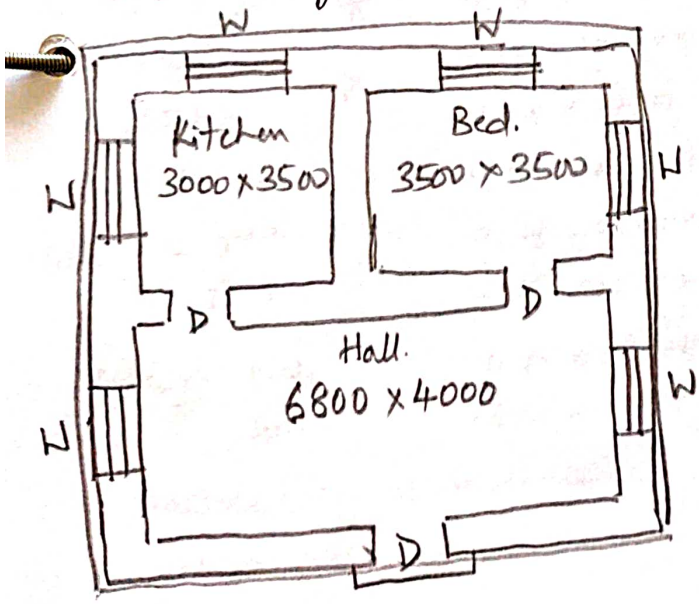
D.L.W. = L = c/l - 2(b/2)

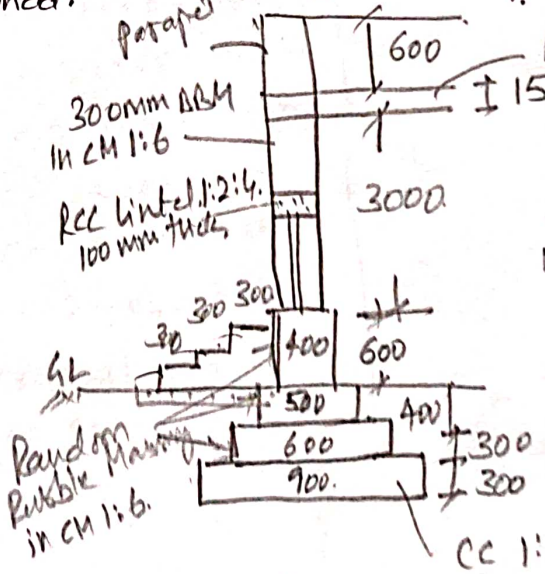
2) PCC = L = c/l - 2(b/2)

3) 1st Flr L = c/l - 2(b/2)

3) Solve example two by c/l method. or Method II.

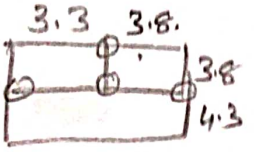
4) From the given figure below calculate the details and abstract estimate for the single storeyed residential building ~~with~~ by centre line method.





SECTION.

Plan.



* BBM in as Sym Abo

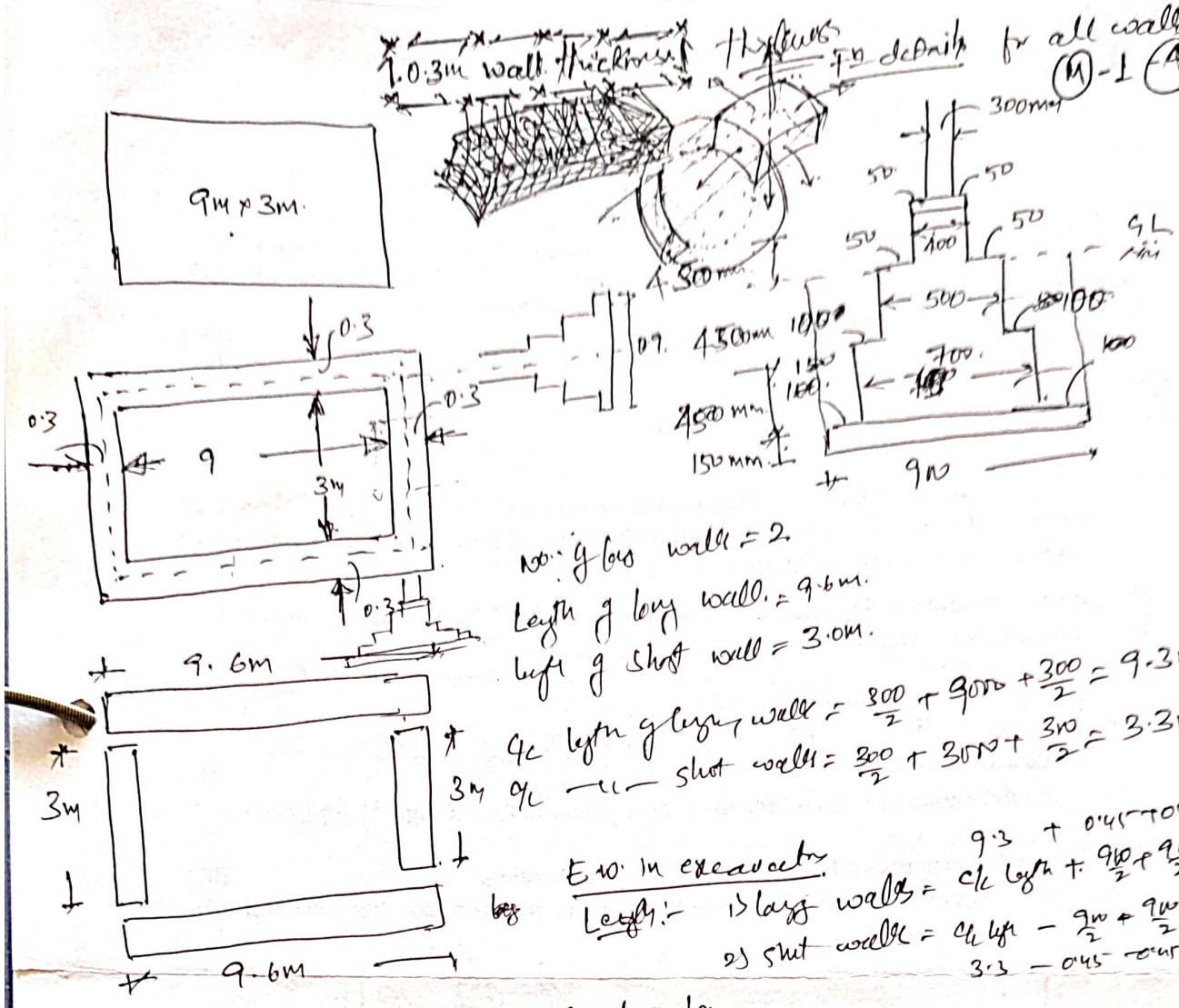
b) Parapet wall

$3(3.3+3.8) + 2(3.8+4.3) + 3.8 = 41.3$ (21.3, 16.2)

(or) $+ 3(3.8) + 2(4.3) = 41.3$

No. of jm 'T' jn = (4)

1.0.3m wall thickness 11 floors to depth for all walls (M)-1 (4a)



No. of long wall = 2.

Length of long wall. = 9.6m.

Length of short wall = 3.0m.

c/c length of long wall = $\frac{300}{2} + 9000 + \frac{300}{2} = 9.3m$.

c/c length of short wall = $\frac{300}{2} + 3000 + \frac{300}{2} = 3.3m$.

Exc. in excavation

Length :- 1) long walls = c/c length + $\frac{9w}{2} + \frac{9w}{2}$ = 9.3 + 0.45 + 0.45 = 10.20m.

2) short walls = c/c length − $\frac{9w}{2} + \frac{9w}{2}$ = 3.3 − 0.45 − 0.45 = 2.4m

Quantum for

L.W. − 10.2 × 0.9 × 0.15

S.W. − 2.4 × 0.9 × 0.15

Foundation SSM:-

Long wall.

1st footing :- Length :- c/c length + 0.35 + 0.35 = 9.3 + 0.7 = 10.00m.

2nd footing :- c/c length + 0.45 + 0.45 = 9.3 + 0.9 = 9.80m.

3rd footing :- c/c length + 0.2 + 0.2 = 9.2 + 0.4 = 9.60m

Short wall 1st F. c/c length − 0.35 − 0.35 = 3.3 − 0.7 = 2.60

2nd F c/c length − 0.45 − 0.45 = 3.3 − 0.9 = 2.80

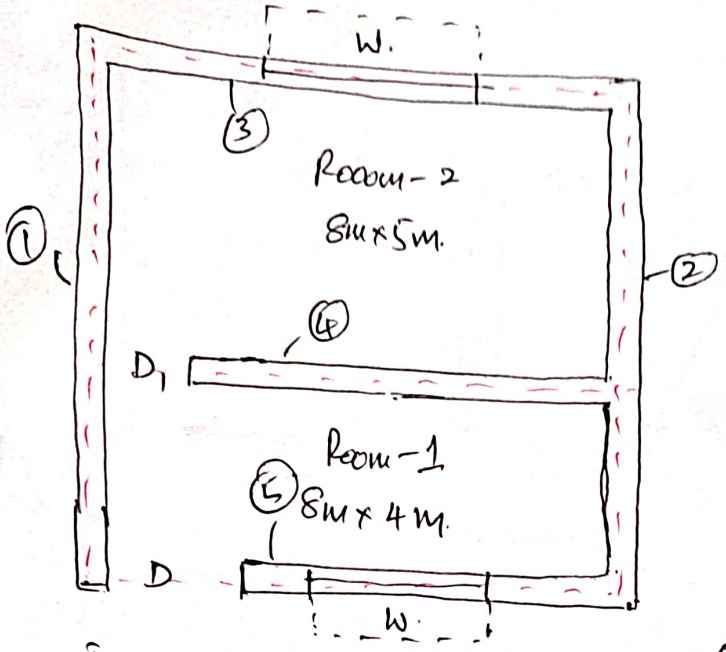
3rd F. c/c length − 0.2 − 0.2 = 3.3 − 0.4 = 2.90.

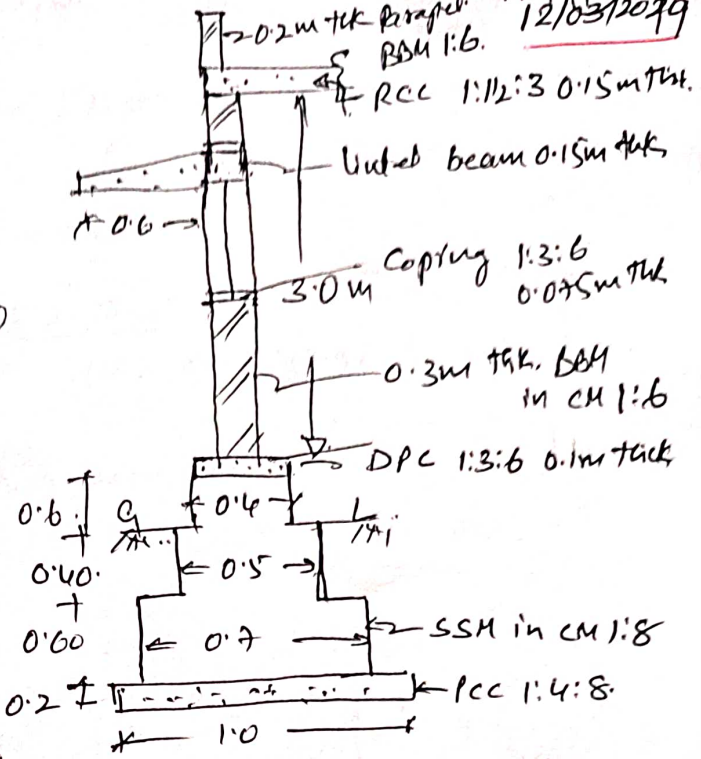
Long wall L.W. c/c length + 0.15 + 0.15 = 9.3 + 0.3 = 9.6m.

S.W. c/c length + 0.15 − 0.15 = 3.3 − 0.3 = 3.0m.

15CV81 June/July 2019.

M-1 (4.1) 12/03/2019





Index:

D = 1.2 × 2.1

D1 = 1.0 × 2.1

W = 1.0 × 1.2

Length of Short walls = 0.3½ + 8 + 0.3½ = 8.3m.

Long walls = 0.3½ + 4 + 0.3 + 5 + 0.3½ = 9.6m.

Sl. No.	Items	particulars of item.	No.	L(m)	B(m)	D(m)	Unit	Qty	Engg. NOTES
1.	E.W. in excavation								
	a) L.W.	- - - -	2	10.6m	1.0	1.2	m^3	✓	9.6+1.
	b) S.W.	- - - -	3	7.3m	1.0	1.2	m^3	✓	8.3-1=7.3
2.	PCC								
3.									
4.									
5.									

Module 1 : Estimation of Building

Estimation for Building, study of various drawing attached with estimates, important terms, units of measurements, abstract, Types of estimates – Approximate, detailed, supplementary and revised, Estimation of building – Short wall and Long wall method – Centre line method.

Estimate of R.C.C. structures including slabs, beams, columns, footings, with bar bending schedule.

Q. 1) The details of a residential building are shown in the following sketch. Estimate the quantities and cost of the following items of works.

a) Earth work excavation for foundation in hard soil at Rs.150/m^3

b) Lime concrete bed 1:2:4 for walls at Rs.1200/m^3

c) First class brick work (CM 1:4) in foundation and plinth at Rs.2000/m^3

d) First class brick work (CM 1:6) in super structure walls at Rs.2200/m^3

e) RCC 1:2:4 in chejja lintel and roof slab at Rs.1400/m^3

f) Determination of total cost abstract of estimate.

Soln: Steps to be followed

1. Study the drawing – Plan & section in detail and get confirmed with dimensions.

2. Draw single line diagram of plan to identify the junctions namely N=1,2,3, . . . (care should be taken at the crossing of walls with different thickness).

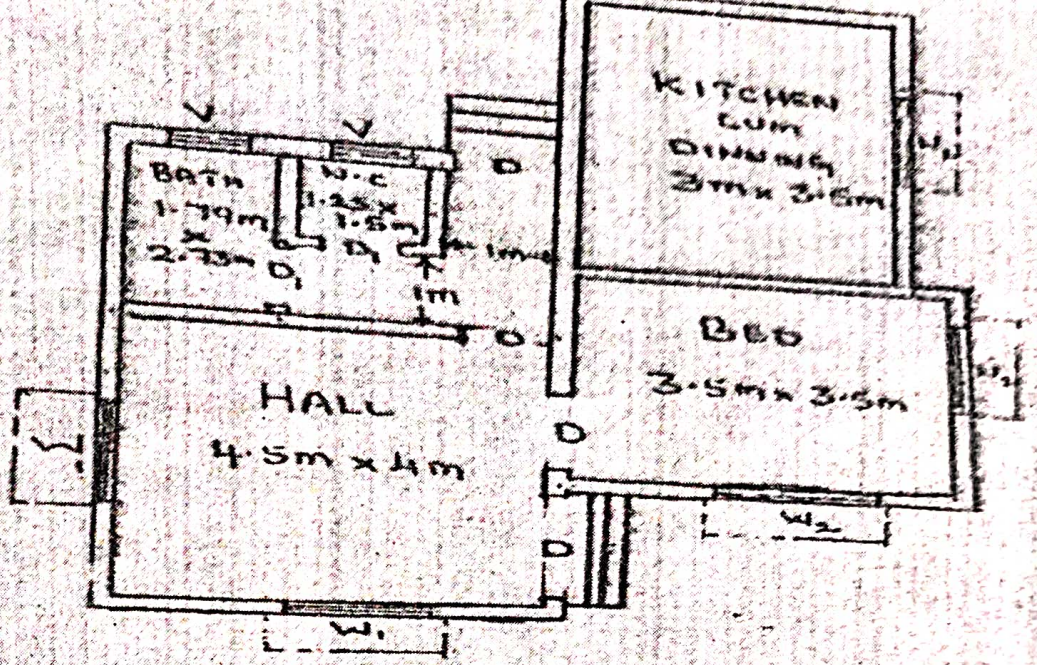
3. Measure along the perimeter of given plan and later move inside the building for Centre Line measurements.

4. Imagine the activity under consideration and note down the at accurate dimensions for L,B, D and enter in the tabular column. (Quantity calculation and Abstract of Estimation).

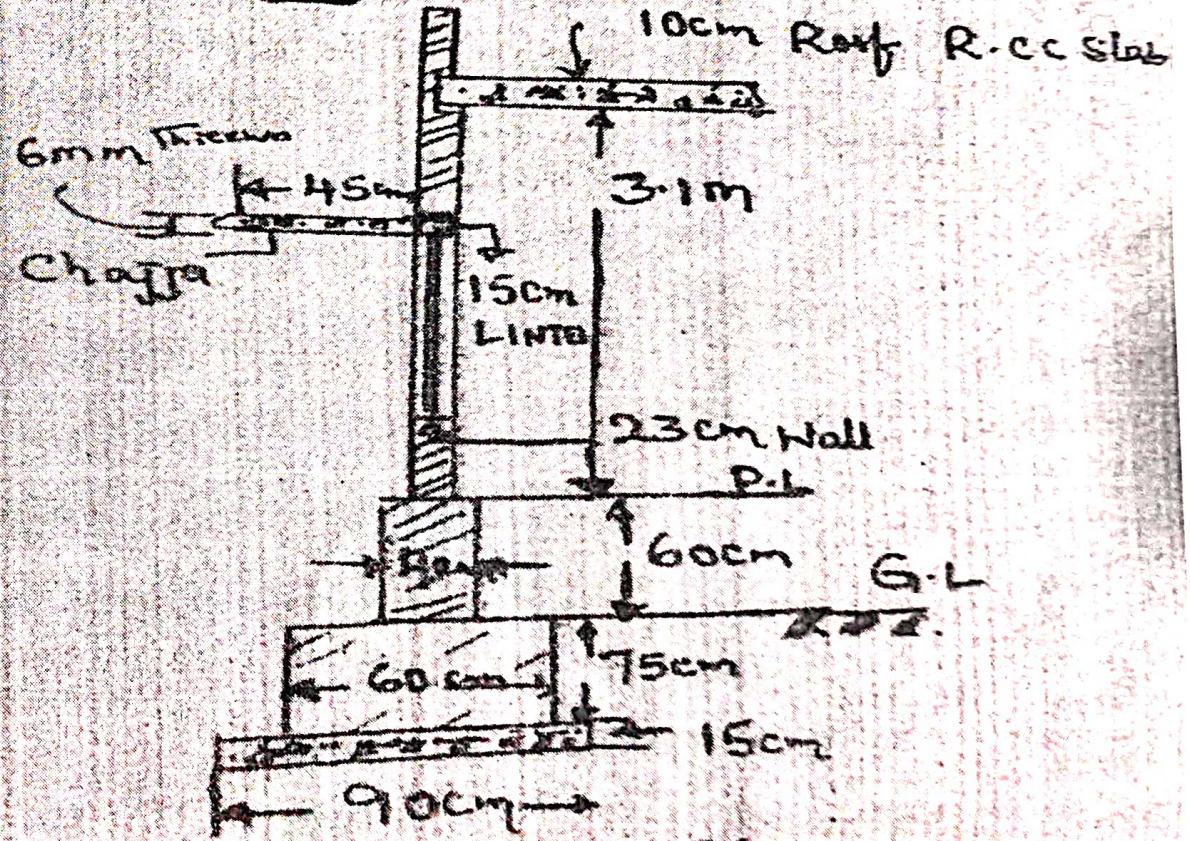
Centre line length from Line Diagram: ……. *m*

Number of junctions crossing i) 230x230 mm = N = nos ii) 230x115mm = n = NIL

N-1-(40)


KITCHEN
CUM
DINING
3m x 3.5m
Bath
1.79m
x
2.33m
W.C
1.25x
1.5m
D
D1
1m
BED
3.5m x 3.5m
HALL
4.5m x 4m
W1
W2

PLAN


10cm Roof R.C.C Slab
6mm Thick
45cm
Chajja
3.1m
15cm
LINTEL
23cm Wall
P.L
60cm
G.L
60cm
75cm
15cm
90cm

Tabular Column1 : - ***Details of measurements and calculation of quantities***

Item No.	Particulars of item and details of works	No.	L (m)	B (m)	H/D (m)	Qty	Explanatory Notes
1. 2. 3.	**EW for foundation in hard soil**	1					

27/02/2019.

Estimate of R.C.C. structures including slab, beam, column, footings with bar bending schedule. M-(1)-(5)

Steel item is taken ~~under~~ as a seperate item in R.C.C. works & unit for which is MT/kg/Qtl. The qty of steel is small, compared to concrete in R.C.C. item and hence no deduction is made for steel in the volume of concrete item.

Steel reinforcement is calculated as per actual requirement, as laid in position including overlaps, hooks, cranks etc., and is determined from the detailed drawings. If the detailed drawings are not available, steel can be calculated approximately on % of concrete, taking density of steel as 7860 kg/m³ 7.86 T/m³.

1) Lintel, slabs – 0.7 to 1%. 2) Beams – 1 to 2%. 3) Column – 1 – 5%. 4) Wall/footing – 0.5-0.8%

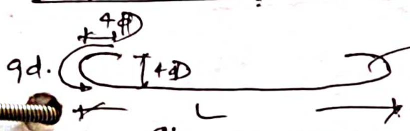
Reinforcement should have a sufficient cover by means of concrete to avoid corrosion in the range 25mm to 50mm (regular constructions).

Schedule of bars (Bar Bending schedule): It is a list of reinforcement bars in a tabular column form giving the particulars of bars, shape of bending with sketches, length of each, total length & total weight.

Description of bar.	Shape of bending	length of each m	NO	Total length m	weight kg/T
Main Reinforcement 12 – 20 φ.	(straight bar with hooks)	–	30	–	
Main Bent up.	(bent-up bar, a – L – a)	–	22	–	
Bottom – Distribution bars	(straight bar with hooks)	–	15	–	–
Top – " –		–	10	–	

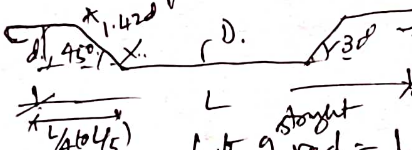
L-Hook = 6D.

IS 2502:



Length of a bar with hook = Hook + L + Hook = 9D + L + 9D
= L + 18d.

d = dia of the rod.



45° Total length = L + 2×(0.42d)

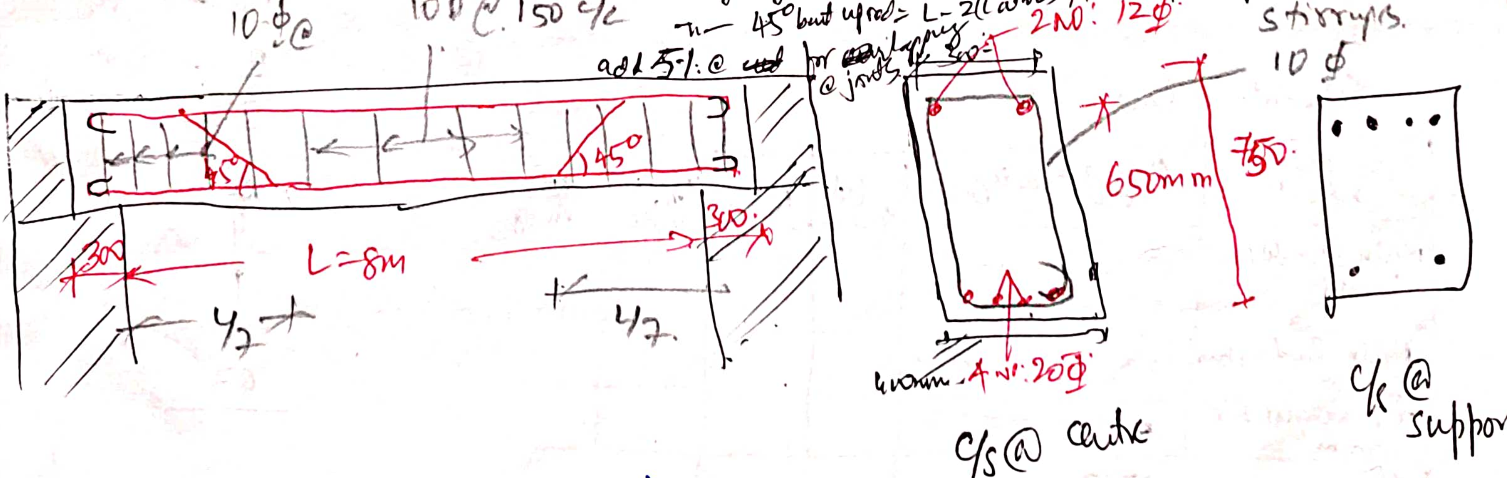
30° — " — = L + 2(0.27d)

Slab & beam:

Length of straight rod = L – 2(covers) + 18(d).

" 45° bent up rod = L – 2(covers) + 18(d) + 1 depth.

add 5% @ ~~end~~ for overlapping @ joints



Head of C.E.D

Item No.	Particulars of items & details of works	No.	Length (m)	Breadth (m)	Height / Depth (m)	Qty.	Explanatory notes
1.	R.C.C. work 1:2:4 excluding steel	1.	8.6	0.4	0.75	2.58 m³	0.3+8+0.2
2.	Steel bars including bending in R.C.C. works						
	a) Main bars.						
	20mm – straight bars @ 2.47 kg/m	42.	8.74. = 17.48			43.17 kg.	L = L + 18d - 2 covers L = 8.6 - 2 cover + 2 hooks = 8.6 - (0.05) + 2(8×0.02) = 8.74 m L = 8.6 - 2(0.05) + 2
	b) Bent-up bars 20mm	2					
2.	a) Main bars 20mm – straight bar @ 2.47 kg/m.	2	8.86 = 17.72			43.78 kg.	Left g each = L - 2(covers, ends) + 18 dia = 8.6 - 2(0.05) + 18(0.02) = 8.86 m.
	b) bent-up bars. 20mm – Bent up @ 2.47 kg/m	2	9.51 =			46.97 kg.	L = 8.6 - 2(0.05) + 18(0.02) + 0.65 = 9.51 m
	c) ~~Stirrups~~ (Construction bars) i) Hanger rods or top rods 0.89 kg/m.	2	8.716			15.51 kg.	L = 8.6 - 2(0.05) + 18(0.012) =
	Stirrups 10mm @ 0.62 kg/m	58	2.08 = 120.64.			74.79 kg.	L = (0.65×2) + (0.3×2) + 2 hook = 1.45×2 + 0.3×2 + 18d. No. = 8.6 - 2(0.05) / 0.15 = 57+1 = 58 Nos

IS:2502 stirrups left = 2d + 2b + 24 dia

Add 5% for total qty.

No steel of Estimated cost

Sl. No.	Particulars	Qty	Unit	Rate/Unit	Amt
1					
2					

Schedule of bars

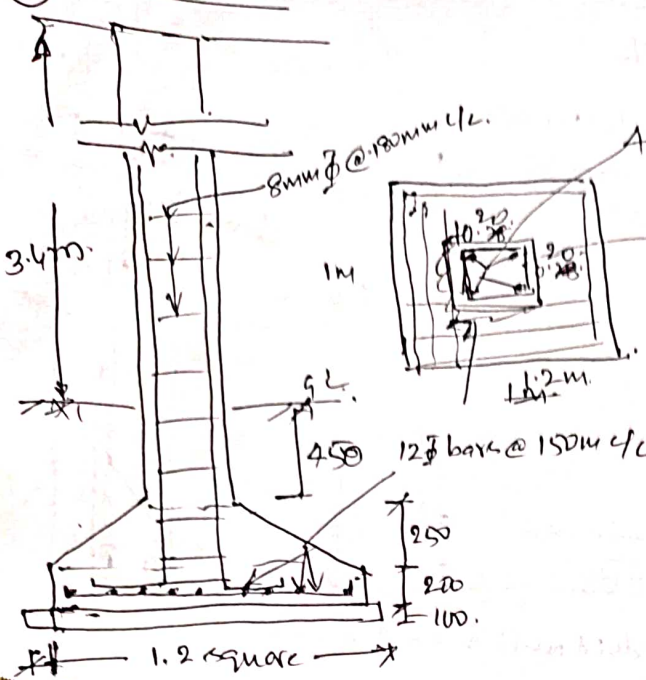
Description of bar	Shape of bending	Length of each	No.	Total length	Wt. in kg
Main straight bar 20mm					
Main Bent up bar 20mm					
Top Straight bar 10mm					
Stirrups 10mm dia					

2 —
2 —
2 —
2
4
1
03

(8)

05/03/19.

M (I) (G)



① E.W.
② P.C.C.
③ Foot. — Vertical part —, Transversal part —
④ Column →

Steel calculation

a) Bottom reinforcement / Main reinforcement

$L = 1.2^2 - 2(0.025) = 1.199 + 2(65) = 1.2m.$

No. = 9-6+1 = 9 bars
No. = 18 bars

b) Main rod. Vl reinforcement No: 4.

$L = 2.00 - 0.05 - 2(12mm) + 250 + 450 + 3400 + 400 mm.$ (cover, lap)

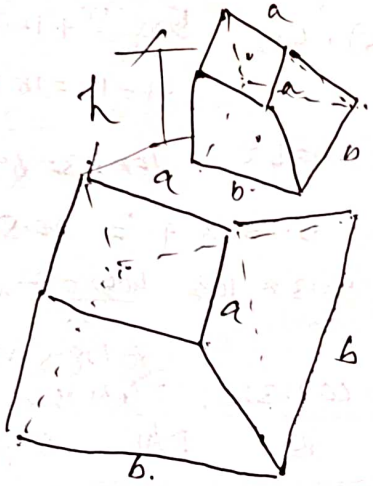
$= 4.626 \times 4$

$= 18.50 m$

Wt: 12mm → 0.89 kg/m
8 mm → 0.39 kg/m.

c)

NOTE:



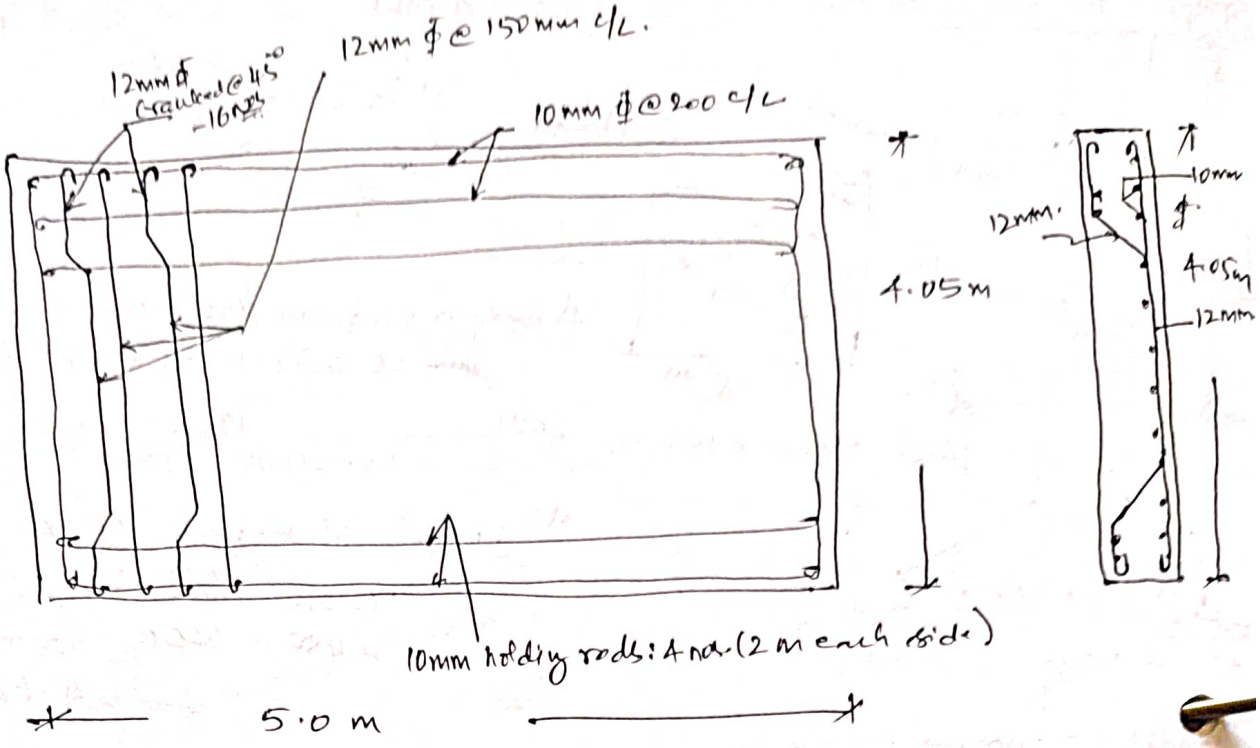
$V = \frac{h}{3}[a^2 + b^2 + ab]$ or $V = \frac{h}{6}[A_1 + A_2 + 4A_m]$

$= \frac{0.25}{3}[0.2^2 + 1.2^2 + 0.2 \times 1.2] \approx 0.143 m^3.$ $= 0.143 m^3$

Slabs :- Details of a simply supported R.C.C. slab of mix 1:2:4 are as below. i) Size 4.05 x 5.0 metres x 120 mm deep ii) Reinforcement :- 12mm dia rods are placed in the direction of 4.05m @ 150mm c/c. Of the total number of rods, 16 nos. are have been cranked @ 45° @ appropriate places and hooked @ ends. Other rods are straight & hooked @ ends. The 12mm dia rod weighs 0.89 kg/m. To hold cranked portions Anor. 10mm dia straight ~~rods~~ & hooked rods have been used. 10mm dia rods are placed in the direction of 5.0m @ 200mm c/c with hooks @ ends. The 10mm dia rod weighs 0.62 kg/m. iii) Cover 15mm @ the bottom & 25mm on all sides.

Draw sketches (plan & section) showing details of reinforcement. b) Estimate the quantities of concrete and steel. c) Write bar bending schedule chart.

Head of C.E.D



① 1:2:4 Concrete $5 \times 4.05 \times 0.12 =$

② Steel- 12mm straight rod. alternate. $4050 + 1800^{12} - 2(25) = 4.22$ $\frac{5000-50}{15}+1 = 34$

$34-16 = 18 \times 4.22 = 76$

12mm cranked rod $4050 + 1800^{12} + 1d$ $= 4.3$ $16 \times 4.3 = 69m$

10mm holding rod $5000 + 1800^{12} - 8(25) = 5.13 \times 4 = 20.5m$

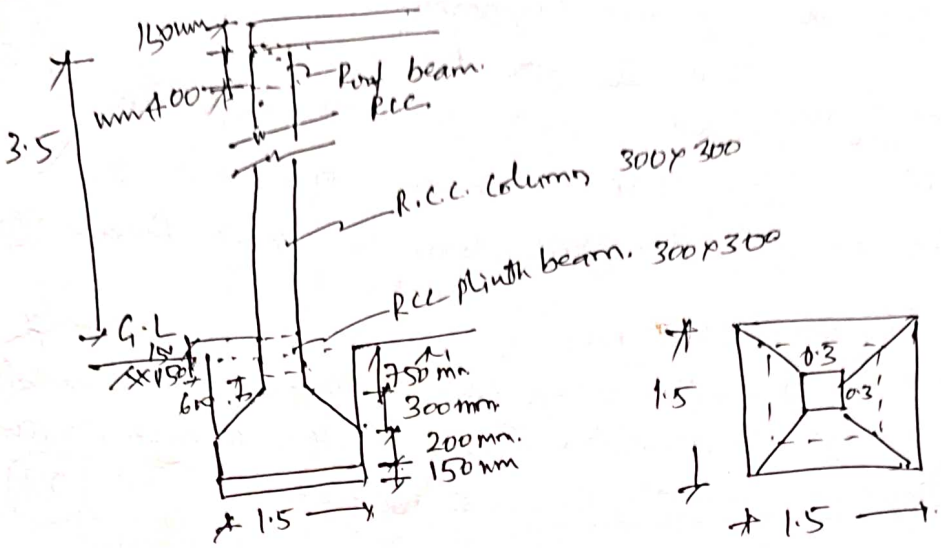
10mm straight rod $5000 + 1800^{12} - 50 = 5.13 \times 108$ $\frac{4050-50}{20}+1 = 108.$

$= 128.5m.$

Dec 2014/Jan 2015 – Man hole estimation. Floor. E.W., CC 1:3:6, I BBM 1:4, ptg., Plastering, slab, roof.

Item no.	Particulars of items		NO.	L	B	D/H	Qty.	Explan
1.	E.W. in excavation		1	2.8	1.9	2.9	$15.43 m^3$	
2.	Cement Concrete 1:3:6 a) as Foundation		1	2.8	1.9	0.2	1.71	
	b) Benching.		1	1.8. $(\frac{0.9+0.36}{2})$		0.4		
	Deduction a) upper portion of main channel		1	1.8. $(\frac{0.9+0.36}{2})$		0.15	-0.48	
	b) " " branch "		1	0.3	0.2	0.15	$1.53 m^3$	Inclined = 0.3
3.	I class BBM in 1:4 cement							
	Lay wall a) 1st step	—	2	2.6.	0.4.	0.9.	1.56	** No deduction for pipes
	b) 2nd step	—	2	2.4.	0.3.	1.0	1.44.	
	c) 3rd step	—	2	1.0	0.2	0.7.	0.28.	
	Shut wall a)	—	2	0.7	0.4	0.9	0.65	
	b)	—	2	0.7	0.3	1.0.	0.42	
	c	—	2	0.9	0.2	0.7.	0.25	$5.04 m^3$
4)	Cement pointing. Lay wall upto slab	—	2	1.8	—	1.5		
	Slab " "	—	2	0.9	—	1.5		
	Left face	—	1	0.9	—	0.82		
	Rt face. $1 \times 0.9 \times 0.7$.	—	1	1.8.	1.2	2.16.		$0.9+0.3=1.2$ curvature of channel.
	Deduct $1 \times 0.6 \times 0.82$.	—						
5)	Cement Plaster: Deduct for 1							
6)	R.C.C as working chamber	—	1	1.35	1.2	0.12		
	Shaft.	—	1	0.80	1.1	0.10.	0.266.	
7)	CI Manhole cover – 1 a) from foot steps – 7.	Deduct Manhole cover	1	$\frac{\pi(0.65)^2}{4}$		-0.016		

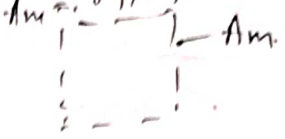
$$V = \frac{h}{6}\left[A_1 + A_2 + 4A_m\right]$$



$A_1 = 1.5 \times 1.5$

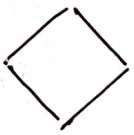
$A_2 = 0.3 \times 0.3$

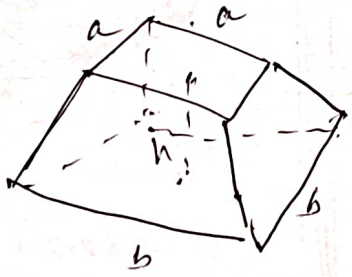
$A_m = 0.9 \times 0.9$



1) Ew. in ft³ for column footing
2) P.C.C. for ~~footing~~ bed in ft³
3) R.C.C. work for footing. < a) Rectangular
   b) Tapering

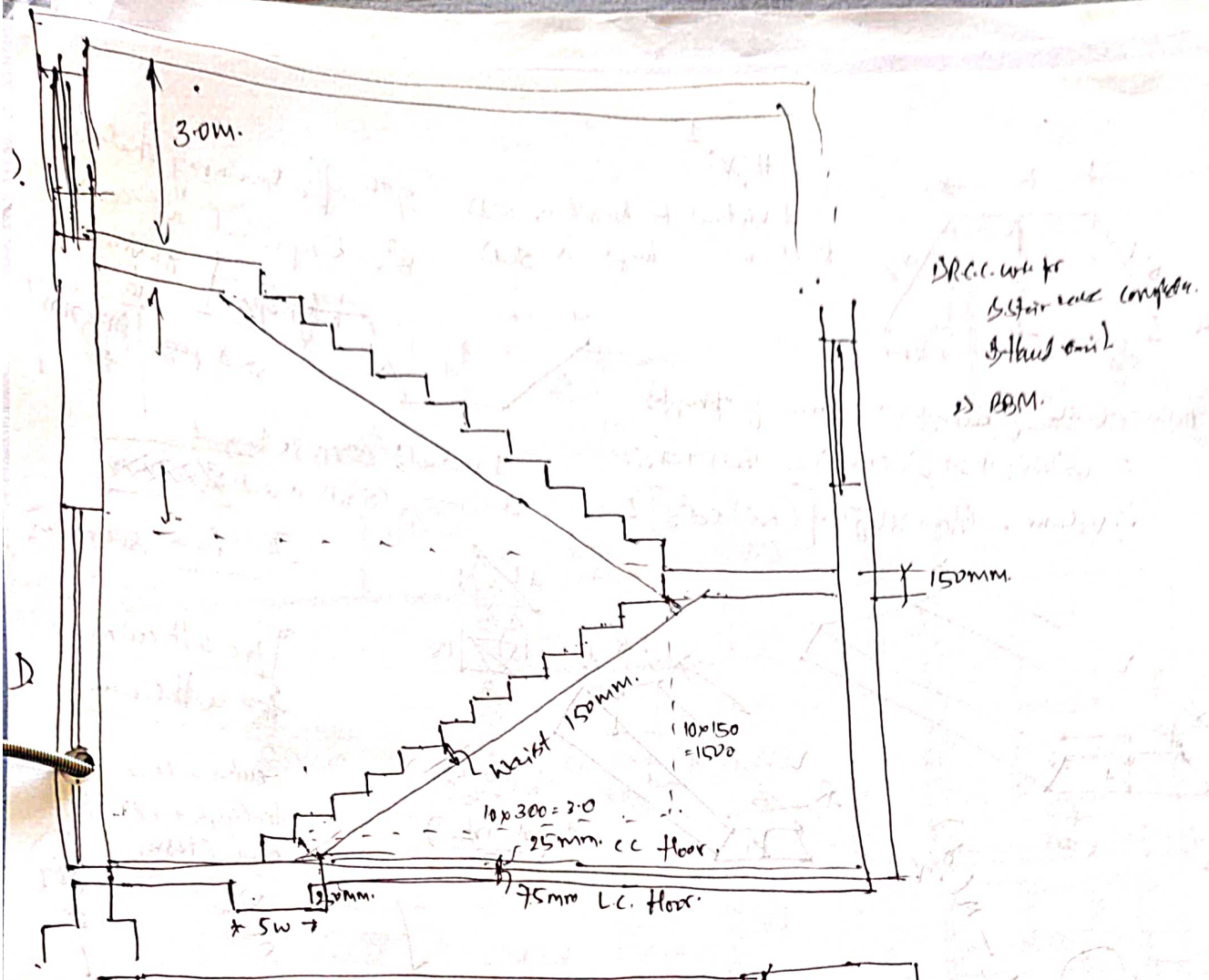
4) R.C.C work for plinth beam.
5) RCC work for columns -H =
6) -H- Lintels
7) -H- Slabs.
8) -H- Roof beam.



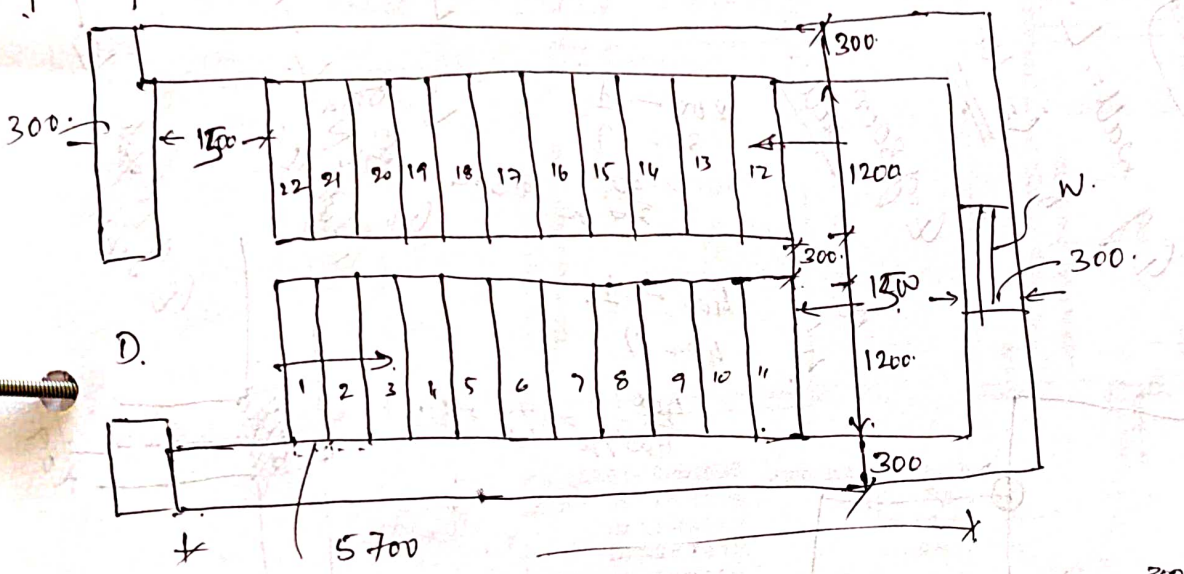


$$V = \frac{h}{3}\left(a^2 + ab + b^2\right)$$

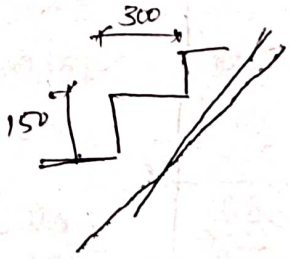
21/08
21/08.
28/09
04/09

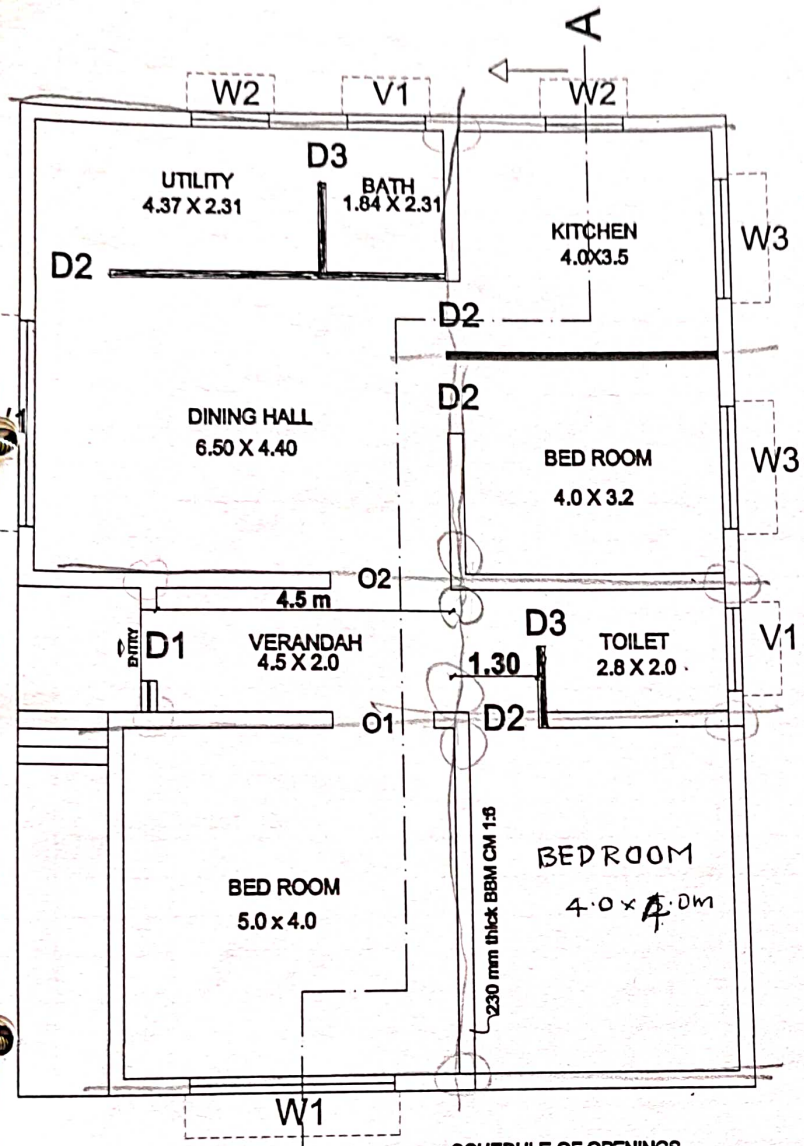


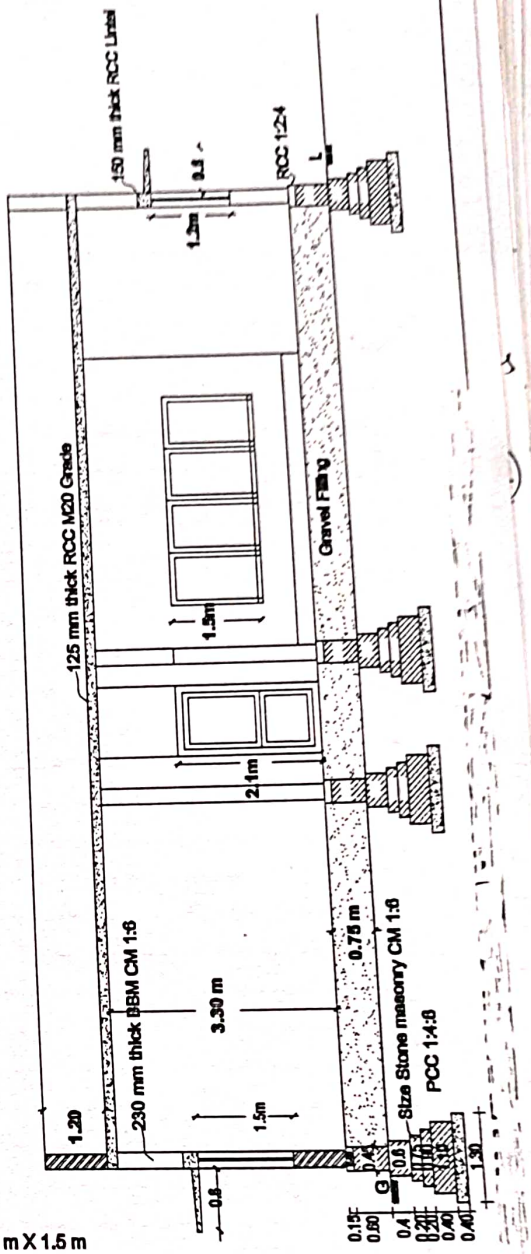
DRCC work for
Staircase complete.
Hand rail.
@ PBM.



Beam 3w/2





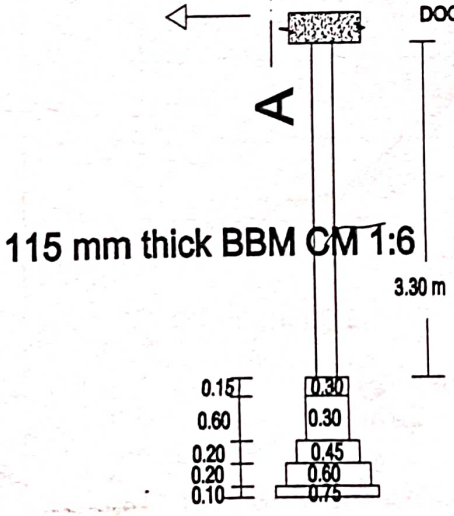


SCHEDULE OF OPENINGS

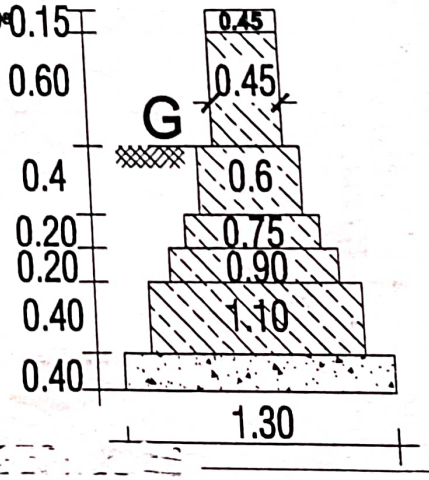
DOORS D1 1.2 m X 2.1 m
D2 1.1 m X 2.1 m
D3 0.9 m X 2.1 m
O1 1.4 m X 2.1 m
O2 1.6 m X 2.1 m

WINDOWS W1 3.5 m X 1.5 m
W2 1.5 m X 1.5 m
W3 1.5 m X 1.5 m
V1 0.6 m X 0.45 m

Chezza 100 mm thick at junction and 75 mm thick at edge



Foundation Details for Partition Walls

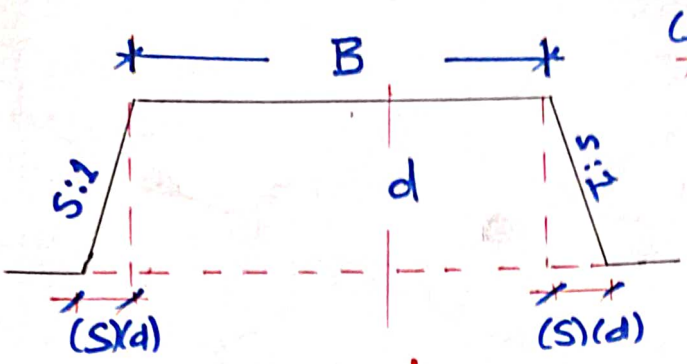


15-16.

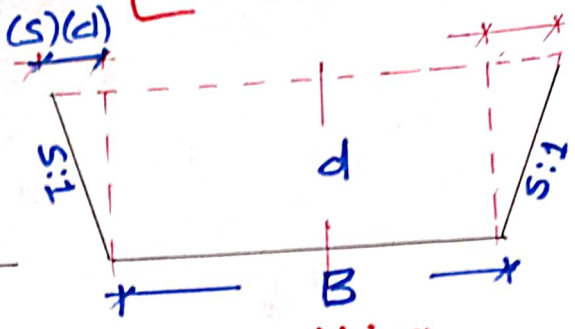
ESTIMATION OF RESIDENTIAL BUILDING

ITEM.NO.	DESCRIPTION OF ITEM	NO.	L	B	H/D	QTY	EXPLANATORY NOTES
1	EARTHWORK IN EXCAVATION						
	IN HARD SOIL						
2.4	C						
KSRB 2	2.1 206/m^3						
2.12.2	EARTHWORK IN FILLING						
KSRB	2.12.3 119/m^3						
4.7 3	BED CONCRETE 1:3:6						
KSRB 4	-1.7 5456/m^3						
5.5 4	SIZE STONE MASONRY						
5.2-3	IN cm 1:6						
	3690/m^3						
4.11 5	PLINTH CONCRETE						
	M 20 GRADE CONCRTE						
4.2.2	6079/m^3						

MODULE-2 [Pdf-2(a)]



Embankment / Filling
Banking.



Cutting

AREA OF TRAPEZIUM = One Rectangle + Two Triangles

$$A = (B)(d) + 2\left[\tfrac{1}{2}\{(S)(d)\}(d)\right] = (B)(d) + (S)(d)^2$$

$$\therefore \text{Volume of Earth work} = (A)(L) = \left[(B)(d) + (S)(d)^2\right](L)$$

Where B = Formation width S = Side slope.

S:1 = Horizontal distance(S) To Vertical distance One

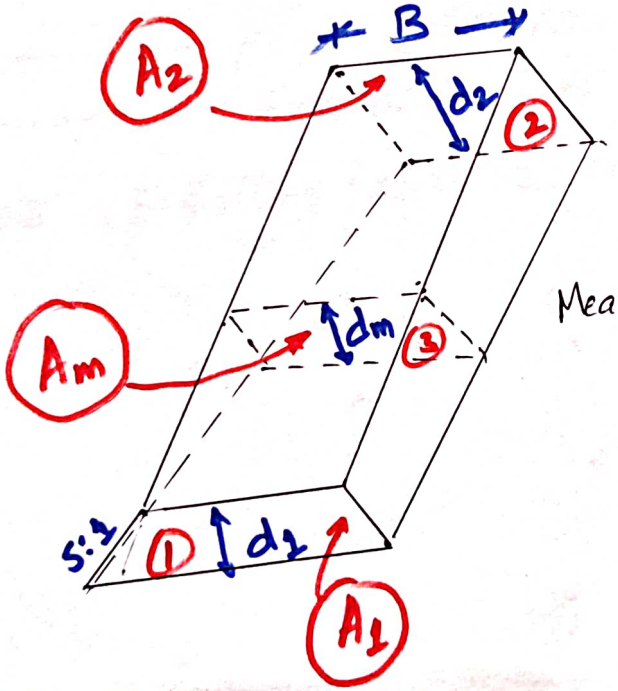
S:1

i.e. S → 1

$\therefore$ Base of Triangle (?) = $\frac{(S)(d)}{1} = (S)(d)$

Base of Triangle (?) → d

Pdf-2(a)-fig(i)



$$d_m = \frac{(d_1 + d_2)}{2}$$

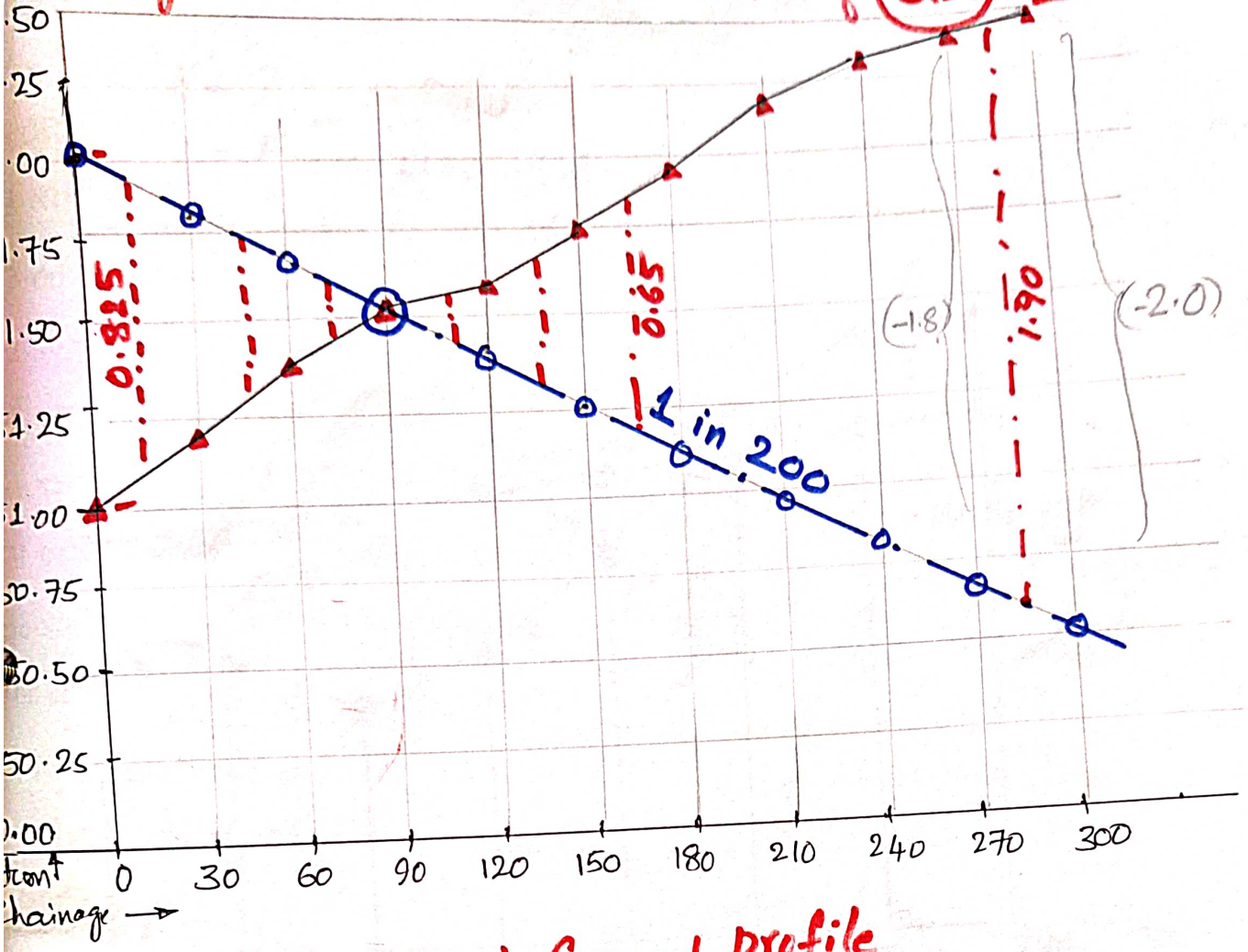
$$A_1 = (B)(d_1) + (S)(d_1)^2$$

$$A_2 = (B)(d_2) + (S)(d_2)^2$$

$$\text{Mean Area} = A_m = \frac{(A_1 + A_2)}{2}$$

... to give a plastic mix of

Longitudinal Section details of (Q2) [M-2]



▲ → R.L. of Ground profile

o → R.L. of Formation Level.

——— Profile of GROUND

—.—.— Formation Line.

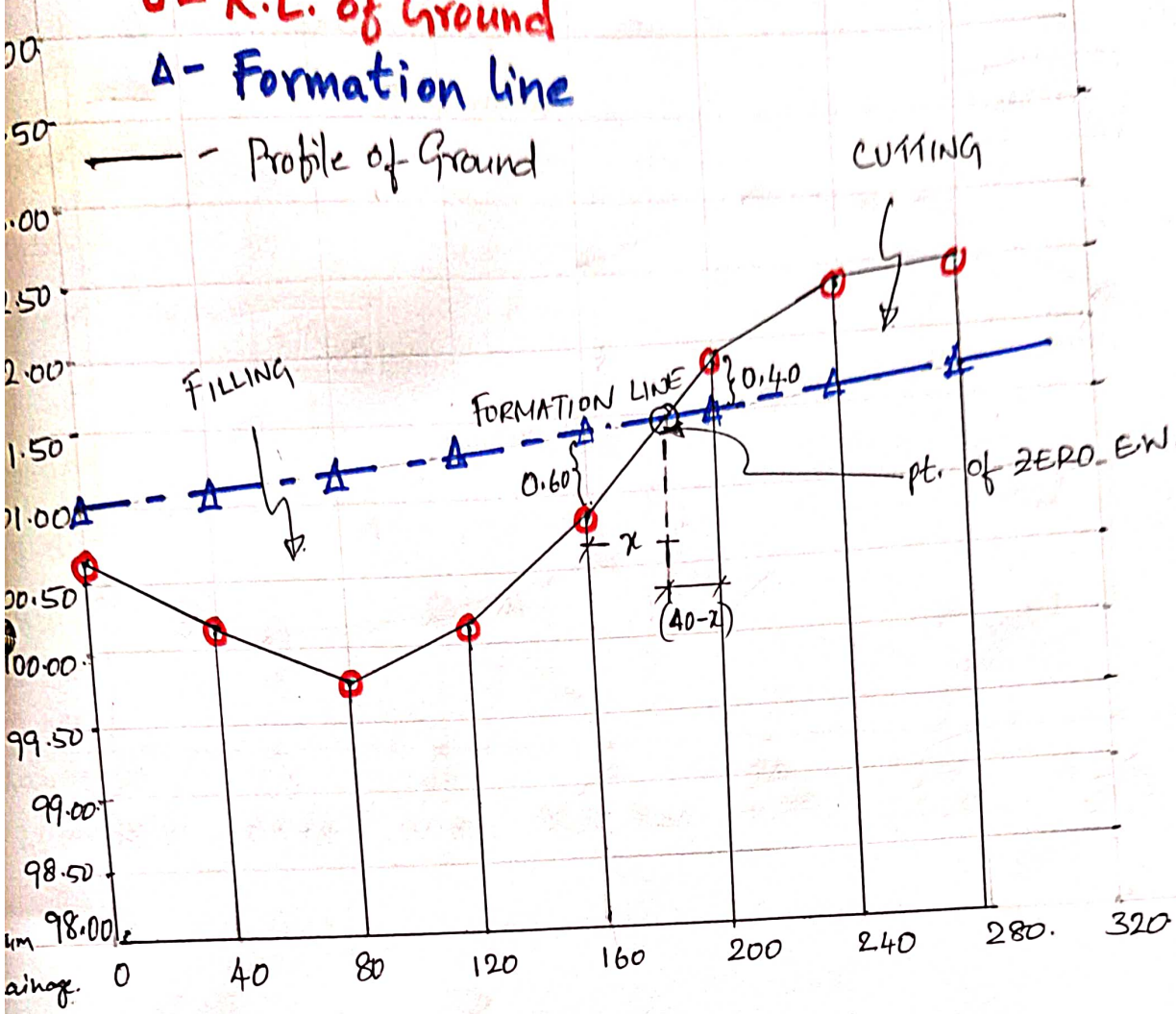
Depth of Filling / cutting [Mean Depth - dm]

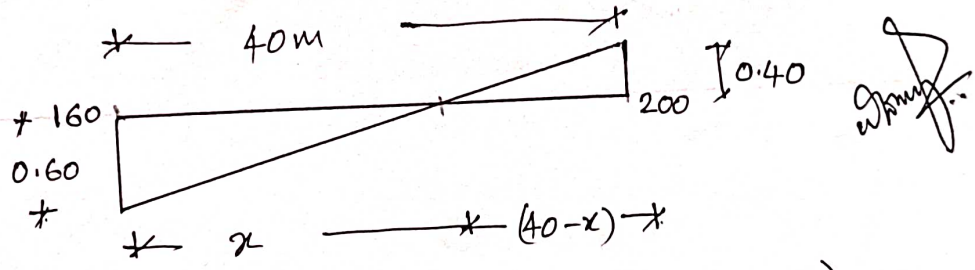
3) M-2-EW — L section [Zero EW in between chainages]

o - R.L. of Ground

Δ - Formation line

—— - Profile of Ground





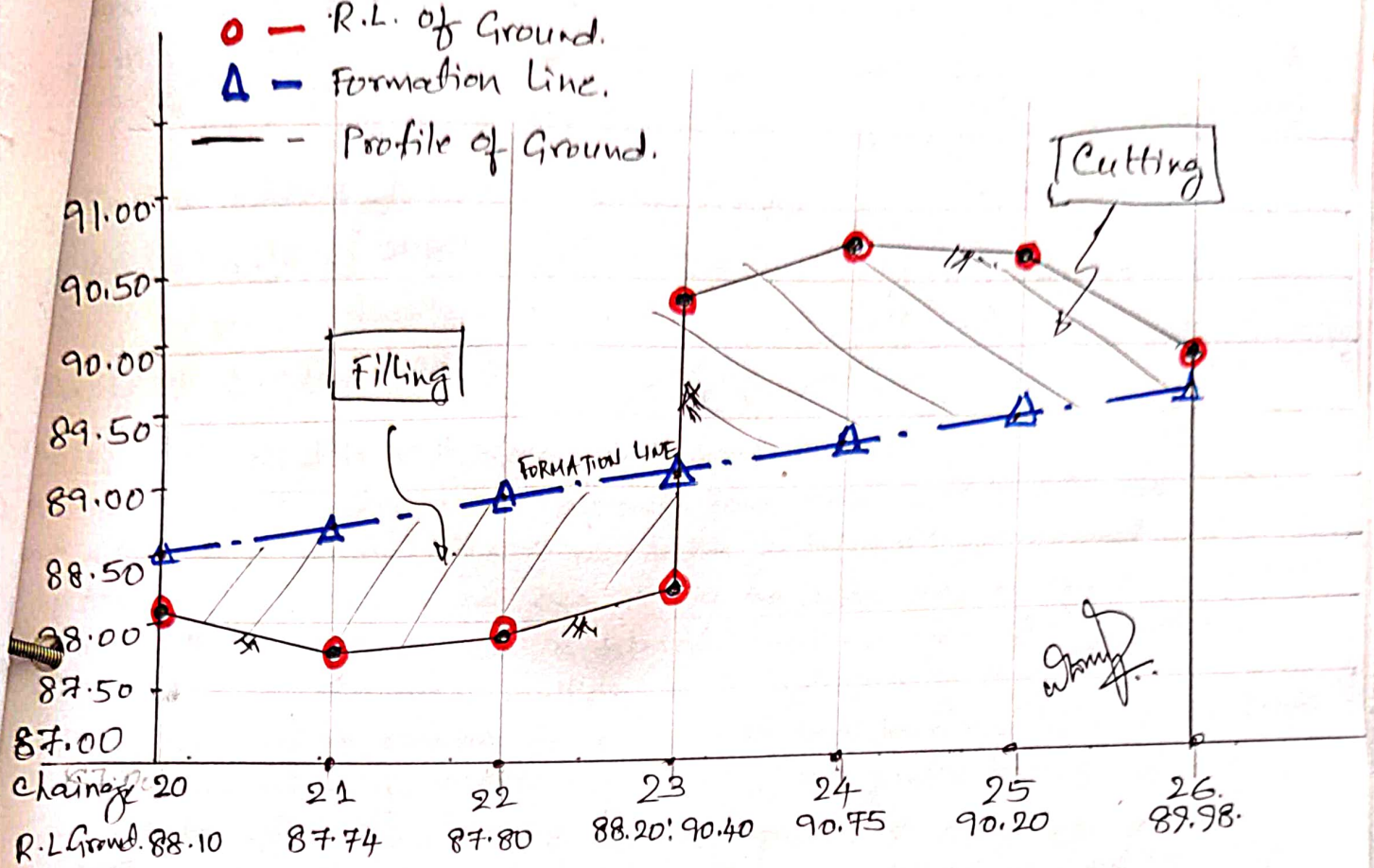
$$\frac{x}{(0.60)} = \frac{(40-x)}{(0.40)} \Rightarrow (0.40)(x) = (0.60)(40-x)$$

$0.4x = 24 - 0.6x \quad \therefore 0.4x + 0.6x = 24$

$\therefore \boxed{x = 24}$

$\therefore$ @ $160 + x \Rightarrow 160 + 24 = 184$ m chainage the depth of cut or fill is equal to ZERO.

1.4) M-2-EW-L Section (Vertical Drop)

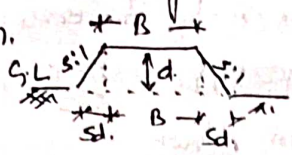


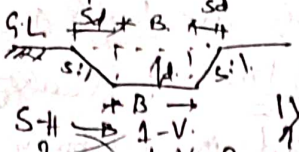
M-(2)-(3)-(4)-(1).

(MEASUREMENT OF EARTHWORK FOR ROADS:) [Part-C- Eg no. 6]

Quantity Estimation of Roads

Cross-Section of earth work of road in banking or cutting is in the form of figure.





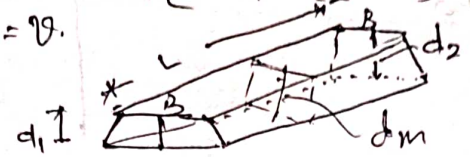
S:1 = Ratio of side slopes as horizontal to Vertical. i.e. for one Vertical, horizontal is S(1), i.e. by for d' Vertical, horizontal is S(d)

∴ Sectional area = A = Area of central Rectangular portion + Area of TWO SIDE triangular portions

$$A = [(B)(d)] + \frac{1}{2}[(Sd)(d)] + \left[\frac{1}{2}(Sd)(d)\right] = [Bd + 2(\tfrac{1}{2}Sd^2)] = Bd + (S)(d)^2.$$

∴ Volume or Quantity = (A)(L) = V.

Where L = length of the Road work



$$d_m = \left(\frac{d_1 + d_2}{2}\right)$$

NOTE: If the ground is with longitudinal slope; the depth of banking or cutting @ the two ends of section will be different. Hence mean height or depth 'd' $\left(\frac{d_1+d_2}{2}\right)$ of sectional area @ mid section is taken out for mean height.

Alternatively, Sectional area area at the two ends may be calculated and the mean of the two sectional areas is taken out. "Sectional area at the mid-section of the mean sectional area, multiplied by the length gives the quantity."

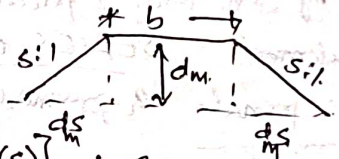
LEAD & LIFT: EW is estimated for 30m lead for distance and 1.5m lift for height or depth, it is known as NORMAL LEAD & LIFT. for greater lead or lift the rates will be higher. Hence EW is estimated separately for every 30m lead & 1.5m lift.

Earth work may be calculated by the various methods with or without cross slopes.

1) Mid-Sectional Area Method (Average) 2) Mean Sectional Area Method.

3) Prismoidal Formula Method & Trapezoidal formula method.

1) Mid-Sectional Area Method:-



Area of mid section = [Area of Rect. portion] + 2[area of Δle portion]

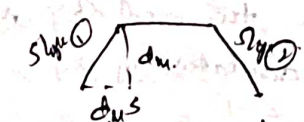
$$A = [(B)(d_m)] + 2\left[\tfrac{1}{2}(d_m S)(d_m)\right] = \left[(Bd_m) + (d_m^2)(S)\right] \quad \therefore Q = A(L)$$

$Q = (Bd + d^2S)(L)$ d = mean height or depth. = $d_m = \left(\frac{d_1+d_2}{2}\right)$

The quantities of EW are calculated using following tabular column.

Station or Chainage	Depth of height	Mean depth or Height d'	Area of central portion Bd	Area of side (Δle portion) d^2S	Total area $Bd + d^2S$	Length bw stations L	Quantity $(Bd + d^2S)L$ Embankment	Cutting

Side slopes: Turfing or pitching will be provided along the slopes.



Area of slopes = $2\left[\sqrt{(d_m)^2 + [(d_m)(S)]^2}\right] = 2 \times 2\sqrt{d_m^2(S^2+1)} = 2(2d_m\sqrt{S^2+1})$.

$A = (2L)(d_m)\sqrt{S^2+1}$.

Station	Depth of Ht.	Mean depth	Slopy breadth $d_m\sqrt{S^2+1}$	Length bw stations L	Total area of both side slopes $= (2L)(d_m)\sqrt{S^2+1}$

2) Mean Sectional area methods. $Q = V = (\text{Mean sectional area})(\text{length})$.

Let A_1 = area @ one end = $Bd_1 + d_1^2 s$ A_2 = area @ the other end = $Bd_2 + d_2^2 s$

Where B = formation width, d_1 & d_2 are heights of cuttings @ the two ends s = side slope

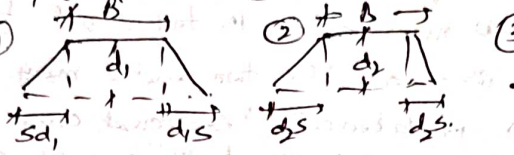
$\therefore$ Mean Sectional area $A = \frac{A_1 + A_2}{2}$ & Quantity = $V = (A \times L) = \left(\frac{A_1 + A_2}{2}\right)(L)$.

The quantities of E.W. may be calculated in a tabular form shown

Stations & Chainage	Height or depth	Area of central portion Bd.	Area of side slopes sd^2	Total area $= Bd + sd^2$	Mean sectional area	Length between Stations L	Quantity $(Bd + sd^2) \times (L)$ Embankment	Quantity $(Bd + sd^2) \times (L)$ cutting

3) Prismoidal Formula Method: Quantity or volume = $\frac{L}{6}[A_1 + A_2 + 4A_m]$

A_1 & A_2 are the C/S area @ the two ends of a road of length L & A_m is mid Sectional area.



$A_1 = Bd_1 + d_1^2 s$

$A_2 = Bd_2 + d_2^2 s$

$d_m = \frac{d_1 + d_2}{2}$

$\therefore A_m = B d_m + d_m^2 s$

$= B\left(\frac{d_1 + d_2}{2}\right) + \left(\frac{d_1 + d_2}{2}\right)^2 s$

$\therefore$ Quantity = $\frac{L}{6}(A_1 + A_2 + 4A_m)$

Substituting & simplifying for A_1, A_2 & A_m $Q = V = L\left[\frac{b(d_1 + d_2)}{2} + \frac{s(d_1^2 + d_2^2 + 2d_1 d_2)}{3}\right]$

$= (L)$ [Sectional area of Central portion + Sectional area of side slope portion]

Rectangular Triangular.

NOTES: E.W. Calculated by prismoidal formula is more accurate than Method I & II but they differ by less than 1 percent. cutting is indicated by -ve sign in order to distinguish from Embankment. SERIES OF CROSS SECTION (Method)

Trapezoidal formula & prismoidal formula for a series of cross-sections

Let $A_0, A_1, A_2, A_3 \ldots\ldots A_n$ are the area of cross section. & D be the distance b/w these sections. & V = volume of cutting or Embankment.

$V_T = \frac{D}{2}[A_0 + 2A_1 + 2A_2 + 2A_3 + \cdots + 2A_{n-1} + A_n] = D\left[\left(\frac{A_0 + A_n}{2}\right) + A_1 + A_2 + A_3 + \cdots A_{n-1}\right]$

Volume by prismoidal formula = $\frac{D}{3}[A_0 + 4A_1 + 2A_2 + 4A_3 + 2A_4 + 4A_5 + 2A_6 \cdots\cdots + A_n]$

$= \frac{D}{3}[A_0 + A_n + 4(A_1 + A_3 + A_5 + \cdots\cdots + A_{n-1}) + 2(A_2 + A_4 + A_6 + \cdots\cdots A_{n-2})]$

$= D/3$[First area + Last area + 4 ΣOdd area + 2 ΣEven area].

It may be noted that in case of P.F., it is necessary to have an odd number of sectional area. If there is an even no. of sections, the end slop should be treated separately and volume of remaining slop should be calculated by P.F.

Estimate the quantity of E.W. required for 180 m length of road by using prismoidal formula from following data.

Gradients 2:1, B = 10 m, S = 2

Chainage	0	30	60	90	120	150	180
R.L of Ground	112.00	111.80	111.70	111.60	111.50	111.30	111.40
R.L of Formation	←	—	112.60	—	—	—	→
∴ d	0.60	0.80	0.90	1.0	1.10	1.30	1.20

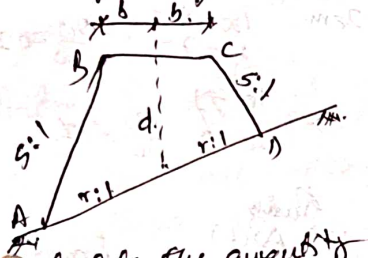
Prismoidal Formula quantity = $\left[B\left(\frac{d_1+d_2}{2}\right) + S\left(\frac{d_1^2+d_2^2+d_1d_2}{3}\right)\right] \times L$

Chainage	R.L Ground	R.L Formation	Height or depth d	$\frac{(d_1+d_2)}{2}$	$B\left(\frac{d_1+d_2}{2}\right)$	d_1^2	d_2^2	d_1d_2	$\frac{(d_1^2+d_2^2+d_1d_2)}{3}$	$S\left(\frac{d_1^2+d_2^2+d_1d_2}{3}\right)$	Area	Length	Quantity
0	112.00	112.60	0.6										
30	111.80		0.8	0.7	7.0	0.36	0.64	0.48	0.493	0.99	7.99	30	
60	111.70		0.9	0.8	8.0	0.64	0.81	0.72	0.723	1.45	9.45		
90	111.60		1.0	0.9	9.0	0.81	1.0	0.90	0.903	1.81	11.13		
120	111.50		1.05	1.0	10.0	0.81	1.10	0.90	1.103	2.21	12.71		
150	111.30		1.20	1.05	10.5	1.00	1.21	1.10	1.143	2.29	14.89		
180	111.40	112.60	1.25	1.20	12.0	1.21	1.69	1.43	1.563	3.13	15.63		
				1.25	12.5	1.69	1.44	1.56					2169.00 m³

Earth work with CROSS SLOPES. (E.W. in HILL ROAD)

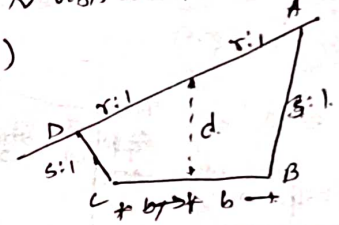
In hilly region, the ground will be irregular and has cross slope; such ground is known as side sloping ground or side-long ground. Instrument used: ① Tangent clinometer ② Ghat Tracer.

Cross-slopes may be measured as the ratio of horizontal distance to vertical i.e. r:1.



Area of ABCD = $\frac{b^2S + r^2(b^2s + 2bd)}{(r^2 - s^2)}$

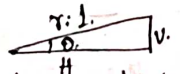
Volume = (A)(L).



Calculate the quantity of E.W. of a hill road in side-long ground, for a length of 200m from chainage 5 to 10. Tangent of the angle of transverse slope is equal to 0.1 all through as measured by Ghat Tracer. The length of each is 20m. The formation width is 7m and slope back is 2:1. R.L of G.L & F.L @ the centre are given below

Chainage	Distance	RL of Ground @ centre	RL of Formation @ centre
5	100m	200.00	201.20
6	120m	199.75	201.80
7	140m	200.50	202.40
8	160m	201.70	203.00
9	180m	202.40	203.60
10	200m	201.50	204.20

Given $\tan\theta = 0.1$



$\tan\theta = 0.1 = \frac{V}{H} = \frac{1}{H}$ ∴ $H = \frac{1}{0.1} = 10$.

r:1 = H:V ∴ r = 10.

S = 2, B = 7.0 ∴ $b = \frac{B}{2} = 3.5$m.

Chainage	Ht of Bank	Sectional Area $A = \frac{b^2S + r^2(b^2s + 2bd)}{(r^2 - s^2)}$	Mean sectional area	Length L	Quantity
5	1.20	12.00	—	—	
6	2.05	23.96	17.98	20	
7	1.90	21.63	22.80	20	
8	1.30	13.26	17.45	20	
9	1.20	12.00	12.63	20	
10	2.70	35.13	23.57	20	1888.60 m³

Prismoidal formula:- $V = \frac{L}{6}(A_1 + A_2 + 4A_m)$.

$A_{10} = A_1 = \left[b^2S + r^2(b^2s + 2bd)\right]/(r^2 - s^2) = (5^2)(1.5) + 8^2(5^2 \times 1.5 + 2 \times 5 \times 36)/(8^2 - 1.5^2) = 5807 m^2$

$A_{11} = A_2 = 44.45$ sqm ; $A_{12} = A_3 = 70.42$.

$\therefore V = \frac{L}{6}\left[A_1 + 4A_3 + A_2\right] =$

Mid area method $\left(\frac{A_{10}+A_{12}}{2}\right)(30) = 1537.80$

$\left(\frac{A_{12}+A_{11}}{2}\right)(30) = 1723.05$

$8260.85 m^3$

$V = (A_{10} + A_{12} + 4A_{11})\left(\frac{L}{6}\right)$ 60

$= 8262.9 m^3$

NOTE: P.F. gives more accurate result.

2) A hill road in side long to be constructed in cutting. Calculate qty of E.W. for two chainages both b/w 10th & 12th. length being 30m.

Depth of cutting @ 10th chainage is 3.60 with 8:1 slope

" " 11th " " 3.00 " " 12:1 "

" " 12th " " 4.20 " " 10:1 "

B = 10m. S = 1½

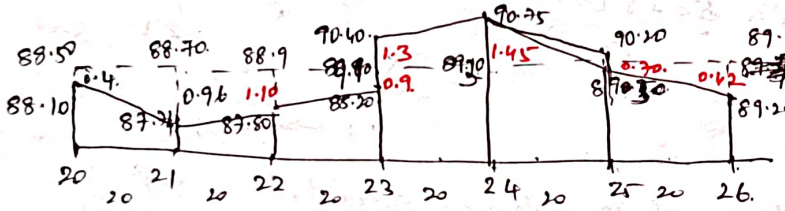
Jan 2015 / Dec 2012 Estimate the quantity of earth work for a portion b/w chainage 20 to 26 required with a standard 20m clear from following data by using average area (Mean area method)

The formation level @ chainage 20th is 88.50 & the road has a rising gradient of 1 in 100. The formation width is 10m & side slope in cutting 1:1 & in banking 2:1. (15)

Chainage	20	21	22	23	24	25	26
G.L above datum	88.10	87.74	87.80	88.20	90.75	90.20	89.28
F.L.				90.40			

(3)

Station or chainage	Height or depth d	Area of central portion Bd	Area of side slopes d^2s	Total sectional area Bd+d^2s	Avg/Mean sectional area	Length b/w stations L	Quantity (Bd+d^2s)L Embankment	Quantity (Bd+d^2s)L cutting
20	0.4	4.0	0.32	4.321	—			
	0.88							
21	0.96	9.6 / 6.8	1.843	11.443	15.763			
	1.05							
22	1.10	11.0 / 10.3	2.42	13.42	24.863			
	1.0							
	0.9	9.0 / 10.0	1.62	10.62	12.82			
23	1.3	13.0 / 11.0	1.69	14.69	12.655			
	1.375							
24	1.45	14.5 / 13.75	2.10	16.60	15.645			
	1.045							
25	0.70	7.0 / 10.75	0.49	7.49	12.045			
	0.56							
26	0.42	4.2 / 5.6	0.353	4.553	6.02			



Chainage = 20m.
B = 10m.
S = 2
s = 1

$\frac{1}{20} = \frac{1-?}{20}$ $? = \frac{20}{100} = 0.20$.

$\frac{100}{120} = \frac{1}{?}$ $\frac{120}{100} = 1.2$.

Station or chainage	R.L of Ground	R.L of formation	Depth of F.G. d	Central area Bd	Side area d^2s	Sectional area Bd+d^2s	Mean sectional area	Length (L)	Quantities (Bd+d^2s)L Fillings	Quantities (Bd+d^2s)L cutting	Remarks
20	88.10	88.50	0.40	4.0	0.32	4.32					
21	87.74	88.70	0.96	9.6	1.84	11.44	7.88	—			
22	87.80	88.90	1.10	11.0	2.42	13.42	12.43	—			
23	88.20	89.10	0.90	9.0	1.62	10.62	12.02	—			
	90.40	89.10	−1.30	13.0	1.69	14.69	12.65				
24	90.75	89.30	−1.45	14.5	2.10	16.60	15.65				
25	90.20	89.50	−0.70	7.0	0.49	7.49	12.05				
26	89.28	89.70	+0.42	4.2	0.35	4.55	6.02				

Jan 2016 / Dec 2012 (Continued)

Refer July 2011 — Mean area method

May / June 2010

Jan 2010

Trapezoidal formula method

TRAPEZOIDAL FORMULA & PRISMOIDAL FORMULA

When a series of c/s areas calculated @ equidistant points, the volume may be worked out by Trapezoidal formula & Prismoidal formula.

$$V_{Tr} = D\left[\frac{A_0 + A_n}{2} + A_1 + A_2 + A_3 + \ldots + A_{n-1}\right]$$

$$V_{Pr} = \frac{D}{3}\left[\text{First area} + \text{Last area} + 4\Sigma \text{odd areas} + 2\Sigma \text{Even areas}\right]$$

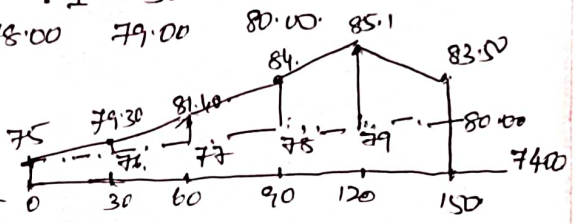
NOTE: To apply Prismoidal formula, it is necessary to have odd number of sectional areas. If there is an even no. of sections, the end strip should be treated separately & remaining odd no. should be calculated by prismoidal area.

Ex: Estimate the Qty of E.W. in cutting for a road of 10m width for the following data using mean sectional area method or Trapezoidal formula method. Side slope is 2:1 (H:V) and no cross slope. If the cost of cutting is 140/m³, estimate the total cost of earth work.

Chainage (m)	0	30	60	90	120	150
Ground level	80.50	79.30	81.40	84.00	85.10	83.50
Formation level	75.00	← Rising gradient is 1 in 30 →				

Soln

R.L of Formation	75.00	76.00	77.00	78.00	79.00	80.00



Chainage	R.L Ground	R.L F.L	Depth of cutt.	Central area Bd	Side area $d^2(s)$	Whole area	Mean Area	B	L	
0	80.50	75	5.50	55	60.5	115.50				
							96.03	30	—	2880.90
30	79.30	76	3.30	33	43.56	76.56				
							79.64	30	—	2389.20
60	81.40	77	4.40	44	38.72	82.72				
							107.36	30	—	3220.80
90	84.00	78	6.0	60	72.0	132.0				
							133.71	30	—	4011.30
120	85.10	79	6.1	61	74.42	135.42				
							97.46	30	—	2923.80
150	83.50	80	3.5	35	24.50	59.50				

Q = 15,426.00 m³

15,426 m³

Trapezoidal formula = $V_{Tr} = D\left[\frac{A_0 + A_n}{2} + A_1 + A_2 + A_3 + \ldots A_{n-1}\right]$

$= 30\left[\frac{(115.50 + 59.50)}{2} + 76.56 + 82.72 + 132.0 + 135.42\right]$

$= 30[87.50 + \ldots] = 30[514.20] = 15,426\ m^3.$

Module 2 : Road works & Estimation

Volume of earthwork shall be measured in cubic meters without any allowance for increase in bulk. The volume of EW shall be obtained by multiplying the length, breadth and depth/height measured from the ground level.

If Formation Level (FL) of a Road is > Ground Level (GL) : EW in Filling/Embankment (+ve)

If Formation Level (FL) of a Road is < Ground Level (GL): EW is in Cutting (-ve)

***Lead & Lift*: EW is estimated separately for 30m distance as lead and 1.5 m height or depth as lift which is known as NORMAL LEAD & LIFT. For greater lead or lift the rates will be increased.**

Note:* Longitudinal Slope, Side Slope S:1 i.e., Horizontal to Vertical , Cross Slopes r:1, Trapezoidal Section, Cross sectional Area, Volume of Earth Work. *{Refer pdf 2(a)}

Earth work may be calculated by various methods with or without cross slopes.

1. **Mid-section method**
2. **Mean sectional Area method or Average End area method or Trapezoidal method**
3. **Prismoidal method according to Simson's one-third Rule.**

I Mid Section Formula Method: *{Refer detailed figure (i.) from pdf 2(a)}*

Following Tabular Column (along with Reduced Levels of GL & FL) will be used for the calculation of EW for the given data.

Station OR Chainage	Depth OR Height (m)	Mean Depth OR Height (m)	Area of Central portion (Bd)	Area of sides (triangle shape) (Sd^2)	Total Area ($Bd+Sd^2$)	Length between Stations (L)	Quantitiy (m^3)	
							Filling	Cutting

Side Slopes:

Turfing or Pitching will be provided along the side slopes. $A=(L)(2)\{\sqrt{(d_m)^2 + [(d_m)(s)]^2}\} = (2)(L)(d_m)\{\sqrt{s^2+1}\}$

...thoroughly to give a plastic mix of ... times to have

Q. 1) For the data given below, prepare an estimate of EW at the rate of Rs.100/Cmtr. Take formation width as 10m and slopes of banking as 2:1, length of each chain is 30m. Find also the area of side slopes and cost of turfing at Rs.60/Smtr.

Chainage	10	11	12	13	14	15	16	17	18	19	20
RL of Ground	105.00	105.60	105.44	105.90	105.43	104.30	105.00	104.10	104.62	104.00	103.30
RL of Formation	107.00	←-----Gradient 1 in 150)-----→			←----------Gradient 1 in 100)----------→						

Solution: Given Data B=10 m, s=2, L=30m, EW rate=100/Cmtr, Turfing rate=60/Smtr.

Gradient 1:150 means 150 m Horizontal distance to 1 m vertical distance. Hence for 30 m (H) is (30/150=0.2 m)

Similarly for 1:100 gradient the difference in level will be 0.3 m

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height (m)	Mean Depth OR Height (m)	Area of Central portion (Bd_m)	Area of sides (triangle shape) (Sd^2)	Total Area ($Bd+Sd^2$)	Length between Stations (L)	Quantitiy (m^3)	
									Filling	Cutting
10	105.00	107.00	2.00	-	-	-	-	-	-	-
11	105.60	106.80	1.20	(2+1.2)/2=1.60	16.00	5.12	21.12	30	633.60	-
12	105.44	106.60	1.16	1.18	11.80	2.78	14.58	30	437.40	
13	105.90	106.40	0.50	0.83	8.30	1.38	9.68	30	290.40	
14	105.43	106.20	0.78	0.64	6.40	0.82	7.22	30	216.60	
15	104.30	105.90	1.60	1.19	11.90	2.83	14.73	30	441.90	
16	105.00	105.60	0.60	1.10	11.00	2.42	13.42	30	402.60	
17	104.10	105.30	1.20	0.90	9.00	1.62	10.62	30	318.60	
18	104.62	105.00	0.38	0.79	7.90	1.25	9.15	30	274.50	
19	104.00	104.70	0.70	0.54	5.40	0.58	5.98	30	179.40	
20	103.33	104.40	1.10	0.90	9.00	1.62	10.62	30	318.60	

Calculation of Area for Side Slopes:

Chainage	Height/Depth	Mean depth (d_m)	Sloped Breadth $= d_m(\sqrt{s^2+1})$	Length	Area of Both sides $A=(2)(L)(d_m)\{\sqrt{s^2+1}\}$
10	2.00	-	-	-	-
11	1.20	1.60	3.58	30	214.80
12	1.16	1.18	2.64	30	158.40
13	0.50	0.83	1.86	30	111.60
14	0.78	0.64	1.43	30	85.80
15	1.60	1.19	2.66	30	159.60
16	0.60	1.10	2.46	30	147.60
17	1.20	0.90	2.01	30	120.60
18	0.38	0.79	1.77	30	106.20
19	0.70	0.54	1.21	30	72.60
20	1.10	0.90	2.01	30	120.60
				Total	1297.80 Smtr

Abstract of Estimate:

Item No.	Particulars	Quantity	Unit	Rate/Unit	Cost Rs=Ps
1.	Earthwork in Banking/Embankment/Filling.	3513.60	Cmtr	100/m^3	351360=00
2.	Turfing of Side Slopes	1297.80	Smtr	60/m^2	77868=00
				Total	429228=00
	Add (3% for contingencies and 2% work charged establishment) 5%				21461=40
				Total	450689=40
	(Rupees Four lakhs Fifty thousand Six hundred Eighty Nine only)				

Q. 2) Estimate the cost of EW for a portion of road from following data. Draw Longitudinal section for the road. B=10 m, S=2:1 in Banking, S=1.5:1 in Cutting. Formation level is 152.00 m at 0th Chainage.

Distance	0	30	60	90	120	150	180	210	240	270	300
RL of Ground	151.00	151.20	151.35	151.55	151.60	151.75	151.90	152.20	152.30	152.45	152.50
RL of Formation	152.00	<---------- Downward Gradient of 1 in 200 ---------->									

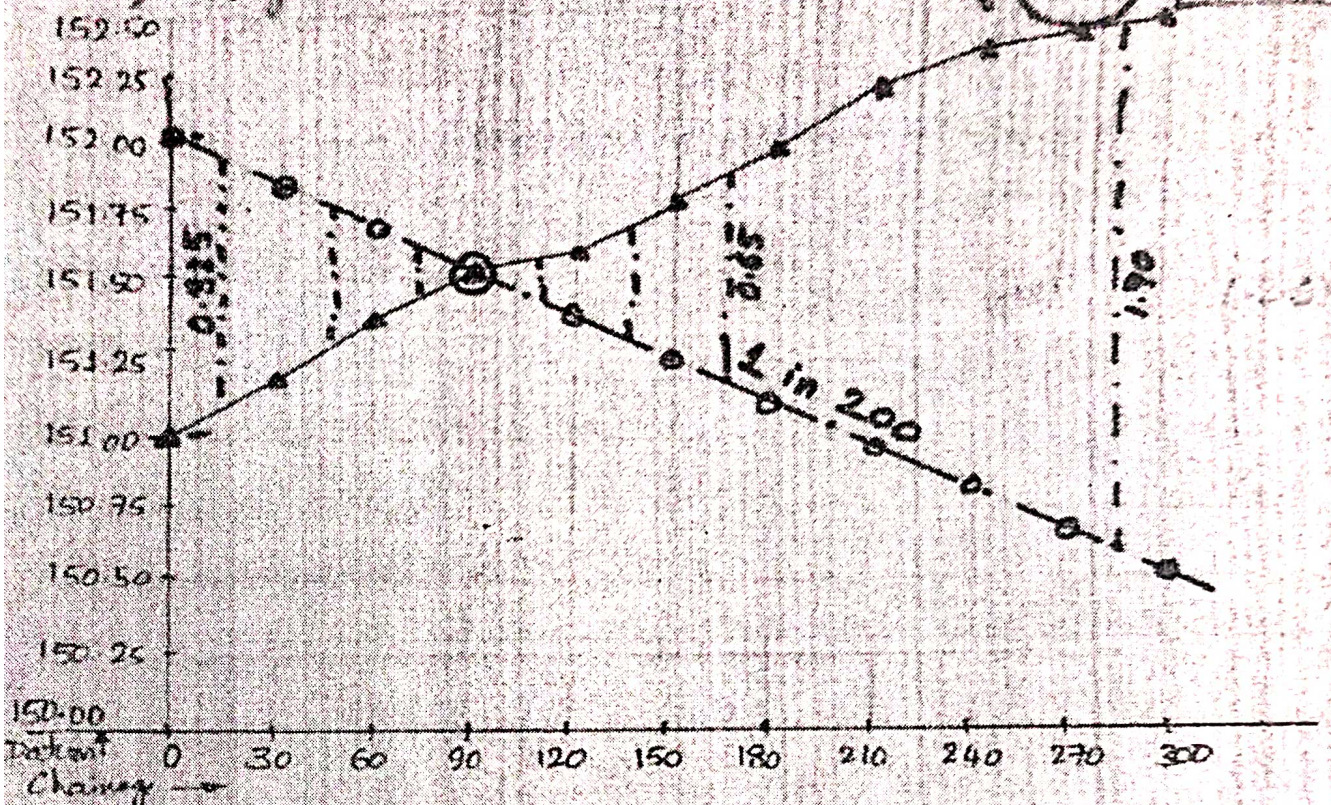
Solution: Downward Gradient of 1 in 200 is (30/200) = 0.15 m for every 30 m

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height (m)	Mean Depth OR Height (d_m)	Area of Central portion (Bd_m)	Area of sides (triangle shape) (Sd_m^2)	Total Area ($Bd+Sd_m^2$)	Length between Stations (L)	Quantity(m^3) $V=(Bd+Sd_m^2)(L)$	
									Filling	Cutting
0	151.00	152.00	1.00	-	-	-	-	-	-	-
30	151.20	151.85	0.65	0.825	8.25	1.36 (s=2)	9.61	30	288.30	
60	151.35	151.70	0.35	0.50	5.0	0.50 (s=2)	5.50	30	165.00	
90	151.55	151.55	0.00	0.18	1.80	0.06 (s=2)	1.86	30	55.80	
120	151.60	151.40	-0.20	0.10	1.0	0.02(s=1.5)	1.02	30		30.60
150	151.75	151.25	-0.50	0.35	3.5	0.18 (s=1.5)	3.68	30		110.40
180	151.90	151.10	-0.80	0.65	6.5	0.63 (s=1.5)	7.13	30		213.90
210	152.20	150.95	-1.25	1.03	10.3	1.60 (s=1.5)	11.90	30		357.00
240	152.30	150.80	-1.50	1.375	13.75	2.84 (s=1.5)	16.59	30		497.70
270	152.45	150.65	-1.80	1.65	16.5	4.08 (s=1.5)	20.58	30		617.40
300	152.50	150.50	-2.00	1.90	19.0	5.42 (s=1.5)	24.42	30		732.60
								Total E.W.	509.10	2559.60

II Mean Sectional Area Method: In this method mean area between the successive chainage is considered and the following table will be used for the calculation of Quantities.

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height (m)	Central portion Area (Bd)	Area of sides (triangle shape) (Sd^2)	Total Area ($Bd+Sd^2$	Mean Sectional Area	Length between Stations (L)	Quantitiy(m^3)	
									Filling	Cutting

Q 2) Longitudinal Section details of (Q2) [M-2]



A → R.L. of Ground profile

o → R.L of Formation Level.

———— Profile of GROUND

—.—.— Formation Line.

!!! Dept of filling / cutting [Mean Depth - dw]

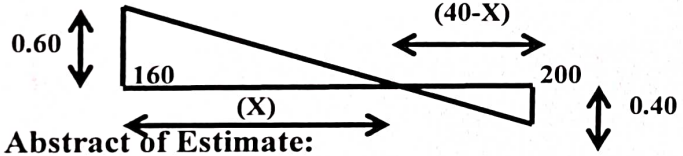
Q. 3) Estimate the cost of EW for a portion of road from following data. Draw Longitudinal section for the road. Formation width is 8 m. Side slope 2:1 in filling and 1.5:1 in Cutting. Cost of filling is Rs.180/m³ and cutting is 120/m³.

Chainage	0	40	80	120	160	200	240	280
RL of Ground	100.60	100.20	99.80	100.20	100.80	101.90	102.40	102.50
RL of Formation	101.00	←--------Rising Gradient 1 in 400----------→						

Solution: - Given Data: B=8, S=2 (in filling). S=1.5 (in cutting), Rise in Gradient for 40m chainage=(40/400)=0.1 m

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height (m)	Central portion Area (Bd)	Area of sides (triangle shape) (Sd^2)	Total Area ($Bd+Sd^2$)	Mean Sectional Area	Length between Stations (L)	Quantitiy(m^3)	
									Filling	Cutting
0	100.60	101.00	0.40	3.20	0.32	3.52	—	—	—	
40	100.20	101.10	0.90	7.20	1.62	8.82	6.17	40	246.80	
80	99.80	101.20	1.40	11.20	3.92	15.20	12.01	40	480.40	
120	100.20	101.30	1.10	8.80	2.42	11.22	13.21	40	528.40	
160	100.80	101.40	0.60	4.80	0.72	5.52	8.37	40	334.80	
Passes from	Banking to	Cutting with	Zero value	.....	.....	0.00	2.76	24	66.24	
200	101.90	101.50	-0.40	3.20	0.24	3.44	1.72	16		27.52
240	102.40	101.60	-0.80	6.40	0.96	7.36	5.40	40		216.00
280	102.50	101.70	-0.80	6.40	0.96	7.36	7.36	40		294.00
								Total EW	1656.52	537.52

Location of Formation level crossing from Filling to cutting i.e., to locate zero depth of filling or cutting:



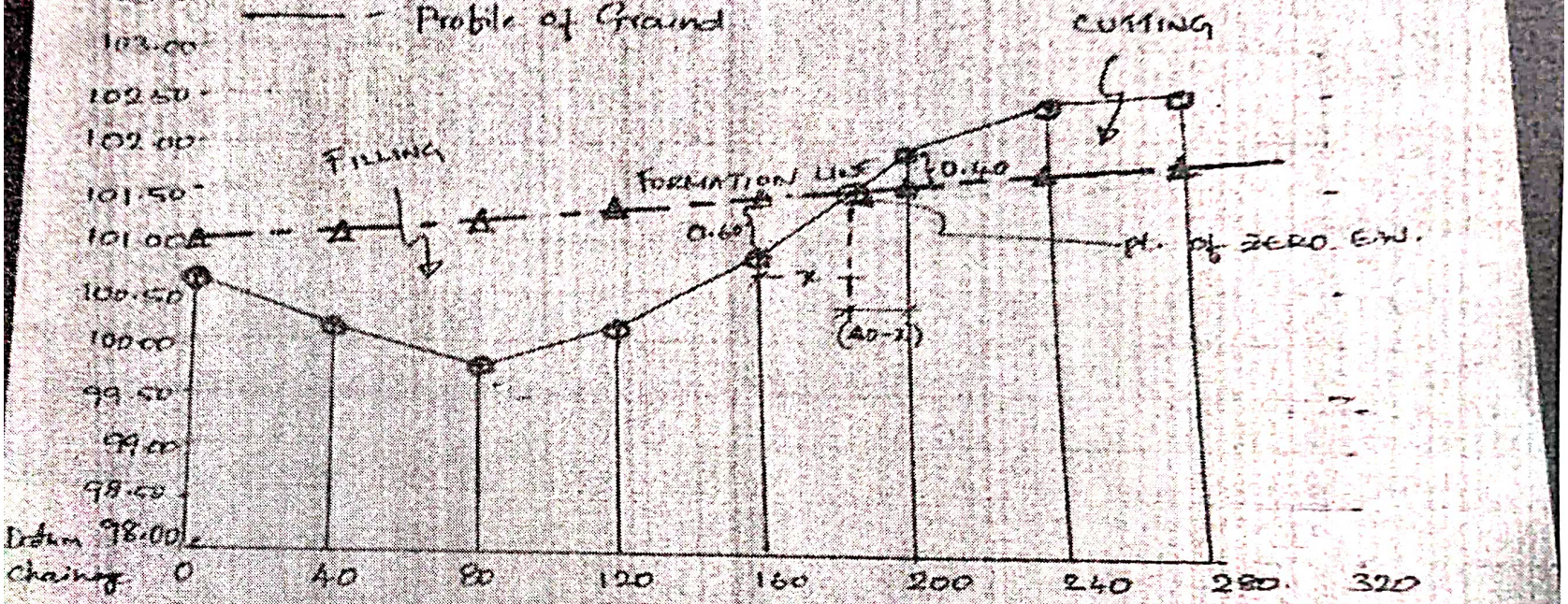
(X)/(0.60) = (40-X)/(0.40) i.e., 0.4(X) = 24-(0.6)(X). Therefore X=24 m from 160 chainage.

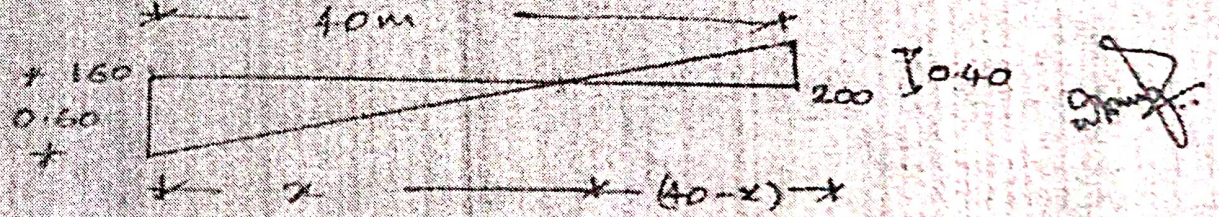
Abstract of Estimate:

Item No.	Particulars	Quantity	Unit	Rate/Unit	Cost Rs=Ps
1.	Earthwork in Banking/Embankment/Filling.	1656.52	Cmtr	180/Cmtr	298173=60
2.	Earthwork in Cutting.	537.52	Cmtr	120/Cmtr	64502=40
				Total	362676=00
	Add (3% for contingencies and 2% work charged establishment) 5%				18133=80
	Grand Total				380809=80
	(Rupees Three lakh Eighty thousand Eight hundred Nine and Paise Eighty only)				

Q.3) M-2 – EW – L section [Zero EN in between chainages]

o – R.L. of Ground
Δ – Formation line
——— – Profile of Ground





$$\frac{x}{(0.60)} = \frac{(40-x)}{(0.40)} \Rightarrow (0.40)(x) = (0.60)(40-x)$$

$0.4x = 24 - 0.6x$ $\therefore 0.4x + 0.6x = 24$

$\therefore \boxed{x = 24}$

$\therefore$ @ $160 + x \Rightarrow 160 + 24 = 184$ m chainage the depth of cut or fill is equal to ZERO.

Q.4) Estimate the quantity of Earthwork from chainage 20 to 26 measured with a standard 20 m chain from the following data adopting average end area formula. Draw Longitudinal section for the given data. Formation level at 20th chainage is 88.50 and the road has a rising gradient of 1 in 100. Formation width is 10 m, side slopes in cutting is 1:1 and in filling is 2:1.

Chainage	20	21	22	23	24	25	26
RL of Ground	88.10	87.74	87.80	88.20 90.40	90.75	90.20	89.98

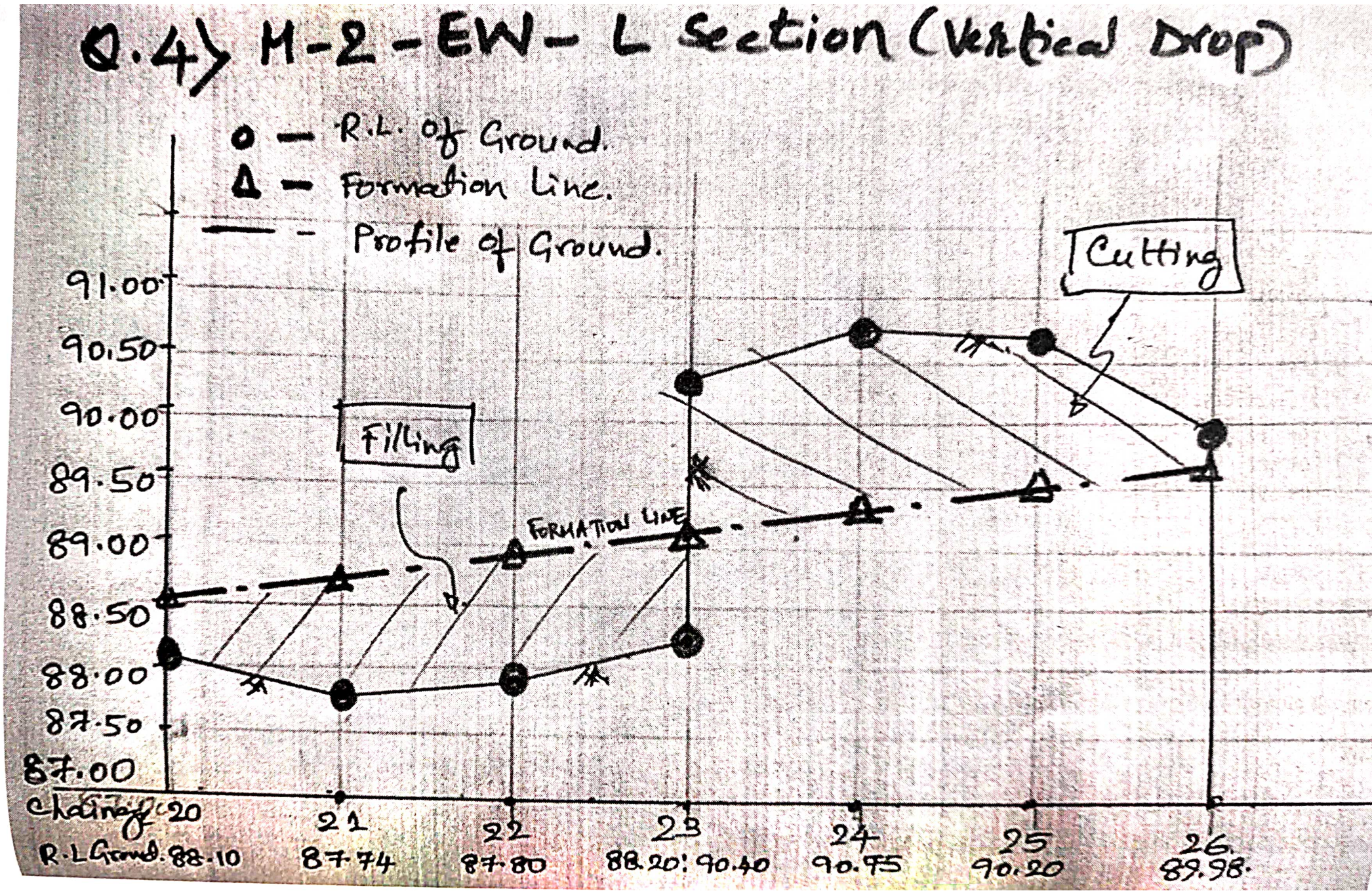
Solution: The RL of ground at chainage 23 is 88.20 & 90.40 : Hence there is a vertical drop at that chainage of natural ground profile.

(Note: Refer Q.4 pdf for the details). Rise in gradient for 20 m chainage length = (20)/(100)=0.20

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height (m)	Central portion Area (Bd)	Area of sides (triangle shape) (Sd^2)	Total Area ($Bd+Sd^2$)	Mean Sectional Area	Length b/w Stations (L)	Quantitiy(m^3)	
									Filling	Cutting
20	88.10	88.50	0.40	4.00	0.32	4.32	------	------	---	-----
21	87.74	88.70	0.96	9.60	1.84	11.44	7.88	20	157.60	
22	87.80	88.90	1.10	11.00	2.42	13.42	12.43	20	248.60	
23	88.20	89.10	0.90	9.00	1.62	10.62	12.02	20	240.40	
	90.40	89.10	-1.30	13.20	1.69	14.89				
24	90.75	89.30	-1.45	14.50	2.10	16.60	15.75	20		315.00
25	90.20	89.50	-0.70	7.00	0.49	7.49	12.05	20		241.00
26	89.98	89.70	-0.28	2.80	0.08	2.88	5.19	20		103.80
									646.60	659.80

NOTE: For Longitudinal section refer pdf Q.4 drawing.

Q.4) M-2-EW- L Section (Vertical Drop)



III. Prismoidal Formula: If A_1 & A_2 are the cross sectional area at the ends of a road of length 'L' with 'A_m' as mid sectional area the Volume of Earth work is given by the expression, 'V' = $\{L/6\}[A_1 + A_2 + 4A_m]$. If continues RL's are given then the final Quantity is obtained by using the formula $V=\{L\}([B\{d_1 + d_2\}/(2)] + (S/3)[d_1^2 + d_2^2 + d_1d_2]) = (L)[\{P\}] + S[Q]$

Where $A_1 = [Bd_1 + Sd_1^2]$, $A_2 = [Bd_2 + Sd_2^2]$ & $A_m = [Bd_m + Sd_m^2]$, also $d_m = \{d_1 + d_2\}/(2)$.

Earth work calculated by Prismoidal Fomula method is more accurate than Method I & II. But they differ by 1%.

Q.5) Estimate the quantity of earth work for given data using prismoidal formula. Chainage length is 50m. The RL of formation at chainage 10 and 18 are 218.90 and 218.10. The formation width is 5.5m in cutting and 6.0m in banking. Take side slopes as 1½:1 in cutting and 2:1 in banking.

Chainage	10	11	12	13	14	15	16	17	18
RL of Ground	220.50	220.10	219.70	219.20	218.50	218.20	217.70	217.30	217.50

Solution: From the RL's of FL given, the gradient will be 0.10 m drop for every successive chainage.

Station OR Chainage	RL of Ground	RL of Formation	Depth OR Height	Mean depth $\{d_1 + d_2\}/(2)$	Area of middle portion (P) $\{B(d1+d2)\}/(2)$	d_1^2	d_2^2	d_1d_2	Side area (SQ)	Total Area A=P+SQ	L	Quantitiy(m^3)	
												Filling	Cutting
10	220.50	218.90	-1.60	---	-	---	---	---	---	---	---	---	
11	220.10	218.80	-1.30	1.45	7.96 (B=5.5)	2.56	1.69	2.08	3.17	11.13	50	---	556.50
12	219.70	218.70	-1.00	1.15	6.33 (B=5.5)	1.69	1.00	1.30	2.00	8.33	50	---	416.50
13	219.20	218.60	-0.60	0.80	4.40 (B=5.5)	1.00	0.36	0.60	0.98	5.38	50	---	269.00
14	218.50	218.50	0.00	0.30	1.65 (B=5.5)	0.36	0.00	0.00	0.18	1.83	50	---	91.50
15	218.20	218.40	0.20	0.10	0.60 (B=6.0)	0.00	0.04	0.00	0.02	0.62	50	31.00	
16	217.70	218.30	0.60	0.40	2.40	0.04	0.36	0.12	0.34	2.74	50	137.00	
17	217.30	218.20	0.90	0.75	4.50	0.36	0.81	0.54	1.14	5.64	50	282.00	
18	217.50	218.10	0.60	0.75	4.50	0.81	0.36	0.54	1.14	5.64	50	282.00	
										Total EW	---	732.00	1333.3

Module 2 : Estimates for Septic Tank(ST), Man hole(MH) & Steel Truss(T)

Estimation of Septic Tank, Man hole and steel truss are being discussed in this topic. To begin with the details given in the drawing is thoroughly studied in order select, exact and correct dimensions of each of the required items.

Q.1) The details of Septic Tank is given in Fig.2. Find the quantities of the following items of works:
a) Earth work excavation for foundation in hard soil. b) Constructing burnt brick masonry in CM 1:4 for side walls. c) Providing and laying 1:2:4 for cover slab.

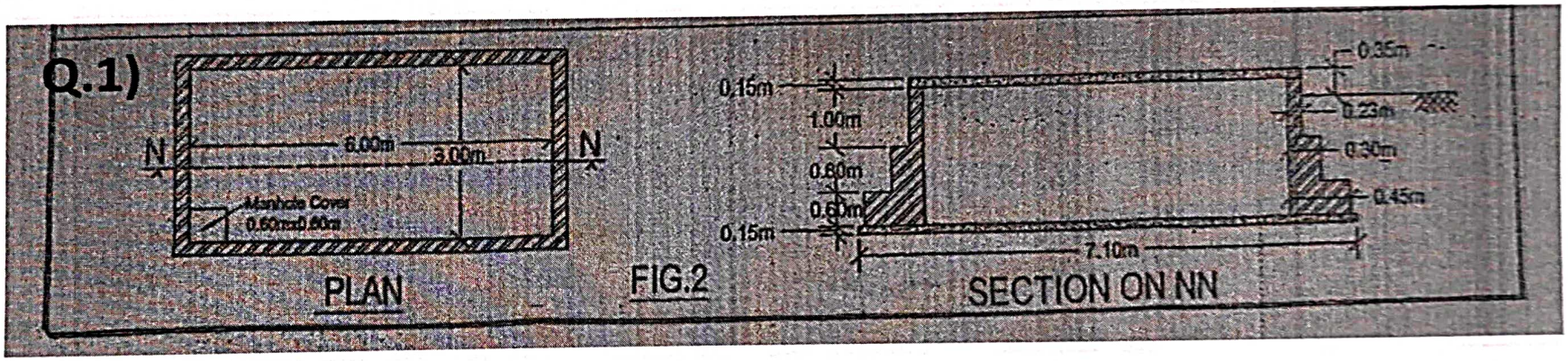


FIG.2

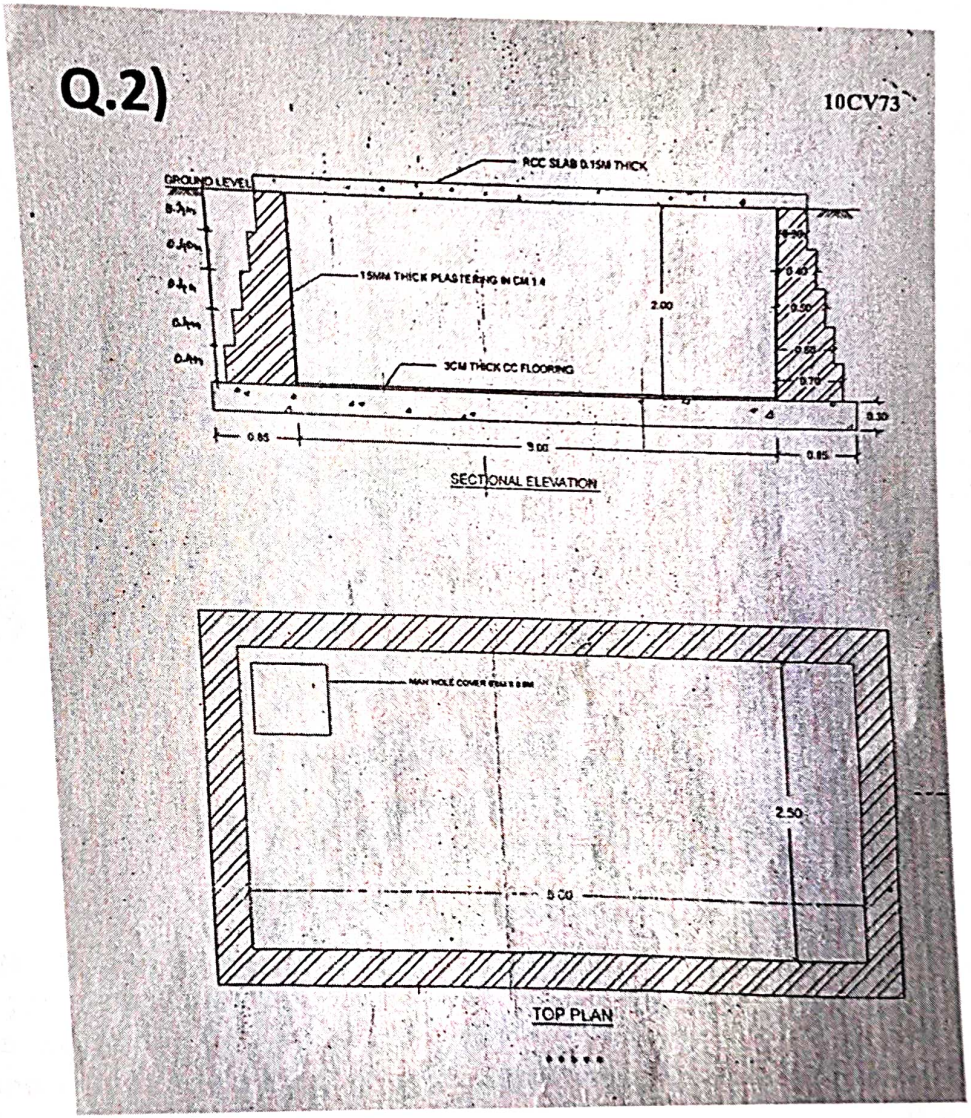
Solution: Studying the drawing in details, following points are noted.
1. The ST is having FOUR walls, of which TWO are long walls & TWO are short walls. Below these walls & at the bottom PCC has been laid.
2. Depth of Septic Tank (ST) including PCC from GL is = (1+0.15-0.35) + (0.80) + (0.60) + (0.15) = 2.35 m
3. Length of Septic Tank (ST) along long wall direction (outer to outer) including PCC off set = 7.10 m (Given in drawing)
4. Breadth/Width of Septic Tank (ST) along short wall direction (outer to outer) including PCC off set = (3) + 2 (0.45) + 2 (0.1) = 4.1 m
Hence Volume of Earth Work for ST ----→ V = (L)(B)(D) = (7.1)(4.1)(2.35) = 68.41 m^3
5. BBM: Brick masonry is used for all the four walls with THREE steps (Section NN).
i) for 1st step: Length of long wall = (6) + 2(0.45) = 6.90 m & Length of short wall = 3 m (***) follow same procedure for 2nd & 3rd step
6. RCC slab: L = (6 + 0.23 + 0.23) = 6.46 m, B = (3 + 0.23 + 0.23) = 3.46 m and D = 0.15 m
All these are entered in the tabular column and the quantities are evaluated as show below.

Details of measurements and calculation of quantities (Q.1, Fig.2.)

Item No.	Particulars of item and details of works	No.	Length (m)	Breadth (m)	Height or Depth (m)	Quantity (with unit)	Explanatory Notes
1	Earthwork in excavation for foundation in Hard soil	1	7.1	4.1	2.35	68.41 m^3	Cmtr
2	BBM in CM 1:4 for side walls						
	(i) Long Wall						
	1st Step	2	6.90	0.45	0.60	3.76	6+.45+.45
	2nd Step	2	6.60	0.30	0.80	3.16	Cmtr
	3rd Step	2	6.46	0.23	1.00	2.97	Cmtr
	(ii) Short Wall						
	1st Step	2	3.00	0.45	0.60	1.62	Cmtr
	2nd Step	2	3.00	0.30	0.80	1.44	Cmtr
	3rd Step	2	3.00	0.23	1.00	1.38	Cmtr
	Total BBM:					14.33 m^3	
3	1:2:4 cover to roof slab	1	6.46	3.46	0.15	3.35 m^3	Cmtr
	Deduct for Man hole cover					-0.054 m^3	
						3.29 m^3	
4	PCC (If required)	1	7.1	4.1	0.15	4.37 m^3	Cmtr
5	Plastering to Inner side of walls (If required) and flooring						
	(i) Long wall	2	6.00	-----	2.40	28.80	Smtr
	(ii) Short wall	2	3.00	-----	2.40	14.40	Smtr
	(iii) Flooring	1	6.00	-----	3.00	18.00	
	Total Plastering:					61.20 m^2	

Q.2) The details of Septic Tank is given in following Fig. Find the quantities of the following items of works:

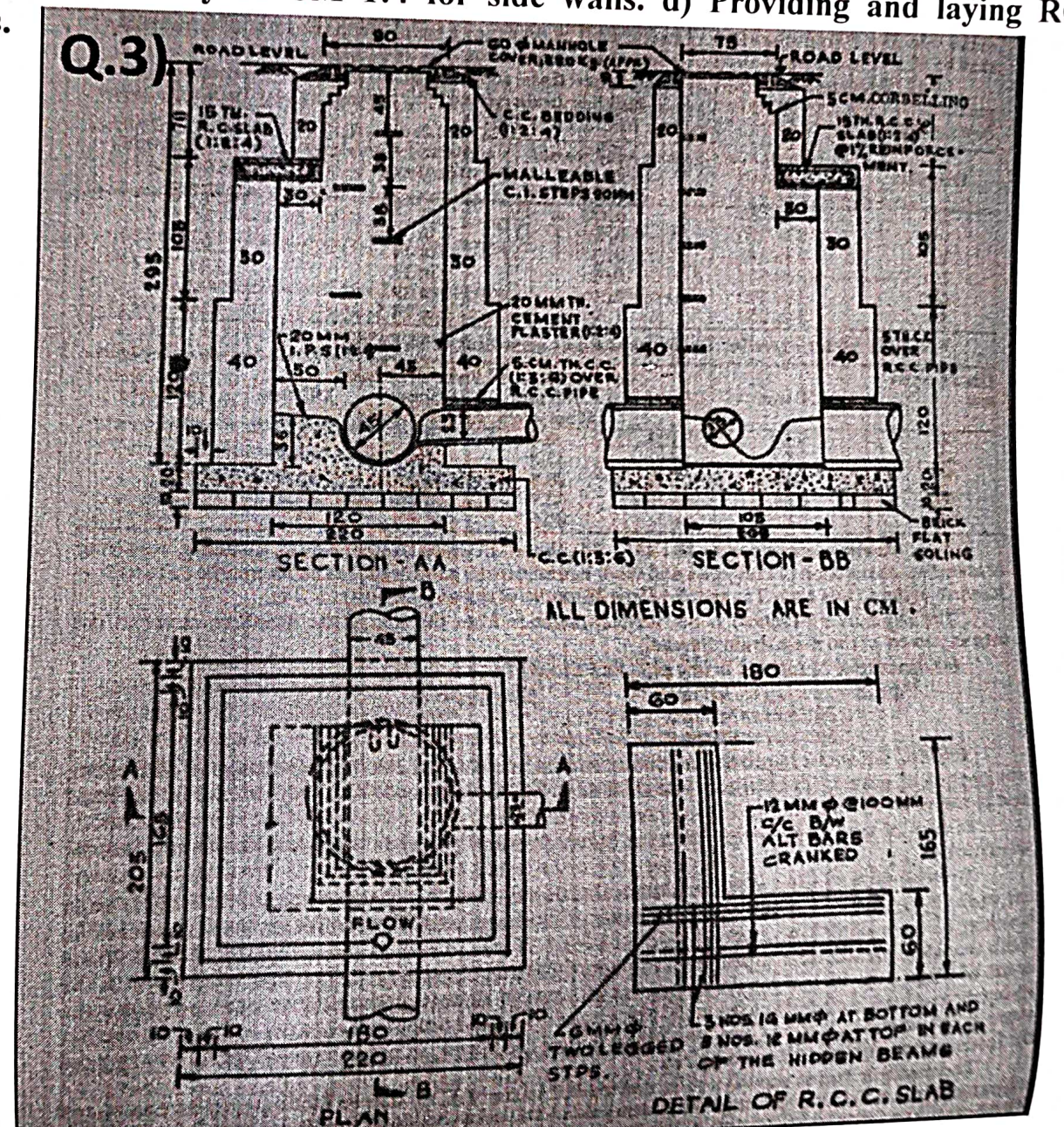
a) Earth work excavation for foundation in hard soil. b) PCC for bottom of Septic tank, c)Constructing burnt brick masonry in CM 1:4 for side walls. d) Providing and laying 1:2:4 for cover slab. e) Plastering to inner walls. f) 3 cm thick CC flooring

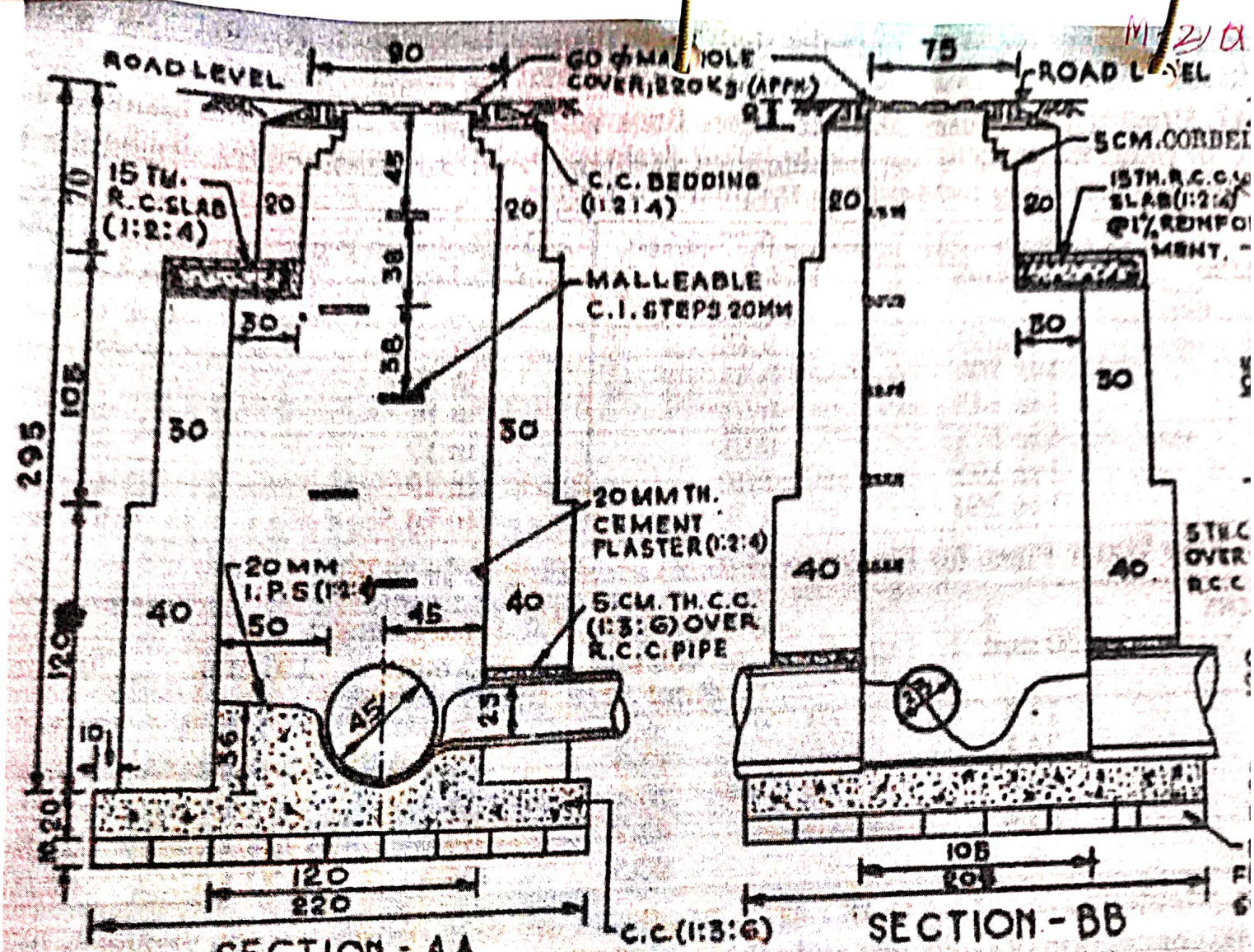


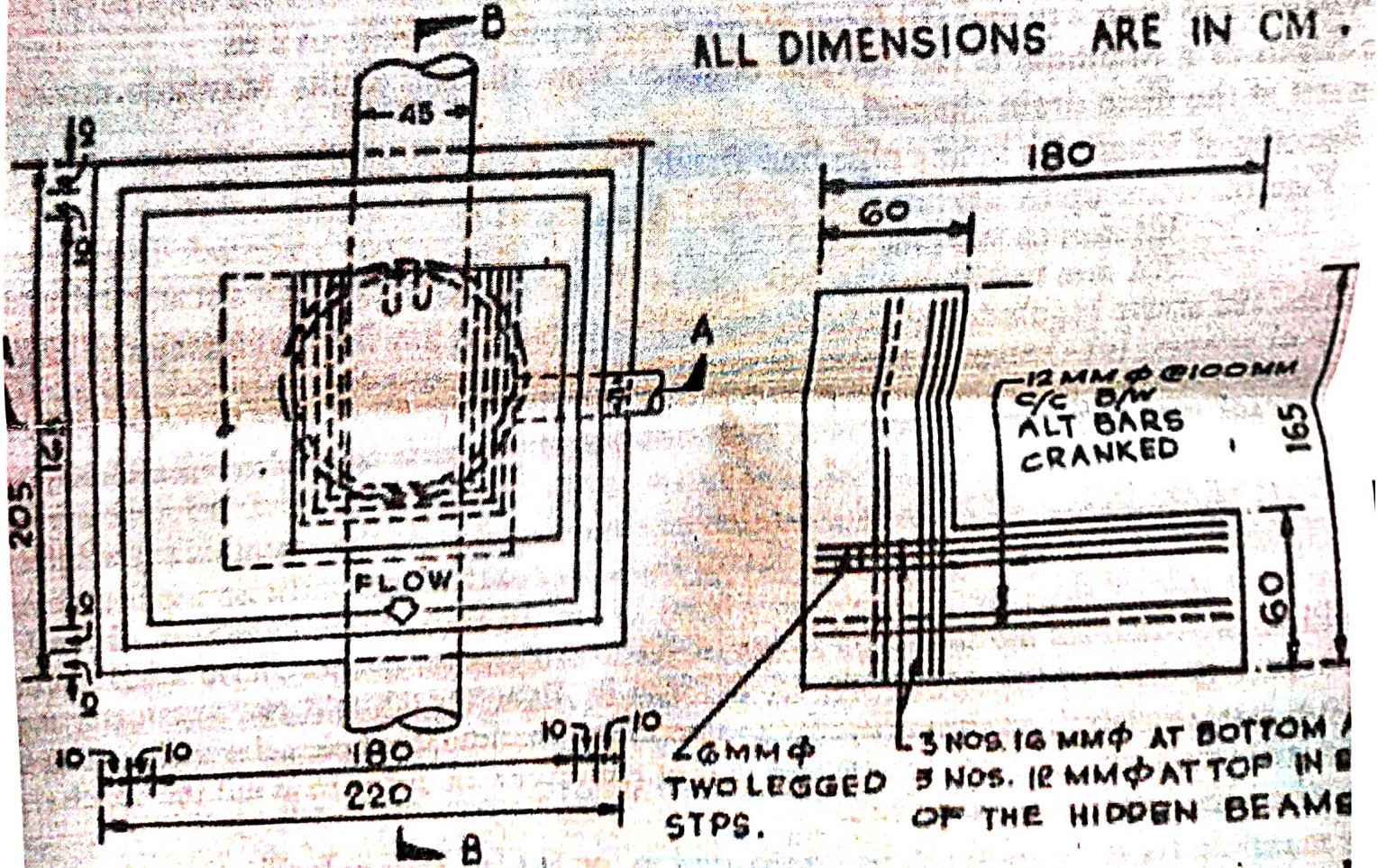
give a plastic mix of

Q.3) The details of Man hole is shown in Fig. Find the quantities of the following items of works:

a) Earth work excavation for foundation in hard soil. b) CC for bottom of Man hole, b') brick flat soling, c)Constructing burnt brick masonry in CM 1:4 for side walls. d) Providing and laying RCC 1:2:4. e) Plastering to inner walls.







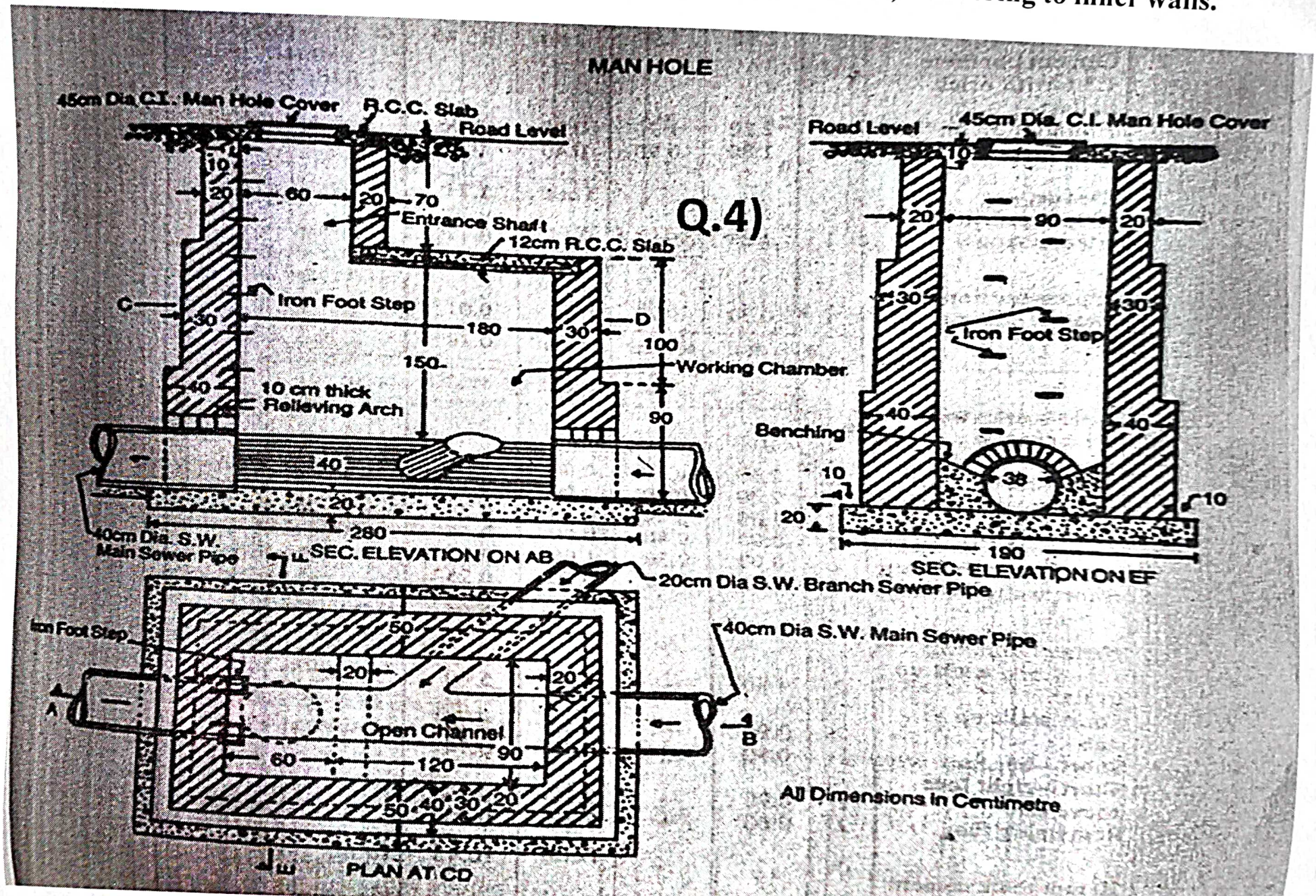
Derivation of the

Details of measurements and calculation of quantities (Cont.)

Item No.	Particulars of item and details of works	No.	Length (m)	Breadth (m)	Height or Depth (m)	Quantity (with unit)	Explanatory Notes
1.	Earth work in excavation for foundation	1	2.20	2.05	3.25	14.65 m^3	2.95+.2+.1=3.25
2.	CC for bottom of MH	1	2.20	2.05	0.20	0.902	
	Benching portion i) main sewer line	1	1.65	0.50	0.36	0.297	
	ii) Branch line	1	1.65	0.45	(0.2)/2	0.074	
					Total	1.273 m^3	
3.	Brick flat soling	1	2.20	2.05	----	4.51 m^2	
4	BBM in CM 1:4 for side walls						
	(i) Long Wall						
	1st Step	2	2.00	0.4	1.2	1.92	
	2nd Step	2	1.80	0.30	1.05	1.134	
	3rd Step	2	1.30	0.20	0.60	0.312	
	(ii) Short Wall						
	1st Step	2	1.05	0.4	1.2	1.008	
	2nd Step	2	1.05	0.30	1.05	0.662	
	3rd Step	2	0.75	0.20	0.60	0.18	
	Deduction for RCC - i) (0.6x0.15x1.05)	1	----	----	----	- 0.095	
	- ii) (0.6x0.15x1.80)	1	----	----	----	- 0.16	
	Total BBM:					4.96 m^3	
5	Providing and laying RCC 1:2:4	As in Item 4 of Deduction part				0.255 m^3	(0.095+0.16)
6	Plastering to Inner face of the walls: i) working chamber	1	2(1.20+1.05){1.74}			7.83 m^2	
	ii) Shaft	1	2(0.9+0.75){0.6}			1.98 m^2	
					Total	9.81 m^2	

Q. 4) The details of Man hole is shown in Fig. Find the quantities of the following items of works:

a) Earth work excavation for foundation in hard soil. b) CC for bottom of Man hole, c)Constructing burnt brick masonry in CM 1:4 for side walls. d) Providing and laying RCC 1:2:4. e) Plastering to inner walls.

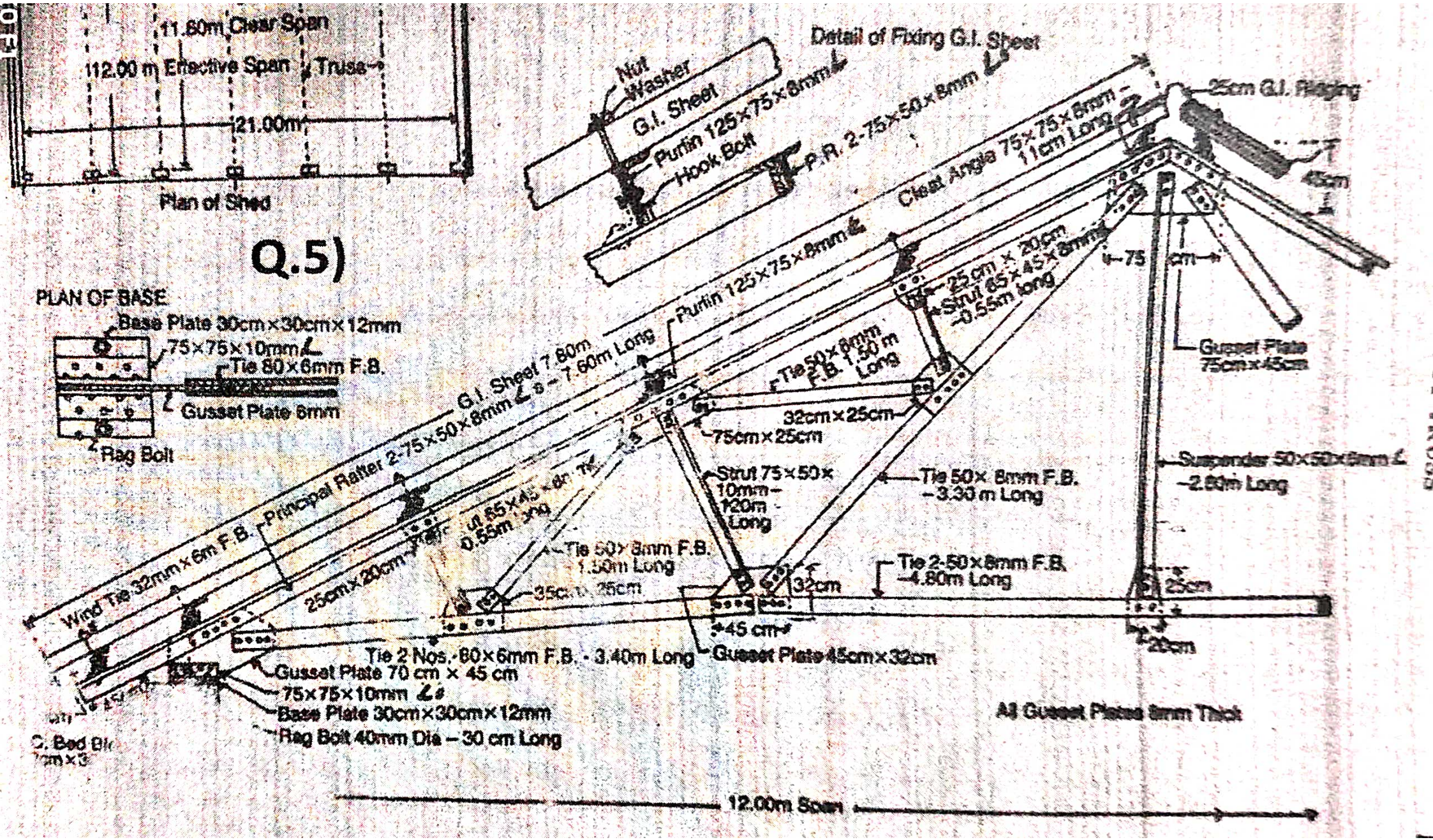


Solution: Details of measurements and calculation of quantities (Q.4)

Item No.	Particulars of item and details of works	No.	L (m)	B (m)	H or D (m)	Quantity (with unit)	Explanatory Notes
1.	Earth work in excavation for foundation	1	2.80	1.90	2.80	14.89 m^3	
2.	CC for bottom with 1:3:6						
	i) Foundation and Bed	1	2.80	1.90	0.20	1.06	
	ii) Benching portion	1	1.80	0.90	0.40	0.65	
	Deductions i) Upper portion of main channel	1	1.80	(.9+.38)/(2)	0.15	- 0.17	
	ii) …….. Do …… branch channel	1	0.30	0.20	0.15	- 0.01	
					Total	1.53 m^3	
3	BBM in CM 1:4 for side walls						
	(i) Long Wall						
	1st Step	2	2.60	0.40	0.90	1.88	
	2nd Step	2	2.40	0.30	1.00	1.44	
	3rd Step	2	1.00	0.20	0.60	0.24	
	(ii) Short Wall						
	1st Step	2	0.90	0.40	0.90	0.65	
	2nd Step	2	0.90	0.30	1.00	0.54	
	3rd Step	2	0.90	0.20	0.60	0.22	
					Total	4.96 m^3	
5	Providing and laying RCC 1:2:4 (i) working	1	1.35	1.20	0.12	0.194	
	chamber, (ii) Roof slab of Shaft	1	0.80	1.10	0.10	0.088	
	Deductions: Man hole cover (1)(Π)(d^2)/(4)=0.16	1	A=0.16	-	0.10	- 0.016	(dia: d=0.45 m)
					Total	0.266 m^3	
6	Plastering to Inner face of the walls: i) working	1	5.4	-	1.5	8.1 m^2	L_{wc}=1.8x2 +
	chamber	1	3.0	-	0.6	1.8 m^2	0.9x2=5.4m
	ii) Shaft				Total	9.9 m^2	L_s=.9x2+ .6x2=3.0m

Q. 5) Estimate the Quantity of Steel work for the truss shown in Fig. for the following items. i) Principal Rafters, ii) Struts, iii) Central Suspenders, iv) Cleats for purlins, v) Ties main central, vi) Ties main side, vii) Ties inclined, viii) Ties (middle horizontal).

Item No.	Particulars of Items and details of works	Nos.	L	B	Quantity	Wt/Unit (Kg/m)	Total Qty.
i)	Principal Rafters (75x50x8) mm angle	2x2	7.60	-	30.40 m	7.4 Kg/m	224.96
ii)	Struts (75x50x10) mm angle	2	1.2	-	2.40 m	9.0 Kg/m	21.60
	Struts (65x45x8) mm angle	4	0.55	-	2.20 m	6.4 Kg/m	14.08
iii)	Central Suspenders (50x50x6) mm angle	1	2.60	-	2.60 m	4.5 Kg/m	11.70
iv)	Cleats for purlins (75x75x6) mm angle	12	0.11	-	1.32 m	8.9 Kg/m	11.75
v)	Ties main Central F.B.	2x2	3.30	-	13.0 m	11.0 Kg/m	143.00
vi)	Ties main Side F.B.	2	4.80	-	9.60 m	3.1 Kg/m	29.76
vii)	Ties Inclined F.B.	2x2	3.40	-	13.60 m	3.8 Kg/m	51.68
viii)	Ties – 1.5m (middle horizontal)	2x2	1.50	-	6.00m		


11.60m Clear Span
12.00 m Effective Span
Truss
21.00m
Plan of Shed
Q.5)
PLAN OF BASE
Base Plate 30cm×30cm×12mm
75×75×10mm ∠
Tie 80×6mm F.B.
Gusset Plate 6mm
Rag Bolt
Detail of Fixing G.I. Sheet
Nut
Washer
G.I. Sheet
Purlin 125×75×8mm
Hook Bolt
P.R. 2-75×50×8mm
Cleat Angle 75×75×8mm
11cm Long
25cm G.I. Ridging
45cm
75 cm
Gusset Plate
75cm×45cm
Purlin 125×75×8mm
G.I. Sheet 7.60m
∠s – 7.60m Long
Principal Rafter 2-75×50×8mm ∠s
Wind Tie 32mm×6m F.B.
Tie 50×6mm
F.B. 1.50 m
Long
25cm × 20cm
Strut 65×45×8mm
–0.55m long
32cm×25cm
75cm×25cm
Strut 75×50×
10mm–
120m
Long
Tie 50× 8mm F.B.
– 3.30 m Long
Suspender 50×50×6mm ∠
–2.60m Long
25cm×20cm
Strut 65×45×8mm
0.55m long
Tie 50× 8mm F.B.
1.50m Long
35cm 25cm
32cm
Tie 2-50×8mm F.B.
–4.80m Long
25cm
45 cm
28cm
Tie 2 Nos. 80×6mm F.B. - 3.40m Long
Gusset Plate 45cm×32cm
Gusset Plate 70 cm × 45 cm
75×75×10mm ∠s
Base Plate 30cm×30cm×12mm
Rag Bolt 40mm Dia – 30 cm Long
All Gusset Plates 8mm Thick
12.00m Span

Q. 6) Prepare a detailed Estimate of steel roof truss shown in Fig. The span of the truss is 11.0 m (effective). All joints are welded 6 mm fillet. (Weight of steel may be obtained from steel tables). Members are marked (MKD) using the numbers.

Item No.	Particulars of Items and details of works	Nos.	L	B	Quantity (m)	Wt/Unit (Kg/m)	Total Qty.
i)	MKD 1 - Main members	1	11.25	-	11.25		
ii)	MKD 2 - Principal Rafters	1x2	5.86	-	11.72		
iii)	MKD 3 - Suspender	1	1.73	-	1.73		
iv)	MKD 4 - Tie	1x2	1.65	-	3.30		
v)	MKD 5 - Strut	1x2	1.43	-	2.86		
vi)	MKD 6 - Tie	1x2	1.05	-	2.10		
vii)	MKD 7 - Strut	1x2	1.13	-	2.26		
viii)	MKD 8 - Tie	1x2	0.66	-	1.32		
ix)	MKD 9 - Strut	1x2	0.81	-	1.62		
x)	MKD 10 - Tie	1x2	0.23	-	0.46		
			Total	length	38.63 m		

Considering Weight per running meters @ 5.8 kg: we get the total Quantity of steel as 38.63 x 5.8 = 224.00 Kg.

Module-(3).

SPECIFICATIONS:-

Describing, the nature and the class of the civil work, materials to be used and workmanship, is referred as specifications. It should be very clear without any ambiguity. By going through specifications, one can understand the nature of the work to be carried out. Drawing do not furnish the details of items of work, quantity of material and proportions. Thus both drawings and specifications will define the civil structure completely.

Specifications may be **i) General or Brief Specification** – This gives the nature, class of the work and materials in general terms with short descriptions.

ii) Detailed Specification. – This gives complete and overall details about the nature, class of the work and materials in a specified descriptions.

Specifications depend on the nature of the work, the purpose for which the work is required, strength of the materials, availability and quality of materials.

Write detailed specifications for the following items of works

1. Earth Work:-

a) *Excavation*: Foundation trenches shall be dug out to the exact width of bed concrete with the sides being vertical. If the soil is poor, sides should be sloped back. Excavated earth shall not be placed within 1m of the edge of the trench.

b) *Finish of trench*: The bottom of foundation trenches shall be perfectly levelled both longitudinally and transversely and the sides should be dressed to be vertical. The bed of the trench shall be lightly watered and well rammed. Due to mistake if excess digging is done, it should be filled with concrete at the expense of the contractor. Concrete shall not be laid without the inspection and approval of engineer-in-charge.

c) Finds: Any valuables or treasures found during excavation shall be the property of Government.

d) Water in foundation: Water if any should be pumped out without any extra payment.

e) Trench filling: After the concreting, the remaining portion of trenches shall be filled up in layers of 0.15m, watered and well rammed. Back filling earth shall be free from rubbish and refuses. Surplus earth should be removed and site shall be levelled.

f) Measurement: The measurement of excavation shall be in **cmtr**, (bottom width x vertical depth x length of trench). Rate shall be for complete work with a lead of 30m and lift of 1.5m. For every additional lead and lift extra rate shall be provided.

2. Plane Cement Concrete PCC/Bed concrete with 1:4:8 (also 1:2:4, 1:3:6, 1:5:6)

a) Materials: Coarse Aggregate (CA), Fine Aggregate (FA), Cement, Water.

Aggregates shall be of good quality and should be clean, dense, hard, sound and durable with capability of good bond with cement. CA shall be hard broken stone of granite, free from dust, dirt and other foreign matters. The ballast shall be of 40mm and down size, well graded. FA shall be of coarse sand and consisting of hard, sharp and angular grains and shall pass through sieve of 4.75mm. Sand shall be clean, free from dust, dirt and organic matters. Sea sand shall not be used. Cement shall be fresh Portland cement of standard ISI specifications with required compressive, tensile stress and fineness. Water shall be clean and free from alkaline and acid matters, suitable for drinking purpose also.

b) Proportions: The proportion of concrete shall be as Cement:Sand:Stone Ballast by volume unless specified. CA & FA shall be measure by volume with boxes. Cement in kgs. All materials shall be dry. Mixing shall be of machine mixing. For small work hand mixing by batches may be allowed. First sand and cement shall be mixed dry thoroughly and to this dry mix stone aggregates are added and whole mixed dry turning at least three times to have uniform mix. Water shall then be added slowly, mixed thoroughly to give a plastic mix of

the required workability and water cement ratio, to get uniform concrete(on a platform or sheet).

For machine mixing, Stone ballast, Sand and Cement shall be put into the cement concrete mixer for the required proportion, the machine shall then be revolved to mix materials dry and then water shall be added gradually. The mixing should continue till a plastic mix of uniform color. Mixed concrete shall be unloaded on a platform or sheet.

c) Slump: Regular slump test should be carried out to control the addition of water and to maintain the required consistency.

d) Formwork: Centering and shuttering shall be provide as required. The inner surface of shuttering shall be oiled to prevent concrete sticking to it and should be removed slowly, carefully, without disturbing or damaging concrete.

e) Laying: Concrete shall be laid gently (not thrown) in layers not exceeding 0.15m and compacted by pinning with rods and tamping with wooden tampers or mechanical vibrating machine until a dense concrete is obtained. Concrete shall be laid continuously, in case of suspension of work, sloped angle of 30° should be made for further joining. For successive layer the upper layer shall be laid before the lower has set.

f) Curing: Concrete should be kept damp with gunny bags or sand, till actual curing starts After 24 hours curing should be done either by ponding or flooding water for 15 days.

3. Cement Concrete 1:2:4 for Roof Slab

a) Materials:

i) **Steel**:- Steel reinforcing bars shall be of mild steel or deformed steel of standard specification and shall be free from corrosion, loose rust scales, oil, grease, paint, etc., It should be capable of being bent without fracture. Bars shall be hooked and bent accurately and placed in position as per design and drawing by using 20SWG annealed steel wire (Binding wire) at their intersection. 40mm diameter and above may be bent by heating to dull red (without immersing in water). Larger diameter bars should be joined by welding and tested .They should be given proper cover on sides and bottom of concrete with cover blocks.

ii) **Centering and Shuttering**: - they shall be made with timber or steel plate and tight to prevent leakage from joints with necessary props, bracings and wedges (sufficiently strong and stable, should not yield after concreting). A coat of oil washing should be applied over the shuttering or paper should be spread to have a smooth finished surface. Centering should not be removed before 14 days and it should be removed safely and slowly.

iii) **Note**: For Cement, sand and Coarse aggregate refer item 2 of this notes (PCC).

b) Mixing: Same as for cement concrete in item 2.

c) *Laying*: Before laying concrete, the shuttering shall be clean, free from dust, dirt and other foreign matters. Concrete should be deposited (not dropped) in its position. Construction joints should be avoided as far as possible. Fresh concrete should be placed within 20minutes after mixing. It should be compacted by mechanical vibrating machine and should continue till the completion of work (over vibration should be avoided). If there is discontinuity an angle of 30° should be provided for next day activity. Structures exceeding 45m length shall be provided with expansion joints.

d) Curing: Same as in item 2.

e) *Finishing*: If specified the exposed surface shall be plastered with 1:3 cement mortar not exceeding 6mm thickness and should be applied immediately after removal of centering which the concrete is green.

f) Measurement: Measurement shall be in cmtr for finished work. Steel reinforcement shall be measure under a unit of MT. The rate for RCC work shall be for the complete work excluding steel but including centering and shuttering and Tools and Plants.

4. First Class Brick work in CM 1:4 (also 1:6)

a) Materials:

i) **Brick**: - All bricks shall be of first class standard specifications, made of good brick earth, thoroughly burnt, copper red in colour. Brick shall be regular in shape and their edges should be sharp and give ringing sound on being struck, free from cracks, chips, flaws and lumps of any kind. Bricks should not absorb water more than One-Sixth of their weight after one hour of soaking in water.

ii) **Mortar**: - Cement shall be fresh Portland cement of standard specifications. Sand shall be sharp, clean and free from organic and foreign matters. Fresh mixed mortar shall be used, old and stale mortar should not be used. Mortar should be used within one hours' time.

b) Soaking of brick: Bricks shall be fully soaked in clean water by submerging in a tank for a period of 12 hours before use. Soaking should continue till air bubbling is ceases.

c) Laying: Bricks shall be well bonded and laid in English bond if not specified. Every course shall be horizontal and to the plumb. Vertical joints of consecutive course shall not come directly over one another (alternate courses can have). Selected best shaped bricks shall be used for face work. Mortar joints shall not exceed 6mm in thickness and joints shall be fully filled with mortar. Frogs are laid upward except in the top course. BBM should be carried out more than 1m height at a time (45° line should be maintained for the continuation of work). All joints should be raked and faces of wall cleaned at the end of each day's work.

d) Curing: The brickwork shall be kept wet for a period of at least 10 days. At the end of days' work the tops of wall shall be flooded with water.

e) Protection: The brickwork shall be protected from the effect of sun, rain, frost, etc. during the constructions.

f) Scaffolding: Necessary and suitable scaffolding shall be provided to facilitate the construction of brick wall and it should be sound and strong with supports at regular intervals.

g) Measurement: Brickwork shall be measured in cmtr. The thickness of wall shall be taken as multiple of half brick 100mm. 1 brick 200mm, 1½ brick 300mm and so on.

5. Cement Plastering 1:4 (also 1:3, 1:6)

The joints of the brickwork shall be raked out to a depth of 18mm and surface of the wall shall be washed and kept wet for two days before plastering.

The materials used should be as per specifications (Cement & Sand: same as earlier). The materials shall be first dry mixed by measuring with boxes to have the required proportion and then water added slowly and gradually mixed thoroughly.

The specified thickness of plastering is applied in two or three coats. To ensure uniform thickness of plaster, patches or strips shall be applied at 2m interval to guide the activity. First mortar is dashed and pressed over the surface, bought to the smooth and uniform surface by using float and towel. Plastering is carried from top to bottom of the wall.

The work shall be tested frequently with a straight edge and plum bob. At the end of the day the plaster shall be left cut clean to line. Next day's plastering is started by scrapping and cleaning the joint. Curing shall be started as soon as the plaster had hardened sufficiently. The plaster shall be kept wet for at least 10 days. Any defective plaster shall be cut in rectangular shape and replaced.

6. Size stone masonry in footing and plinth with CM 1:6 (also 1:4)

The stone shall be hard, tough and durable of approved quarry. Stones shall be chisel dressed on all sides to have perfectly square or rectangular faces so that they be laid in perfectly horizontal and vertical joint. Minimum height of stone shall be 200mm. Stone

shall be laid alternate headers and stretchers with break joint and prober bond shall be maintained. The wall shall be in plumb. No joint shall be thicker than 3.5mm. Not more than 600 height of masonry shall be constructed at a time

Mortar shall be specified and of standard specifications (refer mortar items). First dry mortar is made ready and then mixed with water slowly and gradually mixed to get uniform mortar of workable consistency. All stones shall be thoroughly wetted before use. At the end of days' work the masonry shall be flooded with 25mm water at the upper surfaces. It is kept wet for 10days.

7. DPC 25mm thick in cement concrete 1:1½:3

a) Materials: Damp Proof Course shall consist of cement, coarse sand and stone aggregate of **1:1½:3** proportions with 2% of impermo or cem-seal or Acco proof by weight of cement. The DPC is applied at the plinth level in a horizontal layer of 25mm thickness. The cement shall be fresh Portland cement of standard specifications. The sand shall be clean, coarse and the stone aggregate shall be hard and tough of 20mm size well graded and free from dust and dirt.

b) Mixing: Mixing shall be done in a masonry platform in the proportion of **1:1½:3** by using measuring boxes. The cement is first mixed with water proofing compound to the required quantity, and then mixed dry with the sand with **1:1½.** This mix is added with stone aggregates for the required proportion. Clean water shall be added slowly and gradually to give a plastic mix of required workable consistency.

c) Laying: The level of the surface of plinth shall be checked. The top of walls at DPC course should be laid with frogs of brick downward. Side forms of strong wooden batten be fixed properly and firmly on both sides to confine the concrete with inner edge being oiled. Masonry shall be wetted before concreting. The concrete shall be laid within 30 minutes of mixing and compacted thoroughly by tamping to make dense concrete and levelled both longitudinally and transversely. Top surface is made rough after 2 hours. DPC should be laid in a single stretch. If joints are required, they provided at sills of doors or openings.

Curing is carried for 7 days.

Two coats of asphalt painting may be applied on the upper surface of DPC at 1.5kg/smtr when the concrete is dry.

8. Centering and shuttering (C & S)

Shuttering shall be either of hard wooden planks (30mm) or of steel plates stiffened by angles. The shuttering shall be supported on battens, beams, props and wedges and properly cross braced together so as to make the form sufficiently rigid strong and stable.

Props shall consist of ballies or brick pillar in mud mortar. The shuttering shall be kept clear of wall bearing and made to rest on cross-beams or bracings. Inner surface of shuttering shall be applied with a wash of molded oil. C & S shall not be removed before 14 days. They shall be removed slowly and carefully without any shock or vibration such that no part of the concrete is disturbed or damaged.

C & S are measured square meter and surface area in contact with concrete shall be measured.

9. 25mm Cement concrete flooring with 1:2:4

NOTE:- Refer to item 3 of this notes. Exclude Steel, Centering and Shuttering)

a) Materials: Cement, Sand and stone ballast (refer item 2)

b) Mixing, c) Laying, d) Curing, e) Finishing: Refer item 2

10. Painting

The brand of the paint shall be specified and ready-made paint of the required color should be used. If thinning is required, pure turpentine may be added to the required extent. The surface shall be made perfectly smooth by rubbing with sand paper of different grades, first with coarse one and successively with fine sand papers. All holes and open joints should be filled with strong putty on with a mixture of glue and plaster of Paris and smoothened by rubbing with sand paper. In steel work, all rusts and scales shall be perfectly removed by scrapping and brushing.

The number of coats shall be as specified in new work one priming coat and then two coats of paints shall be applied. The paint shall be applied with brushes evenly and smoothly by crossing and laying of in the direction of grains of wood-work and no brush marks should be visible. Each coat shall perfectly dry before the next is applied. Before the next coat is applied, the surface shall be rubbed with no zero (0) sand paper, to give a smooth and glazed surface. The paint should be stirred in the container immediately before use. Brushes should be cleaned and washed with turpentine at the end of the day's work and kept dry.

If stiff paint is used it should be first prepared by mixing with doubled boiled linseed oil and turpentine to a thin cream.

Measurement of painting work will be on square meter basis.

If old paint is to be removed, it may be removed by washing with soda water or with caustic soda or blowing with blow lamp and scrapping or by using any paint remover. After removing the paint the surface should be dried and rubbed with sand paper and smoothened before paint is applied. In old painted surface if paint is not required to be removed but required repainting, the surface should be washed with soap water and the paint shall be applied.

In steel work exposed to weather, te painting should be done either with red oxide paint or with aluminium paint.

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Module - 3

14/04/2020

Analysis of Rates:-

Factors affecting Cost of Civil works:-

Following are the factors to be considered for arriving @ Cost of a civil work.

1) Cost of Material
   - Types.
   - Quality.
   - Availability.
   - Transit
   - Taxes.
   - Handling charges.

2) Cost of labour
   - Skilled — Mason, Tile layer, Carpentor, plumber, Electrician,
   - Unskilled — Helpers to above category
     - Male
     - Female

3) Miscellaneous expenses
   - Water charges
   - Power bills
   - Security.
   - etc...

4) Contractors profit → 10% of the above is added as Contractors profit

   to meet expenses of → office staff, printing, General stationary, Rent, Travelling, Int. on investment, Job overheads.

5) Tools & plants — 1½% of ①+②+③.

"Determination of Rate per unit of a particular item of work is known as Analysis of Rates"

Rate per unit = {①+②+③+④+⑤}/unit.

Direct Cost:- The costs & expenses that are accountable directly on a (function)(Activity) of product are called Direct costs. Ex:- labours, Material, Equipment etc. Subcontractor cost. etc.

Indirect cost:- This is not directly accountable for a particular activity of product. They are variable or fixed.

Ex:- personnel cost, Security Cost, Administration cost. Project overhead cost, General O.H.C.

Project Costs:- Fixed Cost – It is the cost spent once. for a particular pt. of cost. like equipment, machinery etc.

Time Related cost – particular activity for a given duration wages, equipm & Bldg. rents etc.

Qty – ppl cost :- Material cost are example of quantity proportioned costs [cost will vary based on quantity]

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ANALYSIS OF RATES. Module – 3

(2) 18/03/2019

M-3 – (1).

Factors affecting cost of civil works, concept of direct cost, indirect cost & Project cost.

Rate analysis & preperation of bills, Data analysis of rates for various items of works, Sub-structure components, Rate analysis for R.C.C. slabs, columns and beams.

* Determination of rate per unit of a particular finished item of work: [including cost of material, cost of labour & other miscellaneous expenses] is known as analysis of rates.

A reasonable profit of 6% to 8%, for contractor is included in the analysis of rates. Rate of materials are taken as delivered @ site.

For the above 10% is added towards contractor profit, { office staff, stationary, Printing, Travelling, } General overheads + Establishment for Job overheads

1½ % for tools & plants ⟶ Tools & plants

Rate per unit = [Material cost + labour cost].

Task of OUT-TURN work: The capacity of doing work by a skilled labour. In the form of quantity of work per day is known as Task.

Item	Qty.	Per day.
BBM-I class	1.25 cmtr	Per mason.
BBM-Super class	1.00 cmtr	per mason.
Half brick wall (Partitions)	5.00 Smtr.	per mason.
Coloured Rubble masonry.	0.80 cmtr.	per mason.
Random —"—	1.00 cmtr	per mason.
Ashlar —"—	0.40 cmtr.	per mason.
Lime Concrete I class	8.50 cmtr.	—"—
—"— roof	6.00	—"—
C.C 1:2:4/1:4:8	5/8.5	—"—
R.C.C work	3.00	—"—
12mm CM plastering	8.00 Smtr	—"—
Painting	10.00	—"—
25mm concrete flooring	7.5	—"—
E.W. in ordinary soil	3.0 m³ per Beldar/labour.	
E.W in Hard soil	2.0 m³ per labour. (Bel-hoe-pick axe dar-hard locking)	

Labour catagory:

1) Head Mason/Mestri
2) Mason
3) plumber.
4) Carpentar & joiner. } Skilled labour.
5) Electrician.
6) painter.
7) labour < Male / Female } unskilled labour.
8) unskilled labour.

Material Requirement for different items of works with rates.

① Bricks: [20×10×10] = 2×10^{-3} m³ ∴ No. of Bricks per m³ = 500 Nos — RRM = 4.2m³ (42%. of 10m³)
② Size stone: 9"×9"×9" = 0.01045 m³ —"— SS —"— = 85 Nos — CRM = 4.0m³ (40%. —"—) AM = 2.5m³ (25%. —"—)

④ Dry mortar for brick work – 30%.

③ Cement 1 m³ of cement (Port land) = 1440 kg ; per bag = 50 kg.
(IS 456) ∴ 1m³ = $\frac{1440}{50}$ kg = 28 bags ≒ 30 bags

Head of C.E.D

I. Academic calendar of VTU and the Institute

(5) Cement concrete x:y:z = Cement: FA: CA. Consider $10m^3$ of concrete.
∴ Dry materials required: Increase the finished item volume by 52%.
∴ $10m^3$ of finished item of concrete = 10×1.52 OR 10+(10)(0.52) m^3 of dry materials = $15.2m^3$

(6) Cement mortar BBM → Increase volume by 30% for dry material. $4.2m^3$ mortar

(7) Size stone masonry: SSM → —"— —"— 25% for stone & mortar. < RRM – $4.2m^3$, CRM – $4m^3$, AM – $2.5m^3$

NOTE: For super structure items add:- Scaffolding, centering, shuttering etc. – L.S.
RCC items add:- Bar bender; Add T&P & sundries – L.S.
Water charges for cement items: 1½% (C.M., concrete; RCC etc.)
Contractor's profit = 10% @ the end.

1 Trip 40 ft = 32.5 m.
FA = 1500/m^3
40 = 1100/m^3
20 = 1350/m^3
12 = 950/m^3

(1) From 1st principles work out rate per unit of plain cement concrete for foundation with 1:4:8 mix.

Soln: Consider $10m^3$ of finished plain concrete item:
For Dry materials ~~required~~ Increase by 52%.
∴ Vol. of dry materials required = $10 + \frac{52}{100}(10)$ or $1.52 \times 10 = 15.2m^3$

Particulars / item of work.	Quantity or Numbers	Unit	Rate/unit	Cost.
I Materials:- Concrete 1:4:8				
1) Cement ~~1:4:8~~ $\frac{1}{(1+4+8)}(15.2) = 1.17m^3$. as per IS:456 $1m^3$ = 1440 kg. 1 bag = 50 kg ∴ 1.17×1440 = 1684 kg. ∴ No. of bags = $\frac{1684}{50}$ = 33.69 ≈ 35	35	No.	350/No.	
2) Fine aggregate:- $\frac{(4)}{(1+4+8)}(15.2) = 4.67$	4.67	m^3	1500/m^3	
3) C.A. (40mm) $\frac{8}{(1+4+8)}(15.2) = 9.35$	9.35	m^3	1100/m^3	
II Labour				
1) Head Mason	½			
2) Mason.	1½			
3) Helper/Labour/Mazdoor	12 No.			
4) Bhisthi/curing/waterman	04 No.			
5) Sundries & T.P. —"—	L.S.			

Total:-

add 1½% for water charges
—"— 10% —"— contractor.

∴ Rate per unit = ——— / 10 = /m^3

ಕರ್ನಾಟಕ ಸರ್ಕಾರ

ಲೋಕೋಪಯೋಗಿ, ಬಂದರು ಮತ್ತು ಒಳನಾಡು ಜಲಸಾರಿಗೆ ಇಲಾಖೆ ಶಿವಮೊಗ್ಗ ವೃತ್ತದ 2015-16ನೇ ಸಾಲಿನ ದರಗಳ ಪಟ್ಟಿ

SCHEDULE OF RATES PW, P & IWTD, SHIVAMOGGA CIRCLE 2015-16

Module 5 - RATE ANALYSIS

INDEX

Q 1) "FROM FIRST PRINCIPLES" work out Rate per Unit for Cement Concrete with 1:4:8 for foundation.

Soln

Assume 10 m^3 of Concrete (FINISHED ITEM)

Dry Materials: Increase volume of concrete by 52%.

∴ Vol of Dry materials = $(10) + \frac{10}{100}(52) = 10 + 5.2 = 15.2 m^3$

OR $10 \times 1.52 = 15.2 m^3$.

Particulars OR Item of work.	Quantity OR Numbers	Unit	Rate/unit	Cost Rs = Ps.
I Materials:-				
a) Cement: IS 456 – $1 m^3$ = 1440 kg. 1 bag = 50 kg. $\frac{(1)}{\{1+4+8\}}(15.2) = 1.17 m^3 \Rightarrow 1.17 \times 1440 = 1684.8$ kg. ∴ No. of Bags = $\frac{1684.8}{50} \simeq 34$	34	NO.	300/NO.	10,200=00
b) Fine Aggregate (FA): $\frac{(4)}{\{1+4+8\}}(15.2) = 4.67$	4.67	m^3	1,300/m^3	6,071=00
c) Coarse Aggregate (CA): $\frac{(8)}{\{1+4+8\}}(15.2) = 9.35$	9.35	m^3	1,100/m^3	10,285=00
II Labour:-				
a) Head Mason	1/2	NO.	750/NO.	375=00
b) Mason	1 1/2	NO.	500/NO	750=00
c) Helper (labor) .. (i) Male	8	NO	350/NO.	2,800=00
(ii) Female	4	NO	300/NO.	1,200=00
d) Waterman/curing/Bhishti	3	NO.	250/NO.	750=00
e) Sundries & Tools/plants .. (Lumpsum)	– – – (L.S.) (Round off value)			569=00
			Total	33,000=00
Add 1 1/2 % for water charges = $\frac{1.5}{100}(33,000)$				495=00
Add 10% Contractors profit = $\frac{10}{100}(33,000)$				3,300=00
			GRAND TOTAL	36,795=00

∴ Rate per unit = $\frac{36,795}{10}$ = **Rs 3,679/50 per m^3**

[Rupees Three Thousand Six Hundred Seventy Nine & paise Fifty only]

Q 1 & 2) ASSIGNMENT:- Cement Concrete with 1:3:6 for foundation

Plastering: $100m^2$ $V=(100)\left(\frac{t\,mm}{1000}\right)=P\,m^3$ | 1:6, 1:12 & 1:20

> by 30% $P\times1.3=Q\,m^3$ [Uneven surface, jts, depressions etc].

> by 25% dry makings $=Q\times1.25=R\,m^3$

Plastering to ceiling with 1:3 CM 6mm thick.

12mm thick plastering with 1:3 CM — surface neatly finished with dado.

Same procedure + Add $0.2m^3$ of Cement (ONLY) extra for dado

Cement pointing with 1:1, 1:2 or 1:3 CM.

Dry material req

	CM	C	FA.
1:1	$0.25m^3$	$0.25m^3$	
1:2	$0.20m^3$	$0.40m^3$	
1:3	$0.16m^3$	$0.48m^3$	

$\left.\begin{matrix}1\frac{1}{2}+10+10+5+1\\ +\text{Scaffolding}\end{matrix}\right\}+TP\ \begin{matrix}+1.5\%\\ +10\%\end{matrix}$

E.W. excavation: of E.W. in excavation for ftg not exceeding 1.5m wide

[Includes: i) Dressing of sides
ii) Rearming of bottom
iii) Lift upto 1.5m
iv) Load upto 30m

ORDINARY Sn). / Hard Sn - Dura. Sn).

$10m^3$ of E.W.

Labour — Beldar (−3½ H 400 +1)
water charges 1-(0+2 F.)300
C.P by.

NOTE:
For every additional load of 30m add ½ Male Labour & for addl lift of 1.5m & above add ½ Mate

Hard Rock: — requiring blasting.

Labour = Double the qty. $10m^3$

Material = Fuse = 7 Nos.

Blasting Powder = 6.5 kg

Back filling: ftg plinth. — in layers ≯20 cm - Consolidating $10m^3$

Labour — 4 Nos + 1% + 10%.

Plinth - Gravel/Murrum $=10m^3$ AH = ½ Helper 2 Nos. | water 2 Nos

MODULE 3

Presentation – 1 : Analysis of Rates

"Determination of *Rate per Unit* of a particular item of work is known as *Analysis of Rates*"

Factors influencing cost of civil works:

1. ***Cost of Material***: Depends on types and quality of material used, availability & transit of materials, taxes and handling charges.
2. ***Cost of Labor***: Skilled: Mason, Carpenter, Plumber, Electrician, Tile layer etc., Unskilled: Helpers to skilled labor, male and female labor.
3. ***Miscellaneous Expenses***: Water charges, Electricity bills, Security, etc.,
4. ***Tools and Plants***: It will be assumed as 1.5% of sum of above three factors
5. ***Contractors Profit***: Assumed between 8 to 10% of above factors - to meet the expenses like: Office staff, Printing, General stationary, Rent, Travelling, Interest on investments and Job Overheads.

Rate per Unit = { 1 + 2 + 3 + 4 + 5 }

Task OR Out-Turn Work

The ***CAPACITY of DOING WORK*** by a skilled labor in the form of *Quantity of work* per day is known as Task.

Item	Quantity	per day
Earth work in ordinary soil	3.0 m^3	Per labor/Beldar
….do…. In Hard soil	2.0 m^3	Per Mason
Cement concrete 1:2:4/1:4:8	5/8 m^3	do
Size stone masonry : Coursed Rubble	0.8 m^3	do
: Random Rubble	1.0 m^3	do
: Ashlar	0.4 m^3	do
Burnt Brick Masonry: Super structure	1.0 m^3	do
: Foundation	1.25 m^3	do
: Partition (1/2 Brick)	**5.0 m^2**	do
12mm thick Plastering	8.0 **m^2**	do
Painting	10.0 **m^2**	do

Material Requirement for Different Items of Civil Works

1. **Bricks:** Size of standard brick – 200x100x100 in millimeter = 2 x 10^{-3} m^3. Hence number of bricks per cubic meter of BBM = ***500 Nos.***
2. **Size Stones**: Size of standard size stone – 9"x9"x9" inches = 228x228x228 mm and is equal to 0.0119 m^3. Hence no of size stones per cubic meter = ***85 Nos.***
3. **Cement**: As per IS 456 – One cubic meter of cement = 1440 kg.

One bag of cement = 50 kg. Hence number of bags per m^3 = 1440/50 = 28 bags.

Dry Material Requirements

Cement Concrete: Increase the finished item by 52%

Size stone masonry: a) RRM- volume of dry mortar will be **42%** of work

b) CRM- . . . do . . . . . do . . **40%** . . . . .

c) ASM- . . . . do . . . . . do . . **25%**. . . . .

Burnt Brick Masonry: volume of dry mortar will be **30%** of work

Rates for Various Types of Materials & Labor (Rs)

Cement: 300/bag Fine Aggregates: 1300/m^3 Coarse Aggregates: 1100/m^3

Head Mason:750/No Mason:500/No Male labor:350/No Female:300/No

Carpenter, Plumber, Electrician:600/No Bar Bender:400/No Painter:350/No

Typical Calculation of Dry Materials

Cement Concrete with 1:4:8 for foundation

Assume 10m^3 of cement concrete (Finished item)

Dry Materials: Increase the volume by 52% = 10+10(52/100) = 10+5.2 = 15.2m^3

OR directly can be found: 10 x 1.52 = 15.2 m^3

Given ratio: 1:4:8 i.e, Cement : Fine Aggregate : Coarse Aggregate

Cement: {1/(1+4+8)}{15.2}=1.17m^3 = 1.17(28) = 32.73 say 33 Bags

Fine Aggregates: {4/(1+4+8)}{15.2}= 4.67m^3

Coarse Aggregates: {8/(1+4+8)}{15.2}= 9.35m^3

From First Principles Workout Rate per Unit for Following Items

Q 1) Cement Concrete with 1:4:8 for foundation

Assume $10m^3$ of cement concrete (Finished item)

Dry Materials: Increase the volume by 52% = 10+10(52/100) = 10x1.52 = $15.2m^3$

Given ratio: 1:4:8 i.e, Cement : Fine Aggregate : Coarse Aggreagate

Particulars / Item of work	Quantity OR Numbers	Unit	Rate/Unit	Cost
I Material				
Cement				
Fine Aggregate				
Coarse Aggregate				
II Labor				
Head Mason				
Mason				
Helper i) Male				
ii) Female				
Water man				
Sundries and Tools and Plants (LS)				
Total				
Add 1.5% for water charges				
Add 10% Contractors profit				
Grand Total				

Hence Rate per unit =

Q 1 b) Cement Concrete with 1:3:6 for foundation **(Assignment)**

Earth Work in Excavation in trenches, foundations and Backfilling (Unit = m^3)

NOTE: Earth work in excavation for foundation (Width not exceeding 1.5 m) includes i) Dressing of sides, ii) Ramming of bottom iii) Lift up to 1.5 m and iv) Lead up to 30 m.

For every additional lead of 30m: add ½ male labour and for additional lift above 1.5m add ½ male labour.

Ordinary /Hard soil/Deposited soil: For every $10m^3$ of Earth Work consider 3½ Male labour, 2 Female labour and 1 waterman/Bhisthi. Add 1.5% water charges and 10% Contractors Profit.

Hard rock (Require Blasting): For 10 m^3 of EW increase the labour by two times of above. Material required for this will be Fuse/Detonators (7 nos @ 300/no) and Blasting Powder (6.5Kg @ 800/Kg).

Back Filling for foundation: It is done in layers not exceeding 200mm with complete consolidation. For 10 m^3 of Back filling Male labour 4 Nos along with 1.5% & 10% consideration.

Back Filling for Plinth: New earth/Gravel/Murrum is procured with labour as HM=½, Helper=2, Waterman=2 along with 1.5% & 10% consideration.

Q 6) Earth work in Hard soil for foundation and pipes, cables etc., not exceeding 1.5 m in width

Solution: Assume $10m^3$ of Earth work in Hard soil

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I Labour: (EW excavation including dressing of sides and ramming of bottom)				
a. Helper…i) Male	3.5	Nos.	350=00	1225=00
ii) Female	2	Nos.	300=00	600=00
b. Waterman/Bhisthi	1	Nos.	250=00	250=00
Total				2075=00
Add 1.5% water charges				20=75
10% Contractors Profit				207=50
Grand Total				2303=25
Rate per Unit of Earth Work = {2303.25/10}= Rs230.30/Cmtr (Rupees Two hundred Thirty and Paise Thirty only).				

Module 3:Presentation -2 Analysis of Rates

Q 2) Random Rubble Masonry in Foundation with Cement Mortar (CM) 1:6

Solution:- Assume 10 m^3 of RRM finished item. Increase quantity of stone work by 25% (*to account for irregularity shape, breakages in handling and towards dressing*) i.e.,Actual volume Size Stone for RRM item = $10 \times 1.25 = 12.5m^3$

Dry Materials required for Cement Mortar (CM) = $4.2m^3$ (42% of finished item)

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I. Material:				
a) Size Stone: 12.5x85=1065 (as $1m^3$=85nos)	1065	Nos	12/No	12780=00
b) Mortar:				
Cement: {4.2}=$0.6m^3$=(0.6)(1440)=864kg=864/50=17.28□ 18	18	Bags	300/Bag	5400=00
Fine Aggregate (FA): {4.2}=$3.6m^3$	3.6	m^3	1300/m^3	4680=00
II. Labour:				
a) Head Mason	½	Nos	750	375=00
b) Mason	12	Nos	500	6000=00
c) Helper (Labour) (i) Male	10	Nos	350	3500=00
(ii) Female	10	Nos	300	3000=00
d) Waterman/Curing/Bhisthi	1	Nos	250	250=00
e) Sundries, Tools and Plants . . . . . (Lump Sum). . .				1015=00
Total				37000=00
Add: 1.5% water charges				555=00
10% contractors profit				3700=00
Grand Total				41255=00

Rate Unit of Item of RRM: (41255/10) = 4125=50/Cmtr (Four Thousand One Hundred Twenty Fine & Paise Fifty Only)

ASSSIGNMENT: *Q 2 a) Coursed Rubble Masonry with 1:4 CM* : Note: i) Increase (Only) size stones by 25% ii) Take Dry Cement Mortar as $4m^3$ iii) Increase Mason by 2 nos

Q 2 b) Ashlar Stone Masonry with 1:2 CM in Super Structure

Note: i) Increase (Only) size stones by 25% ii) Take Dry Cement Mortar as $2.5m^3$ iii) Increase Mason by 2 nos and 1 no as stone dresser. iv) Add Scaffolding charges on Lump Sum basis say Rs.2000/- (after Waterman/Curing) ***

Module 3:Presentation -2 Analysis of Rates

Q 3) Burnt Brick Masonry in Superstructure with Cement Mortar (CM) 1:3
Solution:- Assume 10 m^3 of BBM finished item. Dry Materials required for Cement Mortar (CM) = 3.0m^3 (30% of finished item)

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I. Material:				
a) Brick: 10 x 500=5000 (as 1m^3=500nos)	5000	Nos.	6/No	30000=00
b) Mortar: 1:3				
Cement: {1/(1+3)}{3.0}=0.75m^3 = (0.75)(28) = 21 Bags	21	Bags	300/Bag	6300=00
{NOTE: 1m^3 = 1440kg. Bags in No=1440/50=28}-IS 456				
Fine Aggregate (FA): {3/(1+3)}{3.0}=2.25m^3	2.25	M^3	1300/m^3	2925=00
II. Labour:				
a) Head Mason	1	Nos.	750/No.	750=00
b) Mason	10	Nos.	500/No.	5000=00
c) Helper (Labour) (i) Male	8	Nos.	350/No.	2800=00
(ii) Female	8	Nos.	300/No.	2400=00
d) Waterman/Curing/Bhisthi	1	Nos.	250/No.	250=00
e) *Scaffolding charges . . . . . (Lump Sum) . . . .*	.....			*2000=00*
f) Sundries, Tools and Plants . . . . . (Lump Sum). . .	.....			1575=00
Total				54000=00
Add: 1.5% water charges				810=00
10% contractors profit				5400=00
Grand Total				60210=00

Rate Unit of Item of BBM: (60210/10) = RS.6021=00/Cmtr (Six Thousand Twenty One Only)

ASSSIGNMENT: *Q 3 a) BBM with 1:6 CM* for Foundation.

Module 3:Presentation -2 Analysis of Rates

Plastering: Unit of plastering is Square meters (m^2). Volume Cement Mortar required is obtained by multiplying the area of plastering (100 m^2) with the thickness of plastering (say 6mm, 12 mm etc.)

Note: Calculation of dry materials for Cement mortar:

a) Multiply the area of plastering by thickness of plastering to get the volume of CM required for finished item. b) Increase the volume obtained in (a) by 30% to account for depressions, joints, uneven surface of BBM, wastage etc., c) Further increase the volume obtained as in (b) by 25% for dry material requirement.

Typical calculation of dry materials for 12mm thick plastering with 1:6 CM

Solution:- Assume 100 m^2 of plastering (finished item).

Area of Plastering: A= 100 m^2. Thickness of Plastering: t = 12mm = 0.012 m.

Volume of CM = (A)x(t) = (100)x(0.012) = 1.2 m^3. (Finished Item)

Increase volume of CM by 30% = 1.2 x 1.3 = 1.56 m^3. (Finished Item-uneven surface..... etc.,)

Increase volume of CM by 25% for dry material requirements = 1.56 x 1.25 = 1.95 m^3.

Hence volume of DRY MATERIALS required for the above case is 1.95 m^3.

Q 4) 6mm Cement Plastering to new Brick Masonry in Superstructure with Cement Mortar (CM) 1:3

Solution: Assume 100 m^2 of plastering (finished item). Area of Plastering: A= 100 m^2.

Thickness of Plastering: t = 6mm = 0.006 m.

Hence Volume of CM = (A)x(t) = (100)x(0.006) = 0.6 m^3. (Finished Item).

Increase volume of CM by 30% = 0.6 x 1.3 = 0.78 m^3. (Finished Item-uneven surface..... etc.,)

Increase volume of CM by 25% for dry material requirements = 0.78 x 1.25 = 0.975 say 1 m^3.

Hence volume of DRY MATERIALS required for the above case is 1 m^3.

Increase vol... Hence

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I. Material: (Mortar: 1:3)				
Cement: {1/(1+3)}{1.0}=0.0.25m³ = (0.25)(28) = 7 Bags {NOTE: 1m³ = 1440kg. Bags in No=1440/50=28}-IS 456	7	Bags	300/Bag	2100=00
Fine Aggregate (FA): {3/(1+3)}{1.0}=0.75m³	0.75	M³	1300/m³	975=00
II. Labour:				
a) Head Mason	1/2	Nos.	750/No.	375=00
b) Mason	12	Nos.	500/No.	6000=00
c) Helper (Labour) (i) Male .....(5+8)	13	Nos.	350/No.	4550=00
(ii) Female	4	Nos.	300/No.	1200=00
d) Waterman/Curing/Bhisthi	1	Nos.	250/No.	250=00
e) *Scaffolding charges ..... (Lump Sum) ....*	.....			*2000=00*
f) Sundries, Tools and Plants ..... (Lump Sum)...	.....			1050=00
Total				18500=00
Add: 1.5% water charges				277=50
10% contractors profit				1850=00
Grand Total				20627=50

Rate/Unit of Item of Plastering: (20627/100) = RS.206=27/Smtr (Two Hundred Six and Paise Twentyseven)

ASSSIGNMENT: Q 4 a) 12mm Plastering with 1:6 CM superstructure. & 4 b) 20mm Plastering with 1:12 CM
4 c) 6 mm cement mortar plastering for CEILING with 1:6
NOTE: Increase SCAFFOLDING to 4000
4 d) 12 mm thick plastering 1:3 CM, surface neatly finished with dado
NOTE: Adopt procedure as above and further increase quantity of CEMENT only by 0.2m³ for dado work.
4 e) Cement pointing with 1:1 CM: NOTE: Take dry material requirement as 0.25m³ Cement : 0.25 m³ FA
Similarly for 1:2 it will be 0.2(C) & 0.4(FA) m³ and for 1:3 0.16(C) & 0.48 (FA) m³ respectively
{ HM:1/2, M:10, H(M):10, H(F):4, Scaffolding, T&P, 1.5% & 10%

Module 3:Presentation -2 Analysis of Rates

RCC WORKS

NOTE:

1. In case of RCC works, Rate Analysis is carried out based on a) Cement Concrete work b) Reinforcement work and c) Shuttering and Staging wok.

2. If the reinforcement details are not given, following % of steel can be assumed for RCC finished item of work. a) Lintel and Chejja: 0.8% b) Slabs:1% c) Beams:1.5% d) Columns & Footings: 2% and thereby the steel is calculated in kg/q/MT along with Binding wire @ 10kg for 1MT

3. Labour part includes Blacksmith/Barbender (1no for 100kgs), Carpenter (5 Skilled + 5 Unskilled) along with HM, M, H, B etc.,

4. If the steel and cement is supplied by the department, 10% contractors profit is not included. But cost of carriage of these materials are to be included.

5. If machinery (RMC/concrete mixer) are used the hiring charges will be 600/m^3 is included but the number of labours are reduced by 50%.

a) Dry Material Requirement for Concrete Item: Follow the steps followed for Solution to Q1 of Module 3.

b) Typical Calculation of Steel (on Percentage Basis):

Consider 10m^3 of finished item of RCC item. Let the required quantity of reinforcement is 1.2% of Concrete.

Quantity of Steel in 10m^3 of RCC item = {1.2/100}(10) = 0.12 m^3. As 1m^3 of steel is equal to 7860 kgs.

Hence 0.12m^3 will be (0.12)(7860) = 943.2 kgs for which Binding wire required will be 9.4 kg (@ 1kg/100kgs).

c) Shuttering and Staging work: Shuttering and Staging charges are found based on the *COST OF MATERIALS* used for making concrete (as in Step I of Tabular Column). It is taken as 5% to 8% of the material cost of concrete (Cement, FA & CA only) is arrived. (For columns it may be taken as 4%)

d) Labour: Additional *skilled labours viz Barbender/Blacksmith and Carpenters* along with helpers are considered.

Q 5) RCC work with 1 : 1½ : 3 for Beams

Solution: Consider 10 m^3 of concrete. Increase by 52% for dry materials., i.e., V=(10)(1.52)= 15.2 m^3.

Assume 1.5% of steel as Reinforcing steel. Details of Rate Analysis is shown in following Tabular Column

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I Material: (Concrete 1 : 1½ : 3)				
a. Cement: {1/(1+1.5+3)}{15.2}=2.76m^3 = (2.76)(28) =78 Bags {NOTE: 1m^3 = 1440kg. Bags in No=1440/50=28}-IS 456}	78	Bags	300/Bag	23400=00
b. Fine Aggregates: {1.5/(1+1.5+3)}{15.2}=4.15 m^3	4.15	m^3	1300/m^3	5395=00
c. Coarse Aggregates: {3/(1+1.5+3)}{15.2}=8.28 m^3	8.28	m^3	1200/m^3	9936=00
d. Reinforcing steel: Assuming 1.5% of finished item {1.5/100}(10)=0.15m^3 = (0.15)(7860)=1179Kg=1180Kg=1.18MT	1.18	MT	48000/MT	56640=00
e. Binding Wire: @ 100kg/MT= (100)(1.18)=118Kg = 0.118MT	0.118	MT	52000/MT	6136=00
II Labour:				
a. Head Mason	1	750	Nos.	750=00
b. Mason	3	500	Nos.	1500=00
c. Helper.....i) Male (10+5+5)	20	350	Nos.	7000=00
ii) Female	10	300	Nos.	3000=00
d. Carpenter	5	600	Nos.	3000=00
e. Blacksmith/Bar Bender	10	400	Nos.	4000=00
f. Waterman/Bhisthi	2	250	Nos.	500=00
III Shuttering and Staging/Centring (5% of item I i.e, Material) (5/100)(101507) = 5075 say 5100	—	—	—	5100=00
Contegencies, T&P, Sundries . . . (Lump Sum)				3743=00
Total				125000=00
Add i)1.5% water charges				1875=00
ii) 10% Contractors Profit				12500=00
Grand total				139375=00

Rate per Unit of RCC work for Beams = (139375/10) = 13937=50/Cmtr.

(Rupees Thirteen thousand Nine hundred Thirty Seven and paise Fifty only)

Note: If Cost of steel is not considered Rate/Unit = 5800/Cmtr.

Q 5) RCC work with 1 : 1½ : 3 for Beams

Solution: Consider 10 m^3 of concrete. Increase by 52% for dry materials., i.e., V=(10)(1.52)= 15.2 m^3.

Assume 1.5% of steel as Reinforcing steel. Details of Rate Analysis is shown in following Tabular Column

Particulars/Item of Work	Quantity (OR) Nos	Unit	Rate/Unit	Amount Rs=Ps
I Material: (Concrete 1 : 1½ : 3)				
a. Cement: {1/(1+1.5+3)}{15.2}=2.76m^3 = (2.76)(28) =78 Bags	78	Bags	300/Bag	23400=00
{NOTE: 1m^3 = 1440kg. Bags in No=1440/50=28}-IS 456}				
b. Fine Aggregates: {1.5/(1+1.5+3)}{15.2}=4.15 m^3	4.15	m^3	1300/m^3	5395=00
c. Coarse Aggregates: {3/(1+1.5+3)}{15.2}=8.28 m^3	8.28	m^3	1200/m^3	9936=00
d. Reinforcing steel: Assuming 1.5% of finished item				
{1.5/100}(10)=0.15m^3 = (0.15)(7860)=1179Kg=1180Kg=1.18MT	1.18	MT	48000/MT	56640=00
e. Binding Wire: @ 100kg/MT= (100)(1.18)=118Kg = 0.118MT	0.118	MT	52000/MT	6136=00
II Labour:				
a. Head Mason	1	750	Nos.	750=00
b. Mason	3	500	Nos.	1500=00
c. Helper.....i) Male (10+5+5)	20	350	Nos.	7000=00
ii) Female	10	300	Nos.	3000=00
d. Carpenter	5	600	Nos.	3000=00
e. Blacksmith/Bar Bender	10	400	Nos.	4000=00
f. Waterman/Bhisthi	2	250	Nos.	500=00
III Shuttering and Staging/Centring (5% of item I i.e, Material)				
(5/100)(101507) = 5075 say 5100	—	—	—	5100=00
Contegencies, T&P, Sundries . . . (Lump Sum)				3743=00
Total				125000=00
Add i)1.5% water charges				1875=00
ii) 10% Contractors Profit				12500=00
Grand total				139375=00

Rate per Unit of RCC work for Beams = (139375/10) = 13937=50/Cmtr.

(Rupees Thirteen thousand Nine hundred Thirty Seven and paise Fifty only)

Note: If Cost of steel is not considered Rate/Unit = 5800/Cmtr.

Contract Management-Tender and its Process

Module – 4

Invitation to tender, Prequalification, Administrative approval and Technical sanction. Bid submission and Evaluation process. Contract Formulation: covering Award of contract, letter of intent, letter of acceptance and notice to proceed. Features/elements of standard Tender document (source: PWD/CPWD/International Competitive Bidding-NHAI/NHEPC/NPC).
Law of Contract as per Indian Contract act 1872, Types of contract, Entire contract, Lump sum contract, Item rate, % rate, Cost plus with Target, Labor, EPC and BOT, Sub Contracting.
Contract Forms: FIDIC contract Forms, CPWD, NHAI, NTPC, NHEPC.

(Key words: PWD: Public Works Department, CPWD: Central Public Works Department, NHAI: National Highway Authority of India, NPC: National Power Corporation, NTPC: National Thermal Power Corporation, NHEPC: National Hydro Electric Power Corporation, EPC: Engineering Procurement Construction, BOT: Build Operate Transfer, BOOT: Build Own Operate Transfer)

TENDER: - Tender is an offer in writing to execute some specified work or to supply some specified articles at certain rates, within a fixed time under certain conditions of contract and agreement, between the contractor and the department or owner or party.

The construction work is carried done by contract. Sealed tenders are invited and the work is usually entrusted to the lowest tender. While inviting tenders the bill of quantities (BOQ), detailed specifications, conditions of contract and plans with drawings are supplied on payment of the requisite cost to the contractors who tender or quote their rates.

TENDER FORM: - Tender form is a standard printed form of contract giving the following:

a) Standard Conditions of contract, b) General rules and directions for guidance of contractors,

c) General description of work, d) Estimated cost, e) Earnest money, f) Security deposit

g) Time allowed for the work form date of written order to commence.

h) Column for signature of contractor, before submission of tender , signature of witness and signature of officer, by whom accepted.

This tender form is a part of tender document. The price of tender form is given on the form. This printed form and other documents are to be purchased from the office inviting tender during office hours on all working days.

INVITATION TO TENDER/TENDER NOTICE: - The notice inviting tenders is a very important document on which tenders and subsequent agreements with the contractors are based. Tender notice should stipulate reasonable time for completion of work. All tender notices should be in the standard form of the department. It is displayed on the notice boards of the division and also circulated to the related sub-divisions and other divisions of the department. For wide publicity of major works the tender notice is required to be published in two daily local Newspapers. The essential information to be mentioned in tender notice are:

1. Name of the authority inviting tender
2. Particulars of contractors eligible to submit tenders.
3. Name of work and its location.
4. Estimated cost of work.
5. Price of tender form and other tender documents.
6. Earnest Money to be deposited.
7. Time of completion
8. Last date of sale of tender paper.
9. Last date, time limit and place of receipt of tender and also time of opening tender.
10. Accepting authority.

CONTRACT: - An agreement enforceable by law is contract. The term contract means a written undertaking for execution of works or supply of materials of any service connected and duly accepted and registered by the competent authority on behalf of the Union or State Government.

CONTENTS OF CONTRACT DOCUMENT: - Engineering contract documents usually contain the following:

1. Title Page: This is the front page of the set of the documents having the *name of work, contract agreement number, estimated amount put to tender etc.,*

2. Index: Showing contents and page references.

3. Tender Notice: The tender notice or Notice Inviting Tender (NIT) papers are very important documents on which call of tenders and subsequent agreements with the contractors are based. It contains essential information in a standard printed form such as name of the works and its location, estimated cost of works, EMD, last date of sale of tender papers, last date of permission to purchase tender paper, time and place of receipt of tender papers, date and time of opening of tender, time of completion, accepting authority etc.,

4. Letter of acceptance of tender and written order to commence work: In order to avoid legal complication, it is essential that the date of accepting of tender and the date of written order to commence work, forms part of the agreement. But the date on which the agreement is finalized shall not be considered at all.

5. Any letter given by the Contractor with the tender: in clarification of rate or terms therein.

6. Tender form: Printed form giving general directions for guidance of contractors, general description of work, estimated cost EMD, SD, time of completion and conditions of contract etc. There are columns in the tender form for signature of contractor, signature of witness to contractor's signature and of the officer by whom accepted. These columns are signed and sealed by the respective persons authorized to enter into a formal agreement.

7. Conditions of contract: There are several clauses in the conditions of contract to govern the character of the work to be carried out. Governments have their own standard conditions of contract provided in the printed tender form. The conditions specify mainly the following clauses: (a) Amount of security deposit (SD),
(b) Compensation for delay, (c) Action when whole of SD is forfeited, (d) Contractor remains liable to pay compensation, (e) Extension of time, (f) Completion certificate, (g) Payment on certificate, (h) Monthly bill, (i)Payment of bill, (j) Departmental materials, (k) Execution of work in accordance with drawing and specifications, (l) Alteration of designs and specifications, (m) Compensation in case of bad work, (n) Works to be opened for inspection, (o) Notice before the work is covered, (p) Maintenance period up, (q) Labor, (r)Work on Sunday, (s) Supervision by higher officers, (t) Arbitration etc.,

8. Additional conditions: These are inserted in the conditions of contract based on insurance, lighting and watching etc.

9. Schedule of items of Works: Quantities and units gives brief descriptions of completed items of works involved and the approximate quantities are to be executed with their units of rates.

10. General and additional specifications: Each engineering department has its own printed standard detailed specifications for the general types of works commonly involved and contractor should carry out in accordance with the specifications of the department.

Note: Earnest Money Deposit: EMD and Security Deposit: SD.

EMD: While submitting a tender the contractor is to deposit a certain amount, about 2% of the estimated cost with the department, as earnest money as guarantee of the tender. This amount is for a check so that the contractor may not refuse to accept the work or run away when his tender is accepted. In case the contractor refuses to take up the work his EMD is forfeited. EMD tenderer whose tender has not been accepted is refundable. EMD should be in cash or encashable at any time. It may in the form of deposit in Treasury or State Bank or Savings Certificate pledged to the Executive Engineer.

SD: On acceptance of the tender, the contractor has to deposit 10% of the tendered amount as security money with the department which is inclusive of the earnest money already deposited. This amount is kept as a check so that the contractor fulfils all the terms and conditions of the contract and carries out the work satisfactorily according to the specifications and maintain progress and completes the work in time. If the contractor fails to fulfil the terms of contract, his whole or part of the security deposit money is forfeited by the department. The security deposited money is refunded to the contractor after the satisfactory completion of the whole work after the specified time, usual after one rainy season or six months of the completion of work.

Instead of collecting the whole of SD in one instalment before starting the work, this can be collected gradually by deducting from the running account bill of the contractor.

PREQUALIFICATION: - The assessment by an implementing agency of the suitability of firms to carry out a particular contract prior to being invited to submit a bid is a process called pre-qualification.

Prequalification is usually necessary for large or complex works, or in any other circumstances in which high cost of preparing detailed bids could discourage competition, such as equipment, industrial plant, specialized services and contracts to be let under turnkey, design and build or management contracting. This also ensures that invitations to bid are extended only to those who have adequate capabilities and resources. Prequalification may also be useful to determine eligibility for preference for domestic contractors where this is allowed. Prequalification shall be based entirely upon the capability and resources of prospective bidders to perform the particular contract satisfactorily, taking into account their (i) experience and past performance on similar contracts, (ii) capabilities with respect to personnel, equipment, and construction or manufacturing facilities and (iii) financial position.

ADMINISTRATIVE APPROVAL: - For any work or project required by a department, an approval or sanction of the competent authority of the department, with respect to the cost and work is necessary at the first instance. The approval authorizes the engineering department to take up the work. Administrative approval denotes the formal acceptance by the department concerned of the proposal, and after the administrative approval is given the engineering department (P.W.D.) take up the work and prepares detailed designs, plans and estimates and the executes the work. The engineering department prepares approximate estimate and preliminary plans and submits to the department concerned for administrative approval.

TECHNICAL SANCTION: - This sanction amounts to guarantee that the estimate is accurate and structurally sound. Technical sanction means the sanction of the detailed estimate, design calculations, quantities of works, rates and cost of the work by the competent authority of the engineering department. After the technical sanction the estimate is given, then only the work is taken up or construction. In case of original work the counter signature of the local head of the department should be obtained in the plan and estimate before technical sanction is accorded by the engineering department. The power of Technical Sanction differs from state to state.

BID SUBMISION & EVALUATION PROCESS: - Tender documents invariably specify the data, time, place and designation of the officer, to whom the completed documents are to be submitted. Along with the tender, the bidders are also expected to provide an EMD stipulated in the tender, in the form of cash or bond or bank guarantee. The EMD is to ensure that the contractor does not back out from his tender when it is under consideration nor from executing the work after award of work. Tender, unaccompanied by EMD are to be rejected. It is compulsory that the tender should be submitted exactly as per the provisions of the documents. Tenders, with any deviation or conditional tenders, are summarily rejected as non-responsive. The tenders are opened in the presence of the tenderers or their authorized representatives who like to be present at the notified time of opening. After opening, the tenders, amounts are read out by officer opening the tenders for the information of

all those present. Suitable entries of the tenders received are made in a register and signed by all those present.

The first step in the evaluation of tenders is rejection of all conditional tenders and those without EMD. The acceptable tenders are thereafter evaluated. Apart from arithmetical checking, the tendered rates for individual items are compared with the estimated rates to spot out those with high or low rates. The employer reserves the right to accept or reject any offer without assigning any reason and hence he is free to reject any tender with exceptionally high or low rates for individual items. At the same time, it is also not obligatory to reject all the tenders. The impact of such items of the overall costs of work can be assessed and if the variation in the total cost is marginal, such tenders can be considered for comparison. Normally, the lower tender conforming to the requirement stipulated in the tender documents is accepted.

AWARD OF CONTRACT: - Acceptance of a tender is communicated to the contractor through the letter of award. This indicates the award of the work to the contractor for a specified sum with an advice to him to attend the office of the employer to sign the agreement. This also stipulates the date of commencement and the date of completion of work. At this stage, the contractor is expected to furnish performance guarantee which may in the form of bond or a bank guarantee for the notified amount. The guarantee towards EMD will be released at this stage. If, however, the contractor does not turn up to sign the contract or fails to provide the performance guarantee by the stipulated time and date, the work may be awarded to some other contractor. Under this condition, the EMD by the contractor to whom the work was originally awarded, will stand forfeited to the employer.

LETTER OF INTENT (LOI): - Written confirmation of an **award** of a contract by a DEPARTMENT OR OWNER to a successful bidder, stating the amount of the **award**, the **award** date, and when the contract will be signed. It may also contain a notice to proceed, and it is sometimes also used in lieu of a purchase order to a vendor.

It is typically used to describe a letter from an Department or Owner to a contractor (or from a main contractor to a subcontractor) indicating the department or owner intention to enter into a formal written contract for works described in the letter, and asking the contractor to begin those works before the formal contract is executed. While an LOI may come in many forms, it is essentially a communication expressing an intention to enter into a contract at a future date. Typically an LOI will operate in one of three ways:

- as a non-binding statement of the future intention of both parties, sometimes called a 'comfort letter';
- as an interim contract on its own terms, which will govern the relationship between the parties unless and until a formal written contract is executed;
- as a final contract which, despite there having been no formal execution, is deemed to have incorporated the terms and conditions of the formal written contract that the parties intended.

LETTER OF ACCEPTANCE/AWARD (LOA): - On receiving and opening the tender, tenders are evaluated. The purpose of this exercise is to select right contractor for right job so that the work reaches its completion without troubles and to the satisfaction of all concerned. It is essential to examine, before selecting a contractor for the work the following aspects. (a) Contractors financial capacity, (b) Contractors organizational capacity including technical person, (c) Experience in execution of similar type of jobs, (d) Plants and machinery available to execute the job, (e) Works at present in hand & (f) Tendered rates and amount and workability of the same.

Acceptance of a tender is communicated to the contractor through the letter of award. This indicates the award of the work to the contractor for a specified sum with an advice to him to attend the office of the employer to sign the agreement. This also stipulates the date of commencement and the date of completion of work. At this stage, the contractor is expected to furnish a performance guarantee which may in the form of a bond or a bank guarantee for the notified amount. The guarantee towards earnest money deposit will be released at this stage. If, however, the contractor does not turn up to sign the contract or fails to provide the performance guarantee, the work may be

awarded to some other contractor. Under this condition, the EMD by the contractor to whom the work was originally awarded, will stand forfeited to the employer.

Specimen form of letter accepting the Tender:

By Registered Post

From: The Superintending Engineer/Executive Engineer

To: Sri. . . . . (Name & address of the contractor)

Memo No: . . . . . Dated: . . . . . .

Subject: . . . . . Name of the Work: . . . . . .

Dear Sir(s)

Your tender for the above mentioned work has been accepted by the undersigned on behalf of the President/Governor/Authority at your tendered percentage below/above the estimated cost, tender amount of Rs: . . . . . .

You are requested to attend the office of . . . . . to complete the formal agreement within seven days of the receipt of this letter. You are also directed to start the work at once. Pease note that the time allowed for carrying out the work as entered in the tender, shall be reckoned from the 15th day after the date of this order to commence work.

Yours faithfully,

Sd/- Superintending Engineer/Executive Engineer.

A copy of the letter should also be endorsed to the following in addition to the Department Officers and the concerned branches: -

(i) Assistant Labor Commissioner (Central)

(ii) Conciliation Officer (Central)

(iii) Income Tax Officer (concerned)

(iv) Labor Officer.

INTERNATIONAL COMPETITIVE BIDDING (ICB): - The World Bank and other multinational funding agencies who are financing construction of some of the major infrastructure projects required each project to use the Standard Bidding Documents (SBD) designed by it. They were also insisting that some of the large works above Rs.20 crores be put to ICB. Besides ICB involves payment in foreign currency for a part of the cost of works and hence specific provisions have to be made in the contract documents for such payments. Related issues were the mode of payments, repatriation of earnings, deployment of foreign personnel, their fees and taxes to be deducted, import of capital goods and rate of import duty applicable etc. The foreign companies who might win projects through ICB required clear cut provisions on the above and related matters. All multilaterally funded projects in India valued Rs.20 crore and above are contracted out to pre-qualified bidders and are governed by the SBDs of the Ministry of Finance. These SBDs are in three volumes as below

(i) SBD for Procurement of Works, (ii) SBD for Procurement of Goods and (iii) SBD for Procurement of Major Equipment and Industrial Installations.

TYPES OF ENGINEERING CONTRACT: - Following are the different types of contracts for execution of civil engineering works.

1. Item rate contract (or Unit-price contract or schedule contract): In this type contractors are required to quote rates for individual items of work on the basis of schedule of quantities furnished by the department. This will indicate full nomenclature of the items as per sanctioned estimate and quantities. While filling up the rates, the contractors are required to express the amount in figures and words. The final total of the amount tendered for the work is also drawn up by contractor. This is commonly adopted in Railway department.

Advantages:

(i) This form contract ensures a more detailed analysis of cost by the contractors and as such is more scientific. The element of uncertainty and guess which is inherent in case of % rate contract is altogether absent in item-rate contract.

(ii) Since the contractors are to write down their individual rates of each items in figures as well as in words, it is not easy to form a ring during submission of tender and to allot a work to one of the contractors without competition.

(iii) The contractors work out the rates of all items of the schedule in order to put it in the tender. Thus, unworkable rated tender may be avoided and consequently leads to smooth progress and timely completion of a work.

Disadvantages:

(i) Sometimes incorrectness of quoting the item rate will lead to poor workmanship. Contractors may also quote some item rates I words excluding paise intentionally in order to tamper in rates.

(ii) Comparative statement of item rate tenders is more elaborate and hence skilled scrutiny is required.

(iii) Chances of overwriting's will lead to confusion in finalizing the tender.

2. Percentage rate contract: In this form of the contract the department draws up the schedule of items according to the description of items sanction in the estimate with quantities, rates, units and amounts shown. Thus the department fixes up the item rate of the tender. The contractors are required to offer to carry out the work at par with the rates shown in the specific price or percentage above or below the rates indicated in the schedule of work attached to the tender. The percentage above or below or at par, tendered by the contractor apply on the overall quantities.

Advantages:

(i) This type is convenient as the lowest rate and comparative position are readily known by just opening the tender.

(ii) There won't be unbalanced tender

(iii) Comparative statement can be prepared quickly, tampering can be avoided.

Disadvantages:

(i) Work will not to the satisfactory as the contractor is going to have a wild guess on the percentage to compete with others.

(ii) Since the contractors are to write down only the percentage above or at par or below, it is very easy to write such a rate in few minutes before the time of submission of the tender. Thus the tenderers can easily form a ring even up to the time of submission, which leads to drainage of Government money.

(iii) By negotiation among the contractors two or more of them may quote the same rate in order to get a part of the work at a high rate.

3. Lump-Sum Contract: In this form of contract (P.W.D Form 12) contractors are required to quote a fixed sum for execution of a work complete in all respect i.e., according to the drawing, design and specifications supplied to them with the tender within the specified time. The departmental SR for various items of work are also provided which regulates the payments of the contractor.

Advantages:

(i) Owner knows the exact cost of the work before the commencement.

(ii) Detailed measurements of the work done are not required and recorded.

(iii) Excellent planning and efficient management for execution of work is possible as detailed drawings are available.

Disadvantages:

(i) Dispute can easily arise due to violation of drawings.

(ii) Intermediate payment will be difficult against progress of work.

(iii) In case of variation of quantities and prices, this method is not suitable.

4. Labor Contract: This is a contract where the contractor quotes rate for item work exclusive of the element of materials which are supplied by the department at free of cost.

Advantages:

(i) The materials stored by the Government are thus utilized.

(ii) The increase in the cost of work is checked even the prices of material rise in the market.

(iii) Standard quality of materials can be maintained.

Disadvantages:

(i) There may be delay in obtaining the materials by the department.

(ii) A large storage area is required to store different kinds of materials and constant guarding.

(iii) Theft from store, shortage of materials, accounting all materials are constant worries for dept.

5. Materials supply contract or contracts for the supply of materials: In this form the contractors have to offer their rates for supply of the required quantity of materials, inclusive of all taxes, carriage and delivery charges to the specified stores within the time fixed in the tender. This contract is generally used when purchase of materials like bricks, stone, furniture, pipes etc., are involved. All materials received should be checked and counted or measured, as the case may be when delivered.

6. Piece-Work Agreement: In this an agreement is made for the rate of a particular work without reference to the total quantity of work to be done within a given period. Detailed specifications and the total cost of the whole work to be done are mentioned. Work may be executed under simple "Work order agreement" without SD and penalty clause.

Advantages:

(i) Small works may be taken up for execution without inviting tender and thereby saving time.

(ii) If a contractor delays the work, another contractor may be engaged at any time.

Disadvantages:

(i) Lack of interest by the contractors as the construction involved will be very less.

7. Cost plus percentage rate contract: In tendering for work on a cost plus basis the contractor is paid the actual cost of the work, plus an agreed percentage in addition, to allow for profit. This type of contract is generally adopted when conditions are such that labor and materials rates are liable to fluctuations.

8. Cost plus fixed fee contract: In this type, the contractor is paid by the owner and agreed fixed lump-sum amount over and above the actual cost of the wok. This fixed fee shall cover overheads and profit to the contractor. The fee does not vary with the actual cost of the work as in the earlier case.

Advantages:

(i) Contracts can be quickly decided and agreed for urgent works.

(ii) Suitable when uncertainty and fluctuation in the marked rates of labor and materials.

Disadvantages:

(i) Close supervision and checking of delivery and invoices is essential.

(ii) Wastage of material and employing inefficient workmen by the contractor.

9. Target contract: This is the type of contract where the contractor is paid on a cost-plus percentage basis for work performed under this contract, and in addition he receives a percentage plus or minus

on savings or excess effected against either a prior agreed estimate of total cost or a target value arrived at by measuring the work on completion and valuing at prior agreed rates. Advantage is that the contractor is encouraged to use his skill and experience in keeping the cost as low as possible. This type of contract is profitable to both the contractor as well as to the owner.

The disadvantage is the contractor may show higher cost of construction and thus he gains more amount even covering the penalty for excess expenditure.

10. Measured contract or schedule contract: Except lump-sum contract all other types of contracts are measured contracts. Before submitting the bill the cost of a work is worked out by detailed measurement of different items of work after its completion.

11. Rate contract: In order to supply some manufactured like pipes, A.C.sheets, CI specials etc., the Director
General of Supplies and Disposal of Central Government invites tender and fixes rates of such articles.

12. Turn-key job or combined Engineering and construction contracts: It happens sometimes that the owner contemplating a construction project desires to deal with only party for all services, both engineering and construction, in connection with the work. This is called "turn-key or package" job. The contract may be drawn either on a firm price or cost-plus basis.

BREACH OF CONTRACT: - A breach of contract is failure to perform an obligation arising out of the contract. When an agreement is broken only in part, it is partial breach. If a party announces, before his performance is due, his definite unwillingness or inability to fulfil the contract, he thereby admits he is guilty of a breach. The breach in such a case is called anticipatory breach. Occasionally a party may deliberately incapacitate himself or render impossible the performance of his contract duties; or may so interfere to render performance by the other party impossible. Such tactics also constitute a breach of contract. A breach of contract, occurs when a promisor without sufficient excuse or justification, fails to perform in accordance with the dictates of his agreement.

Breach of contract may constitute a means of contract termination. However there are a number of ways other than a breach by which a contract can be terminated. Full and satisfactory performance by both sides is the usual mode. The other modes include: (1) Release under seal, (2) Rescission by consent of parties, (3) Accord and satisfaction, (4) Recession by a party on account of repudiation by the other party and
(5) Frustration or impossibility of performance.

EPC & BOT, SUBCONTRACTING: -

EPC: - Under an EPC (Engineering Procurement Construction) contract, the government funds the construction and the road developer only has to develop the project in a stipulated period of time. A private entity will bid for the tender and execute infra projects on behalf of government. This means that cost for executing the project would be catered by government. Under an EPC contract, the contractor designs the installation, procures the necessary materials and builds the project, either directly or by subcontracting part of the work. In some cases, the contractor carries the project risk for schedule as well as budget in return for a fixed price, called lump sum depending on the agreed scope of work. The main criteria deciding EPC are Guaranteed Price, Guaranteed Timeline for Completion, Specified Level of Performance, Single Point of Responsibility, Post-Commissioning Services, Flexibility and Certainty, Higher Supervision and Control.

BOT: - In the BOT (Build, Operate and Transfer) mode, the developer invests in the project and recoups it either through tolling rights or annuity. This is the simple and conventional PPP model where the private partner is responsible to design, build, operate (during the contracted period) and transfer back the facility to the public sector. Role of the private sector partner is to bring the finance for the project and take the responsibility to construct and maintain it. In return, the public sector will allow it to collect revenue from the users. The national highway projects contracted out by NHAI under PPP mode is a major example for the BOT model.

Subcontracting: - A practice where main contractor hires additional individuals or companies called subcontractors to help complete a project. The main contractor is still in charge and must oversee hires to ensure project is executed and completed as specified in contract. Reducing costs is undeniably subcontracting's greatest and most obvious benefit. By hiring professionals to handle the tasks you are less good at, you can use your time and energy more strategically. You will have less to manage because your project will be coordinated by professionals who know their job. Imagine everything you could take on with the time saved. Areas of subcontracting may be Plumbing, Air-Conditioning, Painting, Electrical work, Tile laying, Carpentry work, Metal sheeting etc.

CONTRACT FORMS: - FIDIC contract forms: FIDIC means the Federatopm Internationale des Ingenieurs-Conseils, or the international federation of consulting engineers and was founded in Belgium in 1913. The original founding countries were France, Belgium and Switzerland.

FIDIC is probably best known to the world at large as the organization, which produces standard forms of contract for engineering construction, and for the provision of mechanical and electrical plant. For example, the form for civil engineering construction, the Red Book, is known to many as the "FIDIC Contract".

The Red Book: Conditions of contract for construction for building and engineering works designed by the employer (Edition 1999).

The Pink Book: Harmonized Red Book-for use as part of standard bidding documents by the multilateral development banks only(Ed: 2010).

The Yellow Book: Conditions of contract for plant and Design-Build for electrical and mechanical plant, and for building works, designed by the contractor (Ed: 1999).

The Silver Book: Conditions for contract for EPC/Turnkey projects (Ed: 1999).

The Orange Book: Conditions of contract for Design – Build and Turnkey (Ed: 1999)

The Gold Book: DBO Contract-Conditions of contract for design, build and operate projects(Ed: 2008)

The Green Book: Short form of contract (Ed: 1999)

The White Book: Client/Consultant Model Services Agreement (Ed: 2006)

The Blue-Green Book: Dredgers Contract (Ed: 2006)

LAW OF CONTRACT AS PER INDIAN CONTRACT ACT 1872: -

The Indian Contracts Act 1872, creates rights and duties between the contracting parties. The parties are free to set the terms of contract. However, ***"Such rights and duties created must not be unlawful and must not infringe the legal principles".*** Promises which do not create legal obligation are not contracts. This law came to enforcement on 01/09/1872 and last updated on 17/12/2018.

In this Act the following words and expressions are used in the following senses, unless a contrary intention appears from the context: -

(a) When one person signifies to another his willingness to do or to abstain from doing anything, with a view to obtaining the assent of that other to such act or abstinence, he is said to make a ***proposal***;

(b) When the person to whom the proposal is made signifies his assent thereto, the proposal is said to be accepted. A proposal, when accepted, becomes a ***promise***;

(c) The person making the proposal is called the "promisor", and the person accepting the proposal is called the ***"promisee";***

(d) When, at the desire of the promisor, the promisee or any other person has done or abstained from doing, or does or abstains from doing, or promises to do or to abstain from doing, something, such act or abstinence or promise is called a ***consideration*** for the promise;

(e) Every promise and every set of promises, forming the consideration for each other, is an ***agreement***;

(f) Promises which form the consideration or part of the consideration for each other are called ***reciprocal*** promises;

(g) An agreement not enforceable by law is said to be ***void;***

(h) An agreement enforceable by law is a ***contract;***

(i) An agreement which is enforceable by law at the option of one or more of the parties thereto, but not at the option of the other or others, is a ***voidable contract;***
(j) A contract which ceases to be enforceable by law becomes void when it ceases to be enforceable.

THE COMMUNICATION, ACCEPTANCE AND REVOCATION OF PROPOSALS: -

The communication of proposals the acceptance of proposals, and the revocation of proposals and acceptances, respectively, are deemed to be made by any act or omission of the party proposing, accepting or revoking by which he intends to communicate such proposal, acceptance or revocation, or which has the effect of communicating it.

The communication of an acceptance is complete,— as against the proposer, when it is put in a course of transmission to him, so as to be out of the power of the acceptor; as against the acceptor, when it comes to the knowledge of the proposer. The communication of a revocation is complete, as against the person who makes it, when it is put into a course of transmission to the person to whom it is made, so as to be out of the power of the person who makes it; as against the person to whom it is made, when it comes to his knowledge.

Revocation of proposals and acceptances. A proposal may be revoked at any time before the communication of its acceptance is complete as against the proposer, but not afterwards.

An acceptance may be revoked at any time before the communication of the acceptance is complete as against the acceptor, but not afterwards.

Revocation how made.: - A proposal is revoked: (1) by the communication of notice of revocation by the proposer to the other party; (2) by the lapse of the time prescribed in such proposal for its acceptance, or, if no time is so prescribed, by the lapse of a reasonable time, without communication of the acceptance; (3) by the failure of the acceptor to fulfil a condition precedent to acceptance; or (4) by the death or insanity of the proposer, if the fact of his death or insanity comes to the knowledge of the acceptor before acceptance.

Acceptance must be absolute.—In order to convert a proposal into a promise, the acceptance must: - (1) be absolute and unqualified; (2) be expressed in some usual and reasonable manner, unless the proposal prescribes the manner in which it is to be accepted. If the proposal prescribes a manner in which it is to be accepted, and the acceptance is not made in such manner, the proposer may, within a reasonable time after the acceptance is communicated to him, insist that his proposal shall be accepted in the prescribed manner, and not otherwise; but if he fails to do so, he accepts the acceptance.

Acceptance by performing conditions, or receiving consideration: - Performance of the conditions of a proposal, or the acceptance of any consideration for a reciprocal promise which may be offered with a proposal, is an acceptance of the proposal.

Promises, express and implied: - In so far as the proposal or acceptance of any promise is made in words, the promise is said to be express. In so far as such proposal or acceptance is made otherwise than in words, the promise is said to be implied.

CONTRACTS, VOIDABLE CONTRACTS AND VOID AGREEMENTS: -

What agreements are contracts: - All agreements are contracts if they are made by the free consent of parties competent to contract, for a lawful consideration and with a lawful object, and are not hereby expressly declared to be void. Nothing herein contained shall affect any law in force in (India) and not hereby expressly repealed by which any contract is required to be made in writing1 or in the presence of witnesses, or any law relating to the registration of documents.

Who are competent to contract: - Every person is competent to contract who is of the age of majority according to the law to which he is subject, and who is of sound mind and is not disqualified from contracting by any law to which he is subject.

What is a sound mind for the purposes of contracting:- A person is said to be of sound mind for the purpose of making a contract, if, at the time when he makes it, he is capable of understanding it and of forming a rational judgment as to its effect upon his interests. A person who is usually of unsound mind, but occasionally of sound mind, may make a contract when he is of sound mind. A person who is usually of sound mind, but occasionally of unsound mind, may not make a contract when he is of unsound mind.

"Consent" **defined:** - Two or more persons are said to consent when they agree upon the same thing in the same sense.

"Free consent" defined.—Consent is said to be free when it is not caused by: (1) coercion, as defined in section 15, or (2) undue influence, as defined in section 16, or (3) fraud, as defined in section 17, or (4) misrepresentation, as defined in section 18, or (5) mistake, subject to the provisions of sections 20, 21 and 22. Consent is said to be so caused when it would not have been given but for the existence of such coercion, undue influence, fraud, misrepresentation or mistake.

"Coercion" defined.—"Coercion" is the committing, or threatening to commit, any act forbidden by the Indian Penal Code (45 of 1860) or the unlawful detaining, or threatening to detain, any property, to the prejudice of any person whatever, with the intention of causing any person to enter into an agreement. Explanation. It is immaterial whether the Indian Penal Code (45 of 1860) is or is not in force in the place where the coercion is employed.

"Fraud" defined: - "Fraud" means and includes any of the following acts committed by a party to a contract, or with his connivance, or by his agent, with intent to deceive another party thereto of his agent, or to induce him to enter into the contract: (1) the suggestion, as a fact, of that which is not true, by one who does not believe it to be true; (2) the active concealment of a fact by one having knowledge or belief of the fact; (3) a promise made without any intention of performing it; (4) any other act fitted to deceive; (5) any such act or omission as the law specially declares to be fraudulent.

Voidability of agreements without free consent: - When consent to an agreement is caused by coercion, fraud or misrepresentation, the agreement is a contract voidable at the option of the party whose consent was so caused. A party to a contract whose consent was caused by fraud or misrepresentation, may, if he thinks fit, insist that the contract shall be performed, and that he shall be put in the position in which he would have been if the representations made had been true.

"Contingent contract" defined: - A "contingent contract is a contract to do or not to do something, if some event, collateral to such contract, does or does not happen.

Effect of refusal to accept offer of performance: - Where a promisor has made an offer of performance to the promisee, and the offer has not been accepted, the promisor is not responsible for non-performance, nor does he thereby lose his rights under the contract. Every such offer must fulfil the following conditions: -

(1) it must be unconditional; (2) it must be made at a proper time and place, and under such circumstances that the person to whom it is made may have a reasonable opportunity of ascertaining that the person by whom it is made is able and willing there and then to do the whole of what he is bound by his promise to do; (3) if the offer is an offer to deliver anything to the promisee, the promisee must have a reasonable opportunity of seeing that the thing offered is the thing which the promisor is bound by his promise to deliver. An offer to one of several joint promisees has the same legal consequences as an offer to all of them.

Compensation for loss through non-performance of act known to be impossible or unlawful: - Where one person has promised to do something which he knew, or, with reasonable diligence, might have known, and which the promisee did not know, to be impossible or unlawful, such promisor must make compensation to such promisee for any loss which such promisee sustains through the nonperformance of the promise.

THE CONSEQUENCES OF BREACH OF CONTRACT: -

Compensation for loss or damage caused by breach of contract: - When a contract has been broken, the party who suffers by such breach is entitled to receive, from the party who has broken the contract, compensation for any loss or damage caused to him thereby, which naturally arose in the usual course of things from such breach, or which the parties knew, when they made the contract, to be likely to result from the breach of it. Such compensation is not to be given for any remote and indirect loss or damage sustained by reason of the breach. Compensation for failure to discharge obligation resembling those created by contract. When an obligation resembling those created by contract has been incurred and has not been discharged, any person injured by the failure to discharge it is entitled to receive the same compensation from the party in default, as if such person had contracted to discharge it and had broken his contract.

Compensation for breach of contract where penalty stipulated for: - When a contract has been broken, if a sum is named in the contract as the amount to be paid in case of such breach, or if the contract contains any other stipulation by way of penalty, the party complaining of the breach is entitled, whether or not actual damage or loss is proved to have been caused thereby, to receive from the party who has broken the contract reasonable compensation not exceeding the amount so named or, as the case may be, the penalty stipulated for.

INDEMNITY AND GUARANTEE: - A contract by which one party promises to save the other from loss caused to him by the contract of the promisor himself, or by the conduct of any other person, is called a "contract of indemnity".

The promise in a contract of indemnity, acting within the scope of his authority, is entitled to recover from the promisor. (1) all damages which he may be compelled to pay in any suit in respect of any matter to which the promise to indemnify applies; (2) all costs which he may be compelled to pay in any such suit if, in bringing or defending it, he did not contravene the orders of the promisor, and acted as it would have been prudent for him to act in the absence of any contract of indemnity, or if the promisor authorized him to bring or defend the suit; (3) all sums which he may have paid under the terms of any compromise of any such suit, if the compromise was not contrary to the orders of the promisor, and was one which it would have been prudent for the promisee to make in the absence of any contract of indemnity, or if the promisor authorized him to compromise the suit.

A "contract of guarantee" is a contract to perform the promise, or discharge the liability, of a third person in case of his default. The person who gives the guarantee is called the "surety"; the person in respect of whose default the guarantee is given is called the "principal debtor", and the person to whom the guarantee is given is called the "creditor". A guarantee may be either oral or written.

Consideration for guarantee. Anything done, or any promise made, for the benefit of the principal debtor, may be a sufficient consideration to the surety for giving the guarantee.

MODULE – 5

Contract Management-Post Award: Basic understanding on definitions, Performance security, Mobilization and equipment advances, Secured Advance. Suspension of work, Time limit for completion, Liquidated damages and bonus. Measurement and payment, additions and alterations or variations and deviations. Breach of contract. Escalation, settlement of account or final payment, claims. Delays and Compensation, Disputes and its resolution mechanism. Contract management and administration.

Mobilization and Equipment Advances: -

The contractor needs funds immediately after the contract has been executed and before commencement of the project to provide, i) initial mobilization, ii) Establishment of contractors camps, work sheds, water and electrical supplies etc., iii) Purchase of plant, machinery, tools and stores.

Mobilization usually entails substantial preliminary expenditure in the initial stages of work. In order to recover initial investment as quickly as possible, contractors try to get a balanced cash flow by quoting relatively high rates for the earlier items of work. This contributes to unbalanced bidding. This could be remedied if mobilization advances are made available to contractors, both for initial mobilization and preliminary works. Such advances would reduce the contractors cost of investment and it will result in more accurate and economical bids. This advance may be made against a bank guarantee prescribed by the owner. If the value of work goes up say by over 10 percent, an additional mobilization advance may be payable.

No mobilization advance is necessary for contracts up to a value of Rs. 1 crore. In respect of contracts valued at more than Rs.10 Crores, mobilization advances may be granted in suitable instalment up 2% contract value. All such advances should be secured by bank guarantees to be furnished by the contractor.

It is suggested that advances against equipment, tools and plant brought to site may b granted both for new and old plant and equipment. The advance, in the case of new plant and equipment, could be limited to 90% of the procurement cost against production of satisfactory evidence of cost. In the case of old plant and equipment the advance is given at 50% of its present value. Advances against new and old equipment may be limited to 10% of contract value though the equipment content of the work could be as high as 20% or even more. These advances should be secured by the contractor by ***hypothecation*** of equipment and plant on a ***stamp paper*** of a specified value.

Secured Advance: -

Most of the codes and manual of Central and State Departments provide for payment of advances against non-perishable materials required for the work such ad coarse and fine aggregates, boulders, bricks and pitching stone. If this advance is not made, the contractor may quote higher rates. The payment of such advances against materials brought to site should not exceed 75% of its value. The contractor must provide adequate storage and protection for these materials against damage by weather or thefts. The CPWD allows 90% of cost as secured advance.

Time limit for completion: -

Time is money. If the contractor is being paid by the sponsor through drawdown, interest starts to run and will continue to run from drawdown. Thus it is normal to expect that construction contract restrict the right of the contractor to extension of time. Substantially restrict any right to payment of delay costs to the contractor require the contractor from the outset to programme the works so as to take into account a number of contingencies. However, in deciding the grounds upon which an extension of time will be given, regard must be had to fair allocation of risk and to whether it is better for the sponsor to have contingency funds for a particular risk.

Late completion – Damages: -

Assuming that there is a delay in completion for which the contractor is not entitled to an extension of time it is then necessary to consider what damages should be paid by the contractor. Depending upon the parties involved, there are a variety of options.

i) that the limit of the liability of the contractor in respect of delays is the amount of the liquidated damages which is sum less than the amount required to service the dept. due to the funding institutions:

ii) that there are no liquidated damages and the contractor remains liable for all the losses which flow.

iii) the contractor agrees to pay liquidated damages and, by way of separate agreement, agrees to service the debt durig the period of delay.

Liquidated damages and bonus: -

Large investment are made in construction contracts. It is desirable that work is completed by the contractor on the date stipulated. Each days delay results in a loss or damage. Often, these losses and damages are difficult to estimate. In such contracts it is permissible and conventional to add a clause relating to the payment of liquidated damages for non-completion of the work within the time stipulated. The pros and cons of provisions to be made for such liquidated damages in the contracts, their purpose, efficacy and limitation must be analyzed. The parties to the contract may, by an agreement, settle a fixed sum or a provision for deduction from contractors bill a fixed sum for each day of delay in completing the work or as a damage for breach of contract. This compensation can be viewed as liquidated damages. There is a clause for the recovery of liquidated damages for delay in execution of the works resulting in loss to the employer. This provides for recovery at the rate of one tenth of 1 percent of the contract value per day of delay with a maximum limit of 10 percent.

Assuming that the contractor has to pay substantial liquidated damages in the event of delay, he may well consider himself entitled to bonuses in the event that the project becomes revenue earning earlier than originally anticipated. On most projects, this is considered appropriate although clearly a provision has to be incorporated whereby if the contractor is prevented from recovering the bonus by reason of delay by the sponsor, then this does not create an additional liability upon the sponsor. .In the construction industry in our country hardly any contract is completed in time. Whenever there is a revision in the original construction program of a work, the most common public opinion, sometimes highly exaggerated is that there is wide spread mismanagements. Besides accrual of benefits therefrom also get delayed. In order to avoid this some sort of incentive like ***bonus*** should be given to the contractor. In respect of quantification of the bonus, it should be related to advantages of money terms. Other yardsticks to quantify bonus could be the extra cost the Government would be required to incur as a result of the delayed completion. Extra cost that the contractor would incur for accelerating the work could be another yardstick.

Measurement and payment: -

Delays in payment seriously affect the cash flow of contractor and in many cases may even delay the progress of work. It is therefore, necessary that some compensation should be made to the contractor for delay in payments which would also make the engineer in charge of measurements and payments, more alert. In the case of delays of final payment by more than 6 months from the date of completion of work or the date of release of claim, whichever is later, te rate of interest at the market rate should be paid.

There are two aspects to the payment provisions. There are payments for those items, which relate to the original works and then there payments for those items, which relate to extras, claims and the hike. So far as the formers are concerned applications may be made for payment by the contractor. Where the contractor is employing an independent expert to advise it, it may be considered acceptable that the certificates are countersigned by the expert.

The second element relates to the claims for extras. Here it is relevant to know what the contingencies are. For instance the contract may be prepared to receive, extras by way of deferred debt so that it is paid out of revenue earned on the project after paying operational expenses and debt service.

Monitoring progress during the course of construction, the funding institutions, through the agency, bank may well require information on the progress of the construction phase, copies of progress reports, right of inspection. Nevertheless, the funding institutions should realize that the proper means of monitoring is through and independent checker, rather than allowing the agent to adopt any particular checking role.

Additions and alterations or variations and deviations: -

Changes in the scope of contract due to: i) inadequate formulation of the feasibility report based on insufficient technical data. ii) Adverse repercussion of detailed project report. iii) Unexpected and unforeseen circumstances. iv) Reduction/changes in specifications and design of structures at a later date resulting in excess/reduced quantity of work.

"Any agreement stipulating that the contractor shall carry out the excess quantity of the work over the above the agreed quantity shall be considered as vague, because through this clause, the contract awarding authority presumes that the contractor is bound to carry out any quantum of the excess works as directed by that authority. The contractor, by this clause, however, is not legally bound to carry out any amount of the excess work. The contract awarding authority muyst specify, in such cases, a percentage of this excess quantity over and above the agreed quantity. A maximum, of 25% can be considered as reasonable."

Escalation or Cost escalation: -

There must be provision for reasonable and easily workable escalation clause in all contract agreements so that the actual increase in prices not provided by the tenderer in his offer. Following are the different types of Escalation i) Escalation on Account of labor costs, ii) Escalation on account of material costs and iii) Escalation on account of POL.

Escalation of labor cost depends on method of construction, type of work, extent of mechanization and availability of labor and topography of site. Consumer price indices for workers are being published by "Ministry of Labor" for important industrial centers of all states and these could be used to represent the variation in cost of labor. "Index of Wage" would be weighted average wage of unskilled, semi and skilled workers in appropriate proportion. The wages should be prescribed under minimum wages act 1948. Material escalation cause is having some difficulty as at present a "Construction Material Index" for material required in engineering construction is not available. An appropriate price index for construction material is evolved by collection date "the wholesale price index for all commodities" polished by Economic Advisor to the Government of India could be adopted as basis. Escalation on account of POL i.e., the prices of Petroleum, Oils and Lubricant products have witnessed a phenomenal increase in recent years. This unpredictable increase in price of these lubricants linked to price of crude oil in the international market. Therefore escalation in cost of POL should therefore, be separately provided for in contracts considering transportation and type of equipment used.

Delays and Compensation: -

Delayed payment: This may be due to either from contractor or owner/client. Delayed payment due to contractor may be i) Delay in construction, ii) Due to late submission of bills by contractor, iii) Providing inadequate details in bills and iv) Fraud in preparation of bills.

From the client side: Not verifying the running bill on time, method of payment by the owner for the work performed and timing of such payment to contractor for his quoted rates, suppose if delay, has been made by the client, a time limit of 10 days from the date of submission of bills is fixed, if it exceeds and still payment has not been made, then, outstanding payments has to be paid by the owner to contractor for the period of delays.

Module – 5:

Definitions of terms used in valuation process, cost, estimate, value and its relationship, capitalized value, concept of supply and demand in respect to properties (land, building, facilities), freehold and lease hold, sinking fund, depreciation-method of estimating depreciation, outgoings, process and methods of valuation: Rent fixation, valuation for mortgage, valuation of land.

Valuation: Valuation is the art of determining the fair price OR value of a property such as a building, land, factory etc. By valuation the present value of a property is determined. The value of a property depends on its structure, life, maintenance, location, bank interest, legal control etc. The value also depends on supply on demand and the purpose for which valuation is required.

Cost: Cost means the original cost of construction and can be known after accounting all day-to-day expenditure from planning stage to completion.

Ex: A building whole cost of construction is Rs.5, 00,000/-. When put for sale, it may fetch Rs.5, 75,000/-. This sale price is known as the value of building. (Similarly, the value may be less than the original cost).

Purpose of valuation: The various purpose of valuation are as follows.

1. Buying or selling of property: When it is required to buy or to sell a property, its valuation is required.
2. Taxation: To assess the tax of a property its valuation is required. (Like municipal tax, wealth tax, property tax etc.)
3. Rent fixation: In order determine the rent of a property, valuation is required. (Usually fixed between 6% to 10% of valuation)
4. Mortgage or Security of loans: When loans are taken against the security of the property, its valuation is required.
5. Compulsory acquisition: Whenever a property is acquired by law, compensation is paid to the owner.
6. Valuation is also required for Insurance, Betterment charges, Speculations.

Definition of important terms:

Gross Income OR Total Receipt: It is the total income which includes all receipts from various sources in which the operational and collection charges are not deducted.

Net Income OR Net Return: This is the amount left after deduction all outgoings, operational and collection expensed from the gross income or total receipt.

Outgoings: Outgoings OR the expenses which are required to be incurred to maintain the revenue of the building. Few of them are: ***Taxes***-Municipal, property, wealth tax paid annually. ***Repairs***-Maintenance expenditures to keep a property in fit condition. ***Management***-Watchman, Liftman, sweeper pump attendant etc. ***Sinking Fund***-"A certain amount of the gross rent is set aside annually as sinking fund to accumulate the total cost of construction when the life of the building is over". ***Loss of rent***-The property may not be kept fully occupied in such a case a suitable amount should be deducted from the gross rent under outgoings. ***Miscellaneous***-These include electric charges for running lift, pump, for lighting common places and similar other charges which are to be borne by the owner.

Salvage Value: It is the value at the end of the utility period without being dismantled. A machine after the completion of its usual span of life or when it become uneconomic, may be sold and one may purchase the same for use for some other purpose, the sale value of the machine is the salvage value. It does not include the cost of removal, sale, etc.

Market Value: The market value of a property is the amount which can be obtained at any particular time from the open market if the property is put for sale.

Book Value: Book value is the amount shown in the account book after allowing necessary depreciations. The book value of a property at a particular year is the original cost minus the

amount of depreciation up to the previous year. It depends on the amount of depreciation allowed per year and will be gradually reduced year to year and at the end of the utility period of the property the book value will be only scrap value.

Obsolescence: The value of property or structures become less by its becoming out of date in style, in structure in design etc., and this is termed as obsolescence. An old dated building with massive walls, arrangements of rooms not suited in present days and for similar reasons, becomes obsolete even if it is maintained in a very good condition, and its value becomes less due to obsolescence.

Capital cost: Capital cost is the total cost of construction including land, or the original total amount required to possess a property. It is the original cost and does not change, while value of a property is the present cost which be calculated by method of valuation.

Capitalized value: The capitalized value of a property is the amount of a money whose annual interest at the highest prevailing rate of interest will be equal to the net income from the property. To determine the capitalized value of a property it is required to know the net income from the property and the highest prevailing rate of interest.

Year's Purchase (Y.P.): years purchase is defined as the capital sum required to be invested in order to receive an annuity of Re1/- at certain rate of interest. For 4% interest per annum, to get Rs.4/- it requires Rs.100/- to be deposited in a bank.

Sinking fund: The fund which is gradually accumulated by way of periodic on annual deposit for the replacement of the building at the end of its useful life, is termed as sinking fund. The object of creating sinking fund is to accumulate sufficient money to meet the cost of construction or replacement of the building after its utility period. The sinking fund is created by regular annual or periodic deposits in compound interest bearing investment, which will form the amount of replacement at the end of the utility period of the property. The sinking fund may be created by taking a sinking fund policy with an insurance company or by depositing in bank to collect highest compound interest. ***The cost of land is not taken into account in calculating sinking fund as land remains intact.***

The sinking fund may also be required for payment of loan, by setting aside a sum of money annually to accumulate with compound interest in order to repay the debt at the end of the term of loan.

Sinking fund may be found by formula $I = (S_i) / \{(1+i)^n - 1\}$ ..... (1)

Where, S=total amount of sinking fund to be accumulated,

n=number of years required to accumulate the sinking fund

i=rate of interest in decimal (example 15%=0.15) and I=annual instalment required.

Example 1: An old building has been purchased by a person at a cost of Rs.30, 000/- excluding the cost of the land. Calculate the amount of annual sinking fund at 4% interest assuming the future life of the building as 20 years and the scrap value of the building as 10% of the cost of purchase.

Soln: Total amount of Sinking fund to be accumulated at the end of 20 year

S=30,000-(10% of 30,000) = 30,000-(0.10x30,000)=Rs.27,000

Annual instalment of sinking fund (from equation 1) I=(27,000x0.04)/{(1+.04)^{20}-1}

= Rs.907.20

Annual instalment for sinking fund required for 20 years = Rs.907/20

Depreciation:

Depreciation is the gradual exhaustion of the usefulness of a property. This may be defined as the decrease or loss in the value of property due to structural deterioration use, life wear and tear, decay and obsolescence. The value of a building or structure will be gradually reduced and hence a certain percentage of the total cost may be allowed as depreciation to determine its present value. Usually a percentage on depreciation per annum is allowed. The percentage rate of depreciation is less at the beginning and gradually increase during later year. ***By***

knowing depreciation amount, the present value of a property can be calculated after deducting the total amount of depreciation from the original cost.

Methods of valuation: Following are the different method of valuation

1. Rental method of valuation: In this method, the net income by way of rent is found out by deducting all ougoings from the gross rent. A suitable rate of interest as prevailing in the marked is assumed and years purchase is calculated. This net income multiplied by Y.P. give the capitalized value or valuation of the property.

2. Direct comparison with the capital value: This method may adopted when the rental value is not available from the property concerned, but there are evidences of sale price properties as a whole. In such cases the capitalized value of the property is fixed by direct comparison with capitalized value of similar property in the locality.

3. Valuation based on profit: This method of valuation is suitable for building like hotels, theatres, shopping malls etc., for which the capitalized value depends on the profit. In such cases the net annual income is worked out after deducting from the gross income all possible working expenses, outgoings, interest on the capital invested. The net profit is multiplied by Y.P. to get the capitalized value. In such cases the valuation may work out to be too high in comparison with the cost of construction.

4. Valuation based on cost: In this method the actual cost incurred in constructing the building or in possessing the property is taken as basis to determine the value or property. In such cases necessary depreciation should be allowed and the points of obsolescence should also be considered.

5. Development method of valuation: This method of valuation is used for the properties which are in the undeveloped stage or partly developed stage. If a large place of land is required to be divided into plots after providing for roads, parks etc., this method of valuation is to be adopted. In such cases, the probable selling price of the divided plots, the areas required for roads parks and the expenditures for development should be known.

6. Depreciation method of valuation: According to this method of valuation the building should be divided into four parts like i) walls, ii) Roofs, iii) Floor and iv) Doors and windows. The cost of each parts should first be worked out on the present day rated by detailed measurements. The life of each of the four parts should then be ascertained with the help of Financial Hand Book and the depreciated value of each part is ascertained by the following formula,

$$D=P\{(100-rd)/(100)\}^n$$

D=Depreciated value, P=cost at present market rate *rd*=(rate of depreciation) fixed percentage of depreciation which varies from 1.00,1.3,2.0,4.0 & 5.0 for 100,75,50,25 & 20 years life.

The value arrived at will be exclusive of cost of land, water supply, electric and sanitary fittings, etc., and will apply to those buildings only which have been properly maintained.

The present value of land and water supply, electric and sanitary fitting should be added to the valuation of the building to arrive at total valuation of the property.

P.W.G. 17

Original/Duplicate/Triplicate

Reference Paras 158 to 170

No. _____

CONTRACT CERTIFICATE

P.W. Account Code

Division :

Bills Received No. Date

(For other Works)
Sub-Division/ Divisional
Head of Account

Date _____ 20 - 20

Cash Book Vr. No.....

Scheduled Docket No.....

Name of Work (as per sanctioned estimate) .....

Name of Contractor and full Address .....

.....

Reference to agreement No. Date :

Certified that the measurement were taken by me on _____ and recorded on Pages _____ of Measurement Book No. _____ and that the work is satisfactorily executed

Contractor *Officer in charge of the work*

Certified that the quantities of measurements were taken by me on _____ and found the work correct, is satisfactorily executed.

Certified that the quantities of materials shown in column 3 of account I have been actually brought to site of the work and the contractor has not previously recieved any advance on this security. These Materials are of imperishable nature and are all reunired the contractor for the immediate use on the work in connection with terms for which rates to finished work have been agreed upon : a formal agreement signed and executed by the Contractor is recorded in the office.

II Memorandum of payment *Sub-Divisional Officer*

1	Total value of work done or suppliers made as per account with in	
2	Deduct amount to held in reserve being_____ percent Rs. _____	
3	_____ Balance	
4	Deduct payments	
	a) Amount of previous payment as in the offfice Cash Book vr _____are_____S.D. No._____ amount adjusted towards cash advance recovery or	
	b) Payments cost to store or other materials suppliers now made recovery of amount creditable to this/other work	
	Amount paid in this bill cheque/cash	
	TOTAL	
5	Balance being unpaid value of work done held in reserve	
6	Deduct cash advance made on the office cash Book vr No. _____ Dated _____ less adjustment	
7	Net amount due to or from contractor	
	Unadjusted items	
8	Advance to contractor for materials to site (as detailed with in)	
9	Value of Government materials supplied.	
	Total amount unadjusted	-

Contractor's Signature

For use in the office

Received Rs_____ (in word) _____

_____by cash by adjustment of payment as per memorandum

(in final settlement of all demands)

witness :

1

2

Date *Signature of Contractor*

Paid by me by cheque No _____ Date _____Cash Rs._____

Date _____

Iinitials of officer making payment Date _____ *Executive Engineer*

Sl. No.	Items of work (group under sub-heads and sub-work of the estimate)	Unit	Rate	Previous Measurement		Present Measurement		Total up - todate	
				Qnty.	Amount	Qnty.	Amount	Qnty.	Amoun

USN | 4 | S | M | 0 | 9 | C | V | 0 | 2 | 6 |

10CV73

Seventh Semester B.E. Degree Examination, Dec.2015/Jan.2016
Estimation and Valuation

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer Q.No. 1 and any FOUR of the remaining.***
2. ***Missing data if any may be suitably assumed.***

1 The details of a residential building are shown in Fig. Q1. Estimate the quantities of the following items of work and cost of the respective items in an abstract form.

a. Earthwork excavation for the foundation @ the rate of ₹ 120/m^3.
b. Size stone masonry in CM 1 : 6 for footing and plinth at the rate of ₹2200 /m^3.
c. First class brick work in CM 1 : 6 for super structure @ ₹3800 /m^3.
d. RCC Roofing concrete 3600/m^3.

(40 Marks)

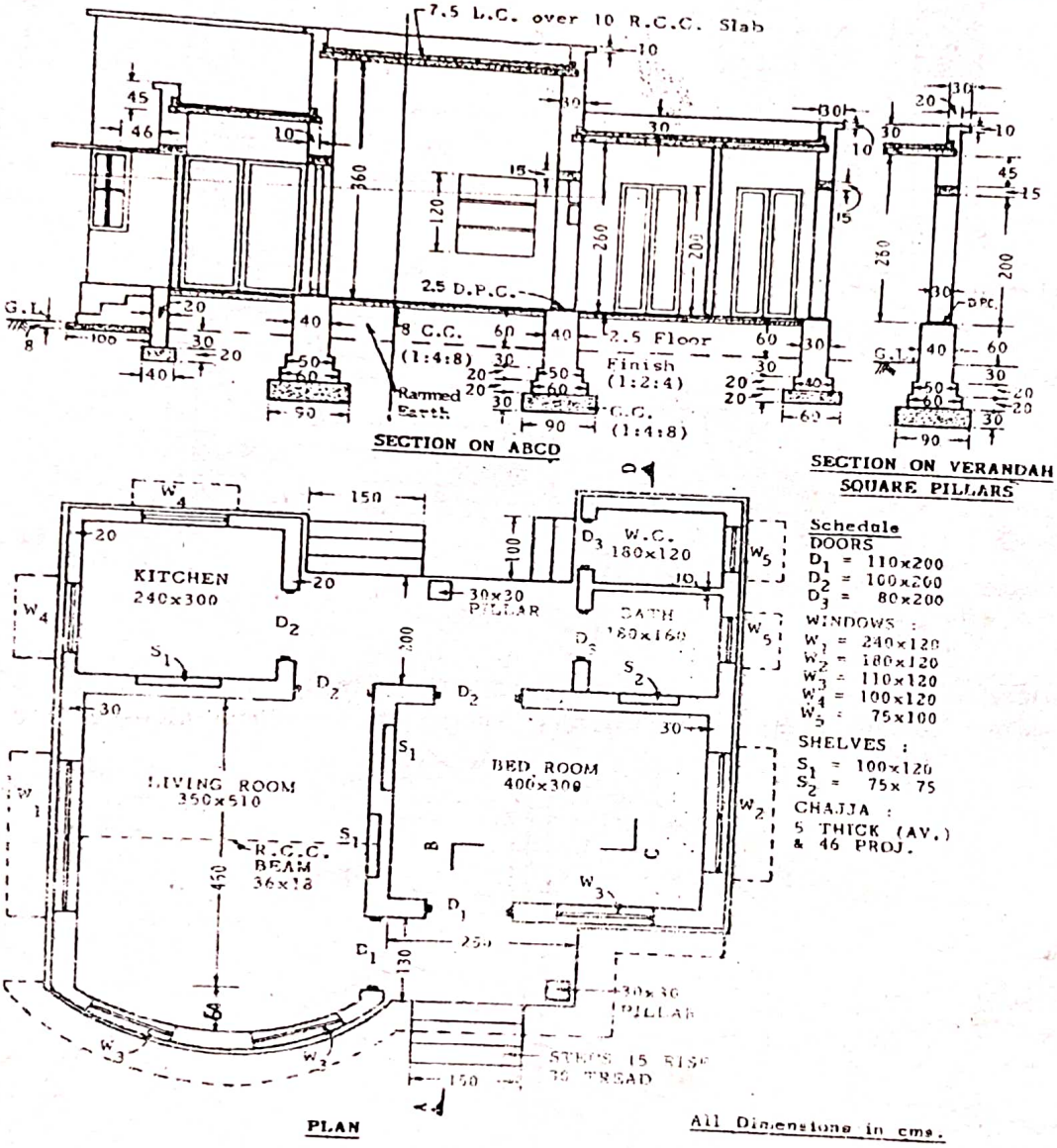

Fig.Q.1

2 The details of septic tank is shown in Fig.Q2. Find detailed quantities of following items:

a. Earth work excavation for foundation in hard soil.

b. Burnt brick masonry in CM 1 : 4 for sidewalls.

c. RCC (1:2:4) for cover slab with 1% steel reinforcement for septic tank and soak pit.

(15 Marks)

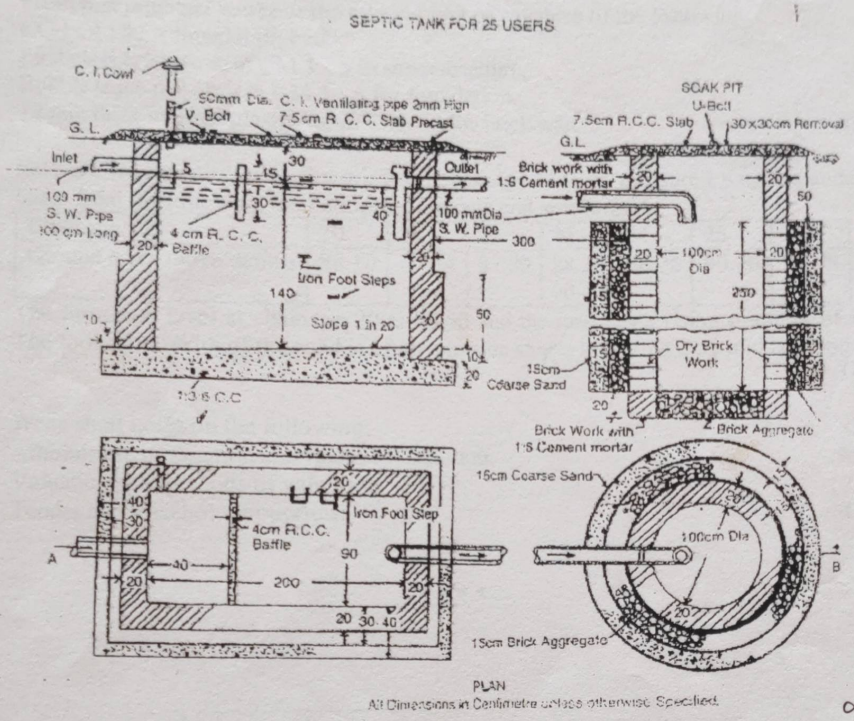

Fig. Q2

3 a. List and explain (any two) different types of estimates. **(08 Marks)**

b. Estimate the quantity of timber required for the door shown in Fig. Q3 (b). **(07 Marks)**

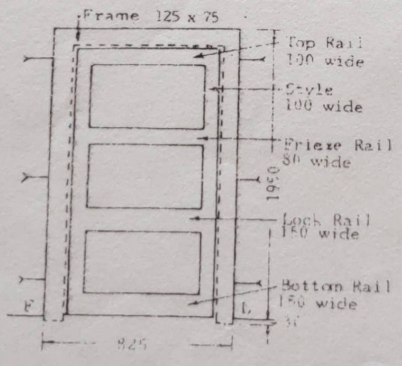

Fig. Q3 (b)