CE801-ESTIMATING, SPECIFICATIONS & CONTRACTS

UNIT – I

General items of work in Building – Standard Units Principles of working out quantities for detailed and abstract estimates –Approximate method of Estimating

UNIT – II

Rate Analysis – Working out data for various items of work over head and contigent charges.

UNIT-III

Earthwork for roads and canals, Reinforcement bar bending and bar requirement schedules

UNIT – IV

Contracts – Types of contracts – Contract Documents – Conditions of contract, Valuation of buildings-
Standard specifications for different items of building construction

UNIT-V

Detailed Estimation of Buildings using individual wall method.

UNIT -VI

Detailed Estimation of Buildings using centre line method.

FINAL EXAMINATION PATTERN:

The end examination paper should consist of SIX questions from Unit 1 to Unit 4, out of which THREE are to be answered (60% weight-age) & ONE mandatory question (40% weight-age) from Units 5 & 6 is to be answered

Unit-1

DEFINITION OF ESTIMATING AND COSTING

Estimating is the technique of calculating or Computing the various quantities and the expected Expenditure to be incurred on a particular work or project.

In case the funds avilable are less than the estimated cost the work is done in part or by reducing it or specifications are altered, the following requirement are necessaryfor preparing an estimate.

a) Drawings like plan, elevationandsectionsofimportantpoints.

b) Detailedspecificationsaboutworkmenship & propertiesofmaterialsetc.

c) Standard schedule of rates of the current year.

NEED FOR ESTIMATION AND COSTING

1. Estimate give an idea of the cost of the work and hence its feasibility can be determined i..e whether the project could be taken up with in the funds available ornot.
2. Estimate gives an idea oftime required for the completionofthe work.
3. Estimate is required to invite the tenders and Quotations and to arange contract.
4. Estimate is also required to controlthe expenditure during the execution of work.
5. Estimate decides whether the proposed plan matches the funds available or not.

PROCEDUREOFESTIMATINGORMETHODOFESTIMATING.

Estimating involves the following operations

1. Preparing detailedEstimate.
2. Calculating the rate ofeachunit ofwork
3. Preparing abstractofestimate

DATA REQUIRED TO PREPARE AN ESTIMATE

1. Drawings i.e.plans, elevations, sections etc.
2. Specifications.
3. Rates

1.4.1 DRAWINGS

If the drawings are not clear and without complete dimensions the prepa- ration of estimationbecomeverydifficult. So, It is veryessential beforeprepar- ingan estimate.

SPECIFICATIONS

a) General Specifications: This gives the nature, quality, class and work and materials in general terms to be used in various parts of wok. It helps no forma generalideaofbuilding.

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

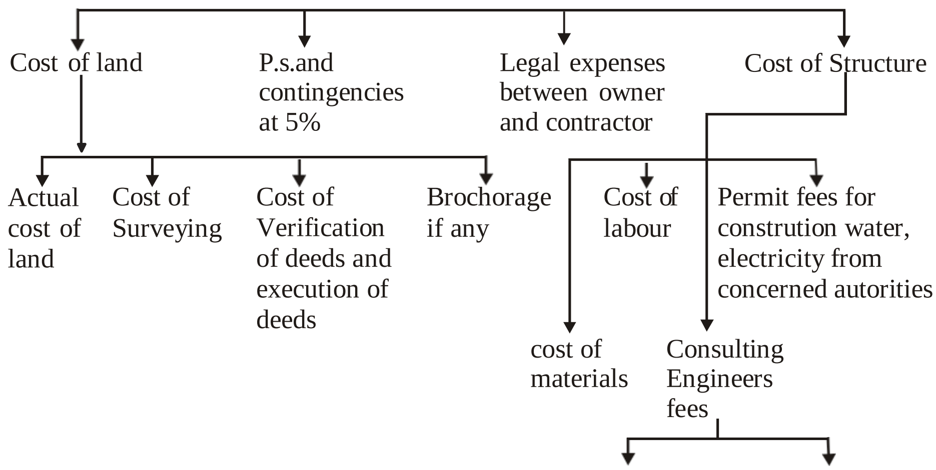
RATES:

For preparing the estimate the unit rates of each item of work are re- quired.

1. For arriving at the unit rates ofeach item.
2. The rates of various materials to be used in the construction.
3. The cost oftransport materials.
4. Thewagesoflabour, skilled or unskilled ofmasons, carpenters, Mazdoor, etc.,

COMPLETE ESTIMATE:

Most of people think that the estimate of a structure includes cost of land, cost of materials and labour, But many other direct and indirect costs included and is shown below. The Complete Estimate



LUMPSUM:

While preparing an estimate, it is not possible to workout in detail in case ofpetty items. Items other than civil engineering such items are called lumpsum itemsor simplyL.S.Items.

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

1. Water supplyandsanitaryarrangements.
2. Electricalinstallations like meter, motor, etc.,
3. Architecturalfeatures.
4. Contingenciesandunforeseenitems.

In general, certain percentage on the cost of estimation is allotted for the above L.S.Items

Even if sub estimates prepared or at the end of execution of work, the actual cost should not exceed the L.S .amounts provided in the main estimate.

WORK CHARGED ESTABLISHMENT:

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

UNITS OF MEASUREMENTS:

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

a) Single units work like doors, windows, trusses etc., are expressed in numbers.
b) Works consists linear measurements involve length like cornice, fencing, hand rail, bands of specified width etc., are expressed in runningmetres (RM)
c) Works consists areal surface measurements involve area like plastering, white washing, partitions of specified thickness etc., are expressed in square meters (m^2)
d) Works consists cubical contents which involve volume like earth work, cement concrete, Masonry etc are expressed in Cubic metres.

Sl. No.	Particulas of item	Units of Measurement	Units of payment
I	**Earth work:**		
	1. Earthwork in Excavation	cum	Per%cum
	2. Earthworkinfillinginfounda-tiontrenches	cum	Per%cum
	3. Earthwork in filling in plinth	cum	Per%cum
II	**Concrete:**		
	1. Limeconcretre in foundation	cum	percum
	2. Cement concrete in Lintels	cum	percum
	3. R.C.C.inslab	cum	percum
	4. C.C. or R.C.C. Chujja, Sun-shade	cum	percum
	5. L.C. inroofterracing (thicknessspecified)	sqm	persqm
	6. Cement concretebed	cum	per cum
	7. R.C. Sunshade(Specified Width& Hight	cum	1rm
III	**Damp ProofCource(D.P.C)**		
	(Thickness should be mentioned)	sqm	persqm
IV	**Brick work:**		
	1. Brickwork in foundation	cum	percum
	2. Brickwork inplinth	cum	percum
	3. Brick work in super struc-	cum	percum

	ture		
	4. Thinpartitionwalls	sqm	percum
	5. Brick work in arches	cum	percum
	6. Reinforced brickwork (R.B.Work)	cum	percum
V	**Stone Work:**		
	Stone masonry	cum	percum
VI	**Wood work:**		
	1. Door sand windows frames or chowkhats, rafters beams	cum	percum
	2. Shuttersofdoors and windows (thicknessspecified)	sqm	persqm
	3. Doorsandwindowsfittings (like hinges, tower bolts, sliding bolts, handles)	Number	per number
VII	**Steel work**		
	1. Steel reinforcement bars etc in R.C.C. and R.B.work. quintal	Quintal	per quintal
	2. Bending, binding ofsteel Reinforcement	Quintal	per quintal
	3. Rivets, bolts, & nuts, Anchor bolts, Lewis bolts, Holding downbolts.	Quintal	per quintal
	4. Iron holdfasts	Quintal	per quintal
	5. Iron railing (height and typesspecified)	Quintal	per quintal
	6. Irongrills	sqm	per sqm

VIII	**Roofing**		
	1. R.C.C. and R.B.Slab roof (excludingsteel)	cum	per cum
	2. L.C. roofover and inclusive oftilesor brickor stoneslab etc (thicknessspecified)	sqm	per sqm
	3. Centering and shuttering formwork	sqm	per sqm
	4. A.C.Sheet roofing	sqm	per sqm
IX	**Plastering, points&finishing**		
	1. Plastering-Cement or Lime Mortar (thickness and proportionspecified)	sqm	per sqm
	2. Pointing	sqm	per sqm
	3. White washing, colour	sqm	per sqm

	washing, cement wash (number ofcoats specified)	sqm	per sqm
	4. Distempering (number of coats specified)	sqm	per sqm
	5. Painting,varnishing(number of coatsspecified)		
X	**Flooring**	sqm	per sqm
	1. 25mm cement concrete over 75mm lime concrete floor(including L.C.)	sqm	per sqm
	2. 25mmor 40mm C.C. floor	sqm	per sqm
	3. Doorsand window sills (C.C. or cement mortar plain)		
XI		1RM	per RM
XII	**Rain water pipe /Plain pipe**	1No	per 1No
XIII	**Steel wooden trusses**	sqm	per sqm
XIV	**Glass pannels(supply)**	No	per no.
	Fixing of glass panels or cleaning		

RULES FOR MEASUREMENT :

The rules for measurement of each itemare invaribly described in IS-1200. However some of the general rules are listed below.

1. Measurement shall be made for finished item of work and description of each item shall include materials, transport, labour, fabrication tools and plant and all types of overheads for finishing the work in required shape, sizeandspecification.
2. In booking, the order shall be in sequence of length, breadth and height or thickness.
3. Allworks shall be measured subject tothe following tolerances.
   i) Linear measurement shall be measured to the nearest 0.01m.
   ii) Areas shall be measured to the nearest 0.01 sq.m
   iii) Cubic contents shall be worked-out to the nearest 0.01 cum
4. Same typeofworkunder different conditions and nature shall be measured separatelyunder separateitems.
5. The bill ofquantities shall fully describe the materials, proportions, workmanships and accuratelyrepresent the work to be executed.
6. In case of masonary(stone or brick) or structuralconcrete, the categories shall be measured separatelyand the heights shall be described:
   a) fromfoundationto plinth level

b) fromplinthlevelto First floor level
from Fist floor to Second floor level and so on.

METHODS OFTAKINGOUT QUANTITIES:

The quantities like earthwork, foundationconcrete, brickwork in plinth and super structure etc., canbe workout by anyof following two methods:

a) Long wall - short wall method

b) Centre linemethod.

c) Partlycentre line and short wall method.

a) Longwall-short wallmethod:

In this method, thewallalongthe length of room is consideredto be long wallwhile the wall perpendicular to long wall is said to be short wall. To get the lengthoflongwallor short wall, calculate first thecentreline lengthsofindividual walls. Then the length of long wall, (out to out) may be calculated after adding half breadth at each end to its centre line length. Thus the length of short wall measuredinto in and may be found by deductinghalf breadthfrom its centre line length at each end. The lengthof long wallusuallydecreases fromearthworkto brick work in super structure while the short wall increases. These lengths are multiplied by breadth and depthto get quantities.

b) Centre linemethod:

This method is suitable for walls of similar cross sections. Herethe total centre line length is multiplied by breadthand depth of respective item to get the total quantity at a time. When cross walls or partitions or verandah walls join with mainall, the centre line length gets reduced by half of breadth for each junction. such junctionor joints are studied caefullywhile calculating totalcentre line length.The estimates prepared by this method are most accurate and quick.

c) Partly centre line and partly cross wall method:

This method is adoptedwhenexternal(i.e., alroundthebuilding) wall is ofonethicknessandtheinternalwallshaving different thicknesses. In suchcases, centre line method is applied to externalwallsand longwall-shortwallmethodis usedto internalwalls. Thismethodsuitsfordifferentthicknesseswallsanddiffeent level of foundations. Because of this reason, all Engineering departments are practicing thismethod.

Typyes of estimates:

DETAILED ESTIMATE:

The preparationof detailed estimate consists of working out quantities of various items ofworkand thendetermine the cost of each item. This is prepared in twostages.

i) *Details of measurements and calculation of quantities:*

The complete work is divided into various items of work such as earth workconcreting, brick work, R.C.C. Plastering etc., The details of measurements are taken from drawings and entered in respective columns of prescribed proforma. the quantities arecalculated by multiplying the values that are in numbers columnto Depth column as shownbelow:

Details of measurements form

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

i) **Abstract of Estimated Cost :**

The cost of each item of work is worked out from the quantities that already computed in the detals measurement form at workable rate. But the total cost is worked out in theprescribedform is known as abstract of estimated form. 4%of estimated Cost is allowedfor Petty Supervision, contingencies and Unforeseenitems

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

The detailed estimate should accompained with

i) Report

ii) Specification

iii) Drawings(plans, elevation, sections)

iv) Designchartsandcalculations

v) Standard schedule of rates.

3.1.1.Factors to be consisdered While Preparing Detailed Estimate:

i) **Quantity and transportation of materials:** For bigger project, the requirement of materials is more. suchbulk volume of mateials will be purchased and transported definitely at cheaper rate.

ii) ***Location of site:*** The site of work is selected, such that it should reduce damageor intransit during loading, unloading, stockingofmateirals.

iii) ***Local labour charges:*** The skill, suitability and wages of local laboures are consideed while preparing the detailed estimate.

DATA:

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

Fixing of Rate per Unit of an Item:

The rate per unit of an item includes the following:

1) ***Quantity of materials & cost:*** The requirement of mateials are taken strictly in accordance with standard data book(S.D.B). The cost of these includes first cost, freight, insurance and transportationcharges.

ii) ***Cost of labour:*** The exact number of labourers required for unit of work and the multiplied bythe wages/ dayto get of labour for unit itemwork.

iii) ***Cost of equipment (T&P):*** Some works need special type of equipment, tools and plant. In such case, an amount of 1 to 2% of estimated cost isprovided.

Overhead charges: To meet expenses of office rent, depreciation of equipment salaries ofstaff postage, lighting an amount of 4% ofestimate cost isallocated

Unit-2

Definition : In order to determine the rate of a particular item, the factors affecting the rate of that item are studied carefully and then finally a rate is decided for that item. This process of determining the rates of an item is termed as analysis ofrates or rate analysis.

The rates of particular item of work depends on the following.

1. Specificationsofworksand materialabouttheir quality, proportionandconstructional operationmethod.
2. Quantityof materials and their costs.
3. Cost of labours and their wages.
4. Location of site of work and the distances from source and conveyance charges.
5. Overhead and establishment charges
6. Profit

<u>Cost of materials at source and at site of construction.</u>

The costs of materials are taken as delivered at site inclusive of the transport local taxes and other charges.

Purpose of Analysis of rates:

1. To workout the actual cost of per unit of the items.
2. To workout the economical use of materials and processes in completing theparticulars item.
3. To workout the cost of extra items which are not provided in the contract bond, but are to be done as per the directions of the department.
4. To revise the schedule of rates due to increase in the cost of material and labour or due to change in technique.

<u>Cost of labour -types of labour, standard schedule of rates</u>

The labour can be classified in to

1) Skilled 1stclass
2) Skilled IInd Class
3) unskilled

The labour charges can be obtained fromthe standard schedule of rates 30% of the skilled labour provided in the data may be taken as Ist class, remaining 70% as II class. The rates of materials for Government works are fixed by the superintendent Engineer for his circle every year and approved by the Board of Chief Engineers. These rates are incorporated in the standard schedule of rates.

<u>Lead statement:</u> The distance between the source of availability of material and construction site is known as "Lead " and is expected in Km. The cost of convenayce of material depends on lead.

This statement will give the total cost of materials per unit item. It includes first cost, convenayce loading, unloading stacking, chargesetc.

The rate shown in the lead statement are for mettalled road and include loading and staking charges . The environment lead on the metalled roads are arrived bymultiplying bya factor

a) for metaltracks - lead x1.0

b) For cartze tracks - Lead x1.1

c) For Sandy tracks - lead x1.4

Note: For $1m^3$ wet concrete = $1.52m^3$ dry concrete approximately

SP.Wt of concrete= 1440 kg/m^3 (or) 1.44 t/m^3

1 bag of cement = 50 Kg

Example 1:- Calculate the Quantity of material for the following items.

a) R.C.C. (1:2:4) for $20m^3$ of work

b) R.C.C. (1:3:6) for $15m^3$ of work

a) Quantityof cement required = $\frac{1}{(1+2+4)}$ x $1.52 \times 20 = 4.14m^3$ x $\frac{1440}{50}$

=119.26 bags

Quantity of Sand required = $\frac{2}{(1+2+4)} \times 1.52 \text{x} 20 = 8.28m^3$

Quantity of cource aggreate = $\frac{4}{7} \times 1.52 \text{x} 20 = 16.56m^3$

b) Quantity of cement required = $\frac{1}{10} \times 1.52 \text{ x } 1.5 = 2.28m^3 \text{ x } \frac{1440}{50} = 65.66$ Bags

Quantity of sand required = $\frac{3}{10} \times 1.52 \text{x } 15 = 6.84m^3$

Quantity of CA required = $\frac{6}{10} \times 1.52 \text{x} 15 = 13.68m^3$

Example 5:- Prepare the lead statement for the following materials

S.No.	Material	Rate at Source	Lead in KM			Conveyance Charge per km
			MT	CT	ST	
1.	40mm HBG Metal	Rs.120/m^3	---	5	7	Rs.5.00/m^3
2.	River Sand	Rs.15/m^3	3	2	6	Rs.3.50/m^3
3.	Cement	Rs. 135/bags	2	---	4	Rs. 4.00 per 4km/bag

S.No	Mateial	Rate of Source	Lead in KM			Equalant lead in km	Conveyance Charge	Total convey-ance Charge	Total cost
			MT	CT	ST				
1.	40mm HBG Metal	Rs.120/m^3	--	5	7	5×1.1+7×1.4=15.3	5.00/m3	15.3x5=76.5	120+76.5=196.5/m^3
2.	River Sand	Rs.15/m^3	3	2	6	3x1+2x1.1+6x1.4 =13.6	3.50/m3	13.6x3.5=47.6	15+47.6=62.6/m^3
3.	Cement	Rs. 135/bags	2	---	4	2x1+4x1.4=7.6	4.00per4km/bag	$\frac{7.6}{4.0}$ x 4.0=7.6	135+7.6=142.6/bag

Cost of cement at site = 142.6/bag

1 bag of cement = 50kg

sp.wt of cement = 1440 kg/m3 = 1.44t/m3

Cost of Cement = $142.6 \text{x} \frac{1440}{50} = 4106.88/m^3$

Example 6:- Prepare the lead statement for the following materials

S.No.	Material	Rate of Source	Lead in KM			Conveyance Charge per km	Seinarage Charges	Cess Charges
			ST	CT	MT			
1.	Cement	Rs.2100/10KN(tonn)	5	2	3	Rs.1.5/m^3	---	---
2.	Bricks	Rs.850/100nos	5	--	3	Rs.30/1000Nos/Km	35	13
3.	Sand	Rs. 15/m^3	4	2	5	Rs.9.00 / km/cum	30	12
4.	40mm HBGMetal	Rs. 250/m^3	3	2	2	Rs.6.50/Km/m^3	35	15

S.No	Material	Rate of Source	Lead in KM			Equalant lead in km	Conveyance Charge Rs.	Total conveyance Charge Rs.	Seinerage Charge Rs.	Cess Charg Rs.	Total cost Rs.
			ST	CT	MT						
1.	Cement	Rs.2100/10KN	5	2	3	5x1.4+2x1.1+3x1=11.2	1.50	16.80	--	--	2116.8/10KN
2.	Bricks	Rs.850/1000nos	5	--	3	5x1.4+3x1=10	30	300.00	35	13	1198/1000nos
3.	Sand	Rs.15m^3	1	2	2	1x1.4+2x1.1+2x1=5.6	9.00/m^3	50.40	30	12	107.4/m^3
4.	40mmHBG Metal	Rs. 250/m^3	3	2	2	3x1.4+2x1.1+2x1=8.4	6.5/m^3	54.6	35	15	354.6/m^3

Preparation of Unit rates for finished items of words

a) Cement Concrete in foundation (1:5:10)

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	40mm HBG Metal	0.92	Cum	547.75	Cum	503.93
2.	Sand	0.46	cum	284.80	Cum	131.00
3.	Cement	0.092	Cum	2700.00	MT	357.70
4.	Mason Ist Class	0.06	No	150.00	Nos	9.00
5.	Mason 2nd Class	0.14	No	131.00	Nos	18.34
6.	Man mazdoor	1.80	No	101.00	Nos	181.80
7.	Women Mazdoor	1.40	No	101.00	Nos	141.40
8.	Add Extra 15%on M.L					52.58
						1395.75
9	Add T.O.T. @4%					55.83
10	Sundries					0.42
				Total Rs.		1452.00

b). Cement Concrete in foundation (1:4:8)

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	40mm HBG Metal	0.92	Cum	547.75	Cum	503.93
2.	Sand	0.46	Cum	284.80	Cum	131.00
3.	Cement	0.115	Cum	2700.00	MT	447.12
4.	Mason Ist Class	0.06	No	150.00	Nos	9.00
5.	Mason 2nd Class	0.14	No	131.00	Nos	18.34
6.	Man mazdoor	1.80	No	101.00	Nos	181.80
7.	Women Mazdoor	1.40	No	101.00	Nos	141.40
8.	Add Extra 15%on M.L					52.58
						1485.17
9	Add T.O.T. @4%					59.40
10	Sundries					0.43
				Total Rs.		1545.00

2) R.C.C.Works

V.R.C.C.(1:2:4) Nominal mix using 20mm Normal size hard broken granitemetalapprovedquarrywith necessaryreinforcement includingcasting, curingcost & conveyance of all materials

2 a) P.C.C.(1:2:4)

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	20mm HBG Metal	0.92	Cum	797.75	Cum	733.93
2.	Sand	0.46	cum	284.80	Cum	131.00
3.	Cement	0.23	Cum	2700.00	MT	894.24
4.	Mason Ist Class	0.2	No	180.00	Nos	30.00
5.	Man mazdoor	1.8	No	131.00	Nos	235.80.
6.	Women Mazdoor	1.4	No	101.00	Nos	141.40
7.	Vibrating charges	1.0	Cum	101.00	Nos	101.00
8.	Machinymixingconcrete	1.0	Cum	28.80	cum	28.80
9	Add Extra 15%on M.L					76.23
				Total Rs.		2372.40

b) For steelreinforcement

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	cost of steel	1.00	MT	27500	MT	27500.00
2.	Fabrication charges	1.00	MT	5.00	Kg	5000.00
						750.00

3.	Add 15% on M.L.					33250.00
						1330.00
4.	Add T.O.T. @4%					0.00
5.	Sundries					
				Total Rs.		34580.00

c).V.R.C.C (1:2:4) for bed blocks, column footings including form work centering charges

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	V.P.C.C (1:2:4)	1.00	Cum	2372.40	Cum	2372.40
2.	Centering Charges	1.00	Cum	430.00	Cum	430.00
3.	Steel @0.5% = 0.5/ 100=0.005m³ (0.005x7.85t/m3 = 0.04t	0.04	MT	34580.00	MT	1383.20
						4185.60
4.	Add T.O.T. @4%					167.40
	Sundries					0.00
				Total Rs.		**4353.00**

d). V.R.C.C(1:2:4) for columns rectangular beams, pedastals including form work at centering charges

S.No.	Descrtiption of Item	Quantity	Unit	Rate	Per	Amount
1.	V.P.C.C. (1:2:4)	1.00	Cum	2372.40	Cum	2372.40
2.	Centering Charges	1.00	Cum	675.00	Cum	675.00
3.	Steel for columns, beams @1.5% =1.5/ 100x7.85=0.117t	0.117	MT	34580.00	MT	4072.00
						7119.40
4.	Add T.O.T. @4%					284.77
5.	Sundries					0.83
				Total Rs.		**7405.00**

e).V.R.C.C(1:2:4) for slabs, lintels including form work at centering charges upto 100mm, thick

S.No.	Descrtiption of Item	Quantity	Unit	Rate	Per	Amount
1.	V.P.C.C (1:2:4)	1.00	Cum	2372.40	Cum	2372.40
2.	Centering Charges	10.00	Cum	710.00	Cum	710.00
3.	Steel for slabs @1% =1/100 x 7.85 = 0.0785 t	0.0785	MT	34580.00	MT	2714.53
						5796.63

	Add T.O.T. @4% Sundries					231.87 1.20
				Total Rs.		**6030.00**

3. Pointing to R.R.Masonary in CM(1:4) mix using cost & conveyance of Cement, sand and all materials from approved sources to site and labour charges for point neatly etc.

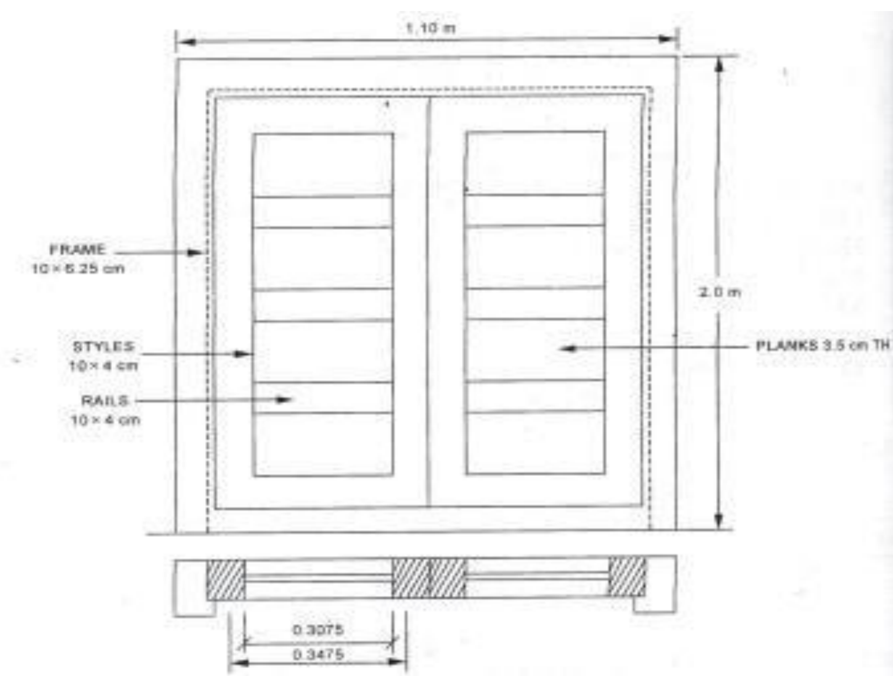
S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
	Cost of CM(1:4)	0.09	Cum			
1.	Cement = $\frac{1}{4} \times 1.44 x 0.09$	0.032	t	2700.00	Mt	87.48
2.	Sand = $\frac{1}{4} \times 0.09$	0.09	Cum	284.80	Cum	25.63
3.	Mining Charges	1.0	Cum	32.50	Cum	32.50
4.	mason Ist Class	0.48	Nos.	150.00	Nos	72.00
5.	2nd Class	1.12	Nos	131.00	Nos	146.72
6.	Man mazdoor	0.50	Nos	101.00	Nos	55.00
7.	Women Mazdoor	1.10	Nos	101.00	Nos	111.10
8.	Add 15% on ML					57.72
						588.15
9.	Add TOT @ 4%					23.53
10.	Sundries					0.32
			Total Rs.			**612.00**

Cement concrete flooring (1:2:4) using 12mm HBG machine crushed chips from approved quarry to site of work including curing cost and conveyance of all materials completed.

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount

1.	12mm HBG metal	0.92	Cum	680.25	cum	625.83
2.	crushed chips					
3.	Sand	0.46	cum	284.80	cum	131.00
4.	Cement	0.23	cum	2700	mt	894.24
	(0.23m^{3}x1.44=0.33t	(or)0.331	MT			
5.	Mason ISt class	0.06	Nos	150.00	nos	9.0
6.	2nd Class	0.14	nos	131.00	nos	18.34
7.	Man mazdoor	1.80	nos	101.00	nos	181.80
8.	Women Mazdoor	1.40	nos	101.00	nos	141.40
9.	Add 15% Extra on ML					52.58
						2054.1
10	Add TOT @4%					82.1
11.	Sundries					0.6
				Total Rs.		**2137.00**

5 a) Supply and fixing teak wood fully panneled with 10x 4 cm styles, and 10x4cmrails and 3.5CM TH panels with teak wood framof 6.25x 10cm size including cost of hold fasts, but hinges and labour charges for fixing door in positionandfixingfurniture etc., complete for one door of size 1.100 x 2.00 of area 2.2 sqm

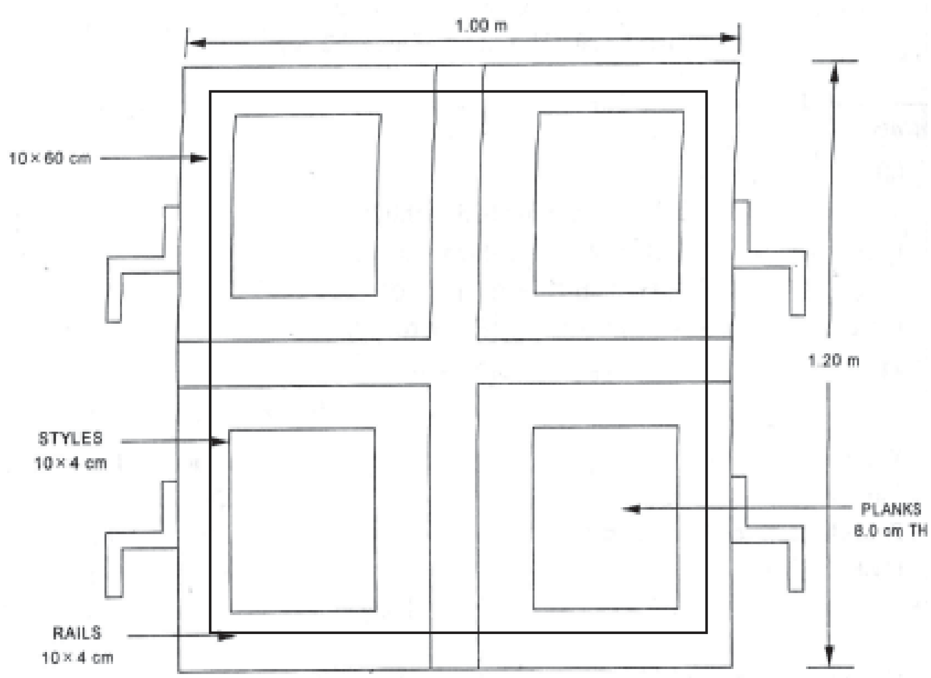


Requirements :

i)	Verticals = 2x 2.0 x 0.10 x 0.0625 =	0.0250
ii)	Horizontals = 1x 1.10 x 0.10 x 0.0625 =	0.0068
iii)	Styles = 4x 1.937 x 0.10 x 0.04 =	0.0300
iv)	Rails = 2x 5x 0.5075 x 0.10 x 0.04 =	0.0020
v)	Planks = 2x 4x 0.364 x 0.3475 x .035=	0.0354
		0.0090m^3

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	wood Cost	0.009	Cum	25000	cum	2470.00
2.	Butt Hinges	6	Nos	20	each	120.00
3.	Z-hold fasts	6	Nos	10	each	60.00
4.	Cost of labour	2.2	sqm	800	sqm	1760.00
					Total	**4410.00**

5 b) Supply and fixing teak wood fully panneled with 10x 4 cm styles, and 10x4cm rails and 3.5CM TH panels with teak wood fram of 6.25x 10cm size including cost of hold fasts, but hinges and labour charges for fixing window in position and fixing furniture etc., complete for one window of size 1.0x1.2 of area 1.2sqm.



Requirements :

i) Verticals = 3x1.2 x 0.10 x 0.0625 = 0.0225

ii) Horizontals = 3x 1.00 x 0.10 x 0.0625 = 0.0188

iii) Styles = 4x 2 x 0.10 x 0.04 = 0.0160

iv) Rails = 4x 2x 0.4062 x 0.10 x 0.04 = 0.0012

v) Planks = 4x 0.3102x 0.2102 x0.03 = 0.0070

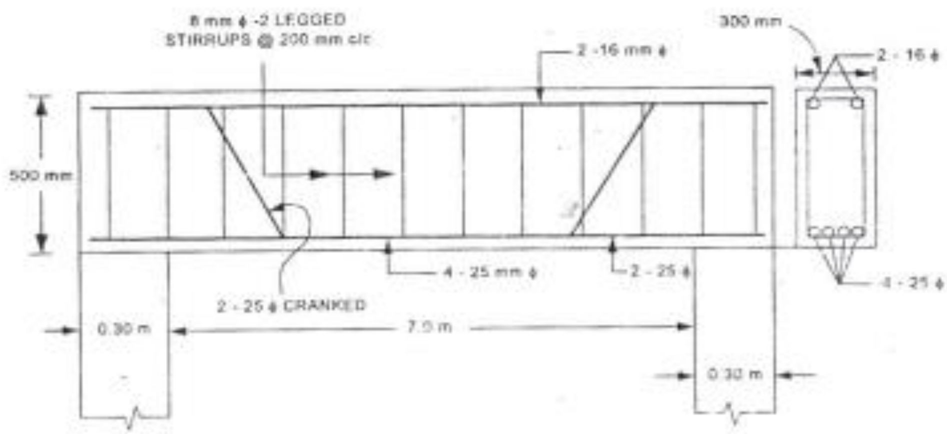
0.0076m^3

S.No.	Description of Item	Quantity	Unit	Rate	Per	Amount
1.	wood Cost	0.0076	Cum	25000	cum	1900.00
2.	Butt Hinges	6	Nos	20	each	120.00
3.	Z-hold fasts	4	Nos	10	each	40.00
4.	Cost of labour	1.2	sqm	1000	sqm	1200.00
					Total	**3260.00**

Cost of door per 1m^2 = 3260/ 1.2 = 2716.67 say Rs.2720/-

EXERCISE

1) Prepare the Bar bending schedule for the beam shown below.



2) Prepare the Bar bending schedule of a simply supported R.C.C. Lintels from the following specification:

Size of lintel 300mm widex 200mm depth.Main bars in tension zone of Fe 250(grade I) 3 bars of 16mm dia., one bar is cranked through 45^0 at 170 mm from each end

2 No. anchor bars at top 8mm dia.

Two legged stirrups@150mm c/c of 6mm dia. through out.

Clear span of the lintel is 1150mm.

Bearing on either side is 150mm.

EARTH WORK CALCULATIONS

Introduction:-

Generally all the Civil Engineering projects like roads, railways, earth dams, canal bunds, buildings etc. involves the earth work.This earth work may be either earth excavation or earth filling or Some times both will get according to the desired shape and level. Basically the volume of earthwork is computed from length, breadth, and depth of excavation or filling.

In this chapter the various methods of calculating the earth work quantities shall be discussed.

Lead and Lift:

Lead:

It is the average horizontal distance between the centre of excavation to the centre of deposition. The unit of lead is 50m.

Lift :

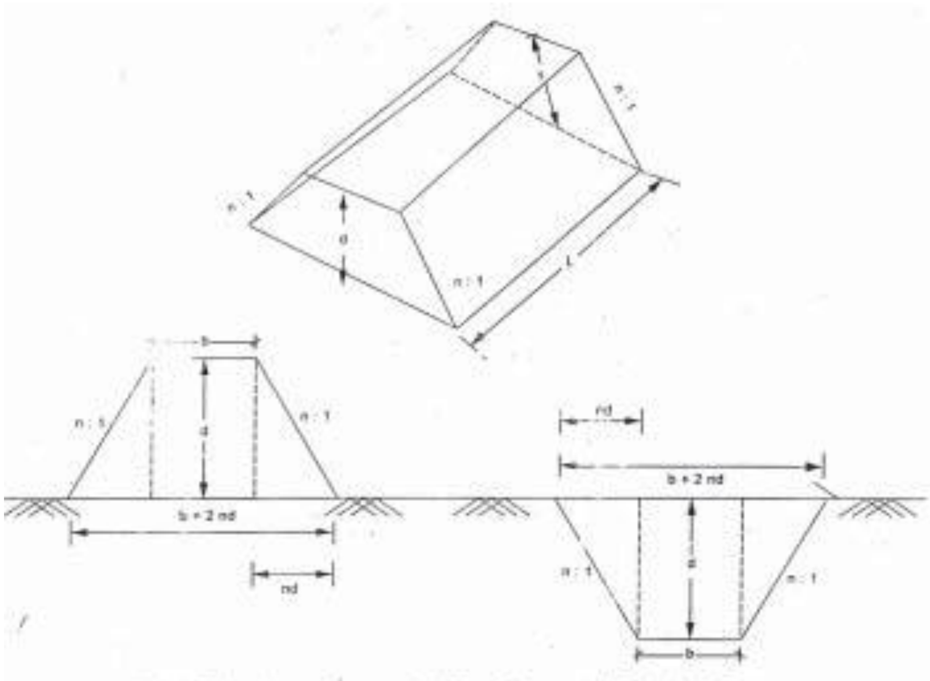
It is the average height through which the earth has to be lifted from source to the place of spreading or heaping. The unit of lift is 2.00m for first lift and one extra lift for every 1.0m. for example when earth is to be lifted for 4.5m, Four lifts are to be paid to the contractor.

i.e. Upto 2.0 -	1 lift		
1.0 -	1 Lift		
1.0 -	1 lift	}	Total 04 lifts
0.5 -	1 lift		

Calculation of earth work for Roads:

case 1) volume of earth work in banking or in cutting having "no longitudi- nal slope".

Earth work Calculations



(a) C/S of Embankment (b) Cross Section of a Canal in Cutting

Volume = Crosectional area x length

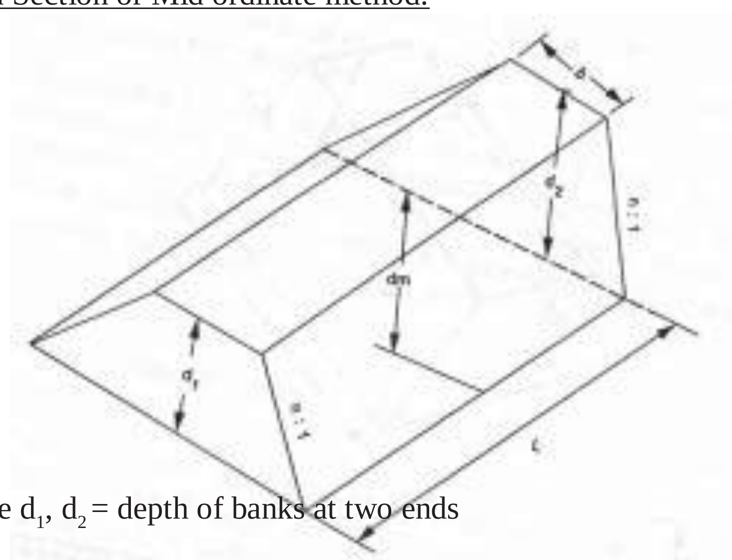
$V = (bd + 2 \times 1/2 \times nd \times d)L$

$V = (bd + nd^2)L$

Case 2:

hen the ground is in longitudinal slope or the formation has uniform gradi- ent for a length the earth work may be calculated by the following methods.

1. By Mid Section or Mid ordinate method.



Where d_1, d_2 = depth of banks at two ends

Mid ordinate (or) Average depth (d_m) $= \dfrac{d_1 + d_2}{2}$

Area of mid section (Am) = $(bd_m + nd_m^2)$

volume of earth work (v) = A_m x L=$(bd_m + nd_m^2) \times L$

ii) Trepezoidal formula: (for two sections)

In this method also called mean sectional area method

Let A_1 &A_2 be two areas at two ends.

$A = (bd_1 + nd_1^2)$, $A_2 = (bd_2 + nd_2^2)$

$$A_m = \frac{A_1 + A_2}{2}$$

Volume of earth work (v) = Am ×L

iii) Trepezoidal formula for a series of c/s areas at equal intervals.

Let A_1,A_2,A_3..............A_n are the cross sectional areas along L.S of Road 'L" is the distance between two cross sections

The volume of earth work

$$V = L\left[\left(\frac{A_1 + A_n}{2}\right) + (A_2 + A_3 + ... + A_{n-1})\right] \text{ (or)}$$

$$= \frac{L}{2}\left[(A_1 + A_n) + 2(A_2 + A_3 + \square + A_{n-1})\right]$$

$$= \frac{\text{length}}{2} \text{ [(sum of first and last areas) + 2(remaing Areas)]}$$

iv) Prismoidal formula for a series of cross sectional areas at equal intervals.

Note : This method is adopted when there is odd number of cross sections.

Volume of earth work

$$V = \frac{L}{3}\left[(A_1 + A_n) + 4(A_2 + A_4 + A_6 + \square + A_{n-1}) + 2(A_3 + A_5 + ... + A_{n-2})\right]$$

$$= \frac{\text{length}}{3} \text{ (Sum of first and last areas)+4(even areas)+2(odd Areas)]}$$

Earth work Calculations

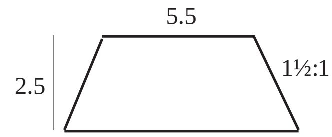
Example 7.1 : Find the volume of earth work in embankment of length 12m. Top width is 5.5m and depth is 2.5m the side slopes ara 1½:1

Sol : Top width b=5.5m

Depth d= 2.5m

side slopes =1½:1 i.e. n=1.5

length L=12m



Volume of earth work V = $(bd+nd^2)L$

$= (5.5 \times 2.5+1.5\times 2.5^2)12$

$= 77.5m^3$

Example 7.2 : The depths at two ends of an embankment of road of length 70m are 2m and 2.5m. The formation width and side slopes are 8m and 2:1 respectively. Estimate the Quantity of earth work by

a) Mid Sectional Area (ii)Mean sectional Area method.

Sol: a) b=8m, d1=2m, d2=2.5m, l=70m, n=2

Mean depth $d_m = \frac{d_1+d_2}{2} = \frac{2 + 2.5}{2} = 2.25m$

Mid sectional Area = Am = $bdm+ndm^2 = (8x2.25+2x2.25^2)2=28.125m^2$

Volume of earth work (V)= AmxL = 28.125x70=1968.75m^3.

b) Area of c/s at one end $A_1= bd_1+nd_1^2=8x2+2x2^2=24m^2$

Area of C/s at other end $A2=bd_2+nd_2^2=8\times 2.5+2\times 2.5^2=32.5m^2$

Mean Sectional Area (Am) $= \frac{A_1+A_2}{2} = \frac{24 + 32.5}{2} = 28.25m^2$

Volume of earth work (V)= AmxL=28.25x70=1977.5m^3.

Example 7.3

The following width of road embank ment is 10m. The side slopes are 2:1 The depth along the centre line road at 50m intervals are 1.25, 1.10, 1.50, 1.20, 1.0,1.10, 1.15m calculate the Quantity of earth work by

a) Mid sectional rule

b) Trepezoidal rule

c) Prismoidal rule

a) Mid Sectional rule : b=10m, n=2.

Chainage	Depths	Mean epth (d_m)	Area of ($bd_m+nd_m^2$)	Length b/w Chainages	Quantity (m^3) $A_m \times L$
0	1.25				
		1.175	14.51	50	725.56
50	1.10				
		1.125	13.78	50	689.06
100	1.15				
		1.175	14.51	50	725.56
150	1.20				
		1.10	13.4	50	671.00
200	1.00				
		1.02	12.70	50	635.25
250	1.10				
		1.125	13.78	50	689.06
300	1.15				
				Total	4135.49m^3

b) Trepezoidal rule

$A= bd +nd^2$

$A_1= bd1+nd_1^2= 10x\ 1.25+2x\ 1.252= 15.625\ m^2$

$A_2= bd2+nd_2^2= 10x\ 1.10+2x\ 1.10^2=13.42m^2$

$A_3= 10x\ 1.15+2.1.15^2= 14.145m^2$

$A_4= 10x\ 1.2+2x1.2^2=14.88m^2$

$A_5=10x\ 1.0+2x1^2=12.0m^2$,

$A_6 = 10\ x\ 1.1 +2x1.1^2 = 13.42m^2$

$A_7= 10x1.15+2x1.152= 14.145\ m^2$

Volume of earth work by Trepezoidal rule

$$v = L\left[\left(\frac{A_1 + A_n}{2}\right) + (A_2 + A_3 + ...A_{n-1})\right]$$

$$= 50\left[\left(\frac{15.625 + 14.145}{2}\right) + (13.42 + 14.145 + 14.818 + 12.0 + 13.42)\right]$$

$= 4137.50\ m^3$

Earth work Calculations

c) By Prismoidal rule

$$v = \frac{L}{3}\left[(A_1 + A_n) + 4(\text{even Areas}) + 2(\text{Odd Areas})\right]$$

$$= \frac{L}{3}\left[(A_1 + A_7) + 4(A_2 + A_4 + A_6) + 2(A_3 + A_5)\right]$$

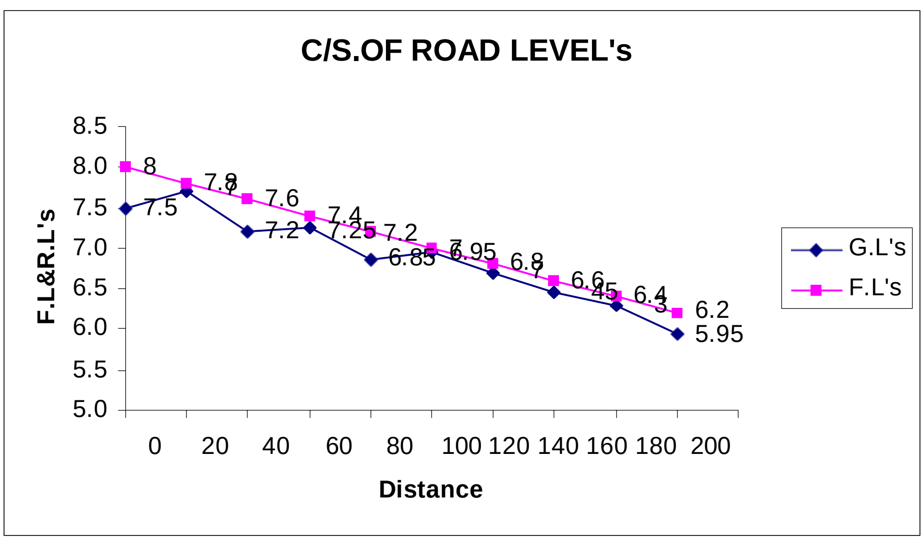
$$= \frac{50}{3}\left[(15.625 + 14.145) + 4(13.42 + 14.88 + 13.42) + 2(14.145 + 12)\right]$$

$$= 4149 \text{ m}^3$$

Example 7.4:- Estimate the Quantity of earth work for a portion of road from the following data

Chainage	0	1	2	3	4	5	6	7	8	9
RL	7.50	7.70	7.50	7.25	6.85	6.95	6.70	6.45	6.30	5.95

The formation level at Chainage 0 is 8.0 and having falling gradient of 1 in 100. The top width is 12m and side slopes 1½ horizontal to 1 vertical assuming the transverse direction is in level calculate the quantity of earth work Take 1 chain = 20m by using trepezoidol & Prismoidol formula.



Sol : -

b=12m n=5

Chainage	Distance	Reduced level	Formation Level	Depth(d) of		Area of	
				Embank-ment	Cutting	Embank-ment $bd+nd^2$	Cutting
0	0	7.50	8.0	0.50		6.375	
1	20	7.70	7.8	0.10		1.275	
2	40	7.50	7.6	0.10		1.215	
3	60	7.25	7.4	0.15		1.839	
4	80	6.85	7.2	0.35		4.38	
5	100	6.95	7.0	0.05		0.63	
6	120	6.70	6.8	0.10		1.215	
7	140	6.45	6.6	015		1.837	
8	160	6.30	6.4	0.10		1.215	
9	180	5.95	6.2	0.25		3.09	

Trepezoidal formula :

$$V= L\left[\left(\frac{A_1+A_n}{2}\right)+(A_2+A_3+....+A_{n-1})\right]$$

$$=20\left[\left(\frac{6.375+3.09}{2}\right)+(1.215+1.215+1.837+4.38+0.63+1.215+1.837+1.215\right]$$

$= 365.53m^3$

Prismoidal formula :

$$V=\frac{L}{3}\left[(A_1+A_n)+4(\textit{even areas})+2(\textit{Odd}\text{ areas})\right]$$

$$=\frac{L}{3}\left[(A_1+A_{10})+4(A_2+A_4+A_6+A_8)+2(A_3+A_5+A_7+A_9)\right]$$

$$=\frac{20}{3}[(6.375+3.09+4(1.215+1.837+0.63+1.837)+$$

$$2(1.215+4.38+1.815+1.215)]$$

$= 317.27\ m^3$

Earth work Calculations

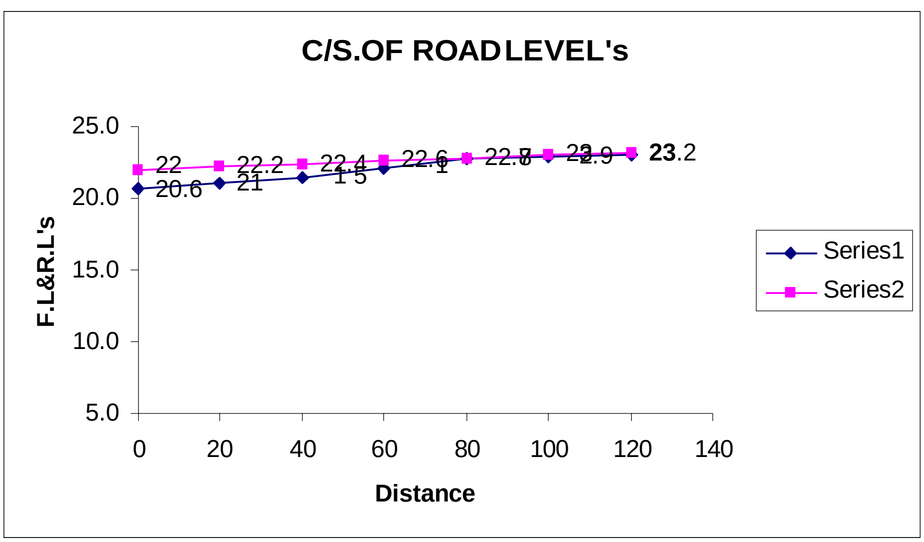
Example 7.5:- The road has the following data

Chainage	0	20	40	60	80	100	120
RL of Ground	20.6	21.0	21.5	22.1	22.7	22.9	23.0

The formation level at chainage zero is 22.0 and having a rising gradient of 1 in 100 the top width is 12.0m and side slopes are1½ :1 Assuming the transverse direction is in level. calculate the quantity of earth work by

a) Trepezoidal formula　　　　b) Prismoldal formula

Chainage Distance	Reduced level	Formation Level	Depth (d)of		Area of	
			Embark-ment	Cut-ting	Embark-ment	Cutting
0	20.6	22.0	1.40		19.74	
20	21.0	22.2	1.20		16.56	
40	21.5	22.4	0.90		12.01	
60	22.1	22.6	0.50		6.375	
80	22.7	22.8	0.10		1.215	
100	22.9	23.0	0.10		1.215	
120	23.0	23.2	0.20		2.460	



a) Trepezoidal formula:

Vol of earth work in embankment

$$V = L\left[\left(\frac{A_1 + A_n}{2}\right) + (A_2 + A_3 + \dots\dots + A_{n-1})\right]$$

$$= 20\left[\left(\frac{19.74 + 2.46}{2}\right) + (16.56 + 12.01 + 6.375 + 1.215 + 1.215)\right]$$

$= 969.5\ m^3$

b) Prismoidal formula

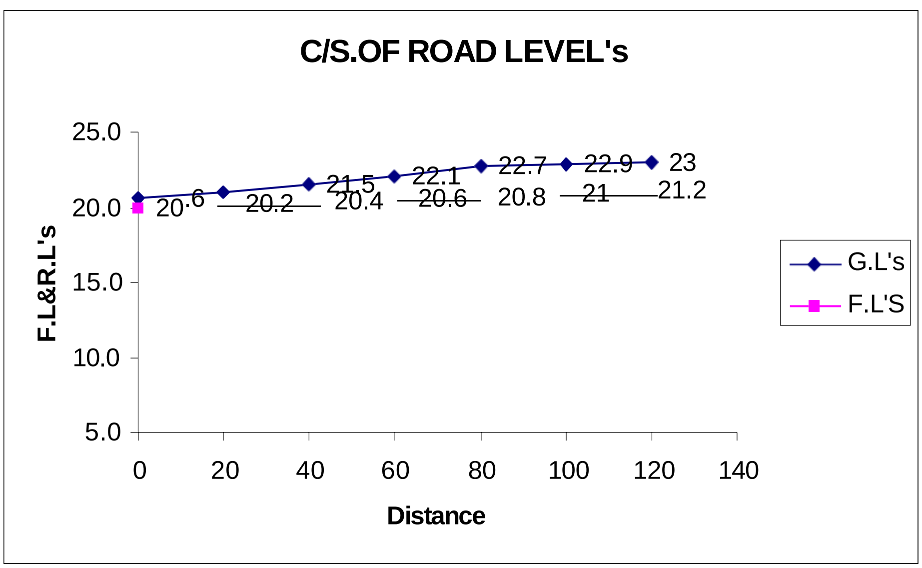
$$V = \frac{L}{3}[(A_1 + A_n) + 4(\text{even Areas}) + 2(\text{Odd Areas})]$$

$$= \frac{20}{3}[(19.74+2.46)+4(16.56+6.325+1.2+5)+2(12.01+1.215)]$$

$= 968.33m^3$

Example 7.6:-From the above problem if the formation level at 0th chainage in 20m. Calculate the volume of earth work by using the formulas?

Chainage	Reduced level	Formation Level	Depth (d)of		Area of	
			Embank-ment	Cutting	Embank-ment	Cutting $bd+nd^2$
0	20.60	20.00	--	0.60	--	7.740
20	21.00	20.20	--	0.80	--	10.56
40	21.50	20.40	---	1.10	---	15.015
60	22.10	20.60	--	1.50	--	21.375
80	22.70	20.80	--	1.90	--	28.215
100	22.90	21.00	--	1.90	--	28.215
120	23.00	21.20	--	1.80	--	26.460



a) Trepezoidal formula:

Vol.of earth work in cutting

$$V = L\left[\left(\frac{A_1 + A_n}{2}\right) + (A_2 + A_3 + \dots\dots + A_{n-1})\right]$$

$$= 20\left[\left(\frac{7.74+26.46}{2}\right) + (10.56+15.015+21.375+28.215+28.215)\right]$$

$= 2409.6\ m^3$

b) Prismoidal formulae:

$$V = \frac{L}{3}\left[(A_1 + A_n) + 4(\textit{even areas}) + 2(\textit{Odd}\ \text{areas})\right]$$

$$= \frac{L}{3}\left[(A_1 + A_7) + 4(A_2 + A_4 + A_6) + 2(A_3 + A_5)\right]$$

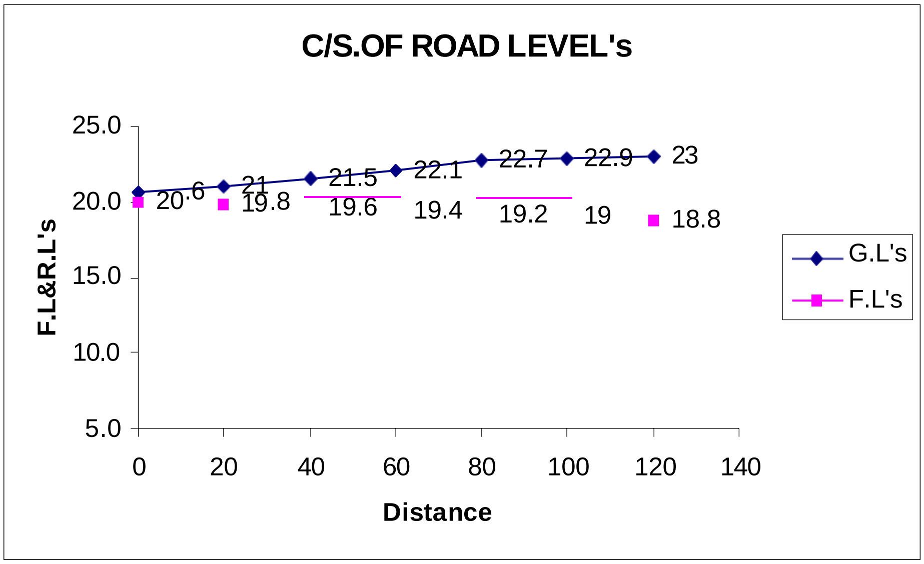
$$= \frac{20}{3}[(7.74+26.46) + 4(10.56+21.375+28.215) + 2(15.015+28.215)]$$

$= 2408.4\ m^3$

Example 7.7:-From the same above problem 7.6 if the gradient is in 100 falling calculate the quantity of earth work by using the formulas

Chainage	Reduced level	Formation Level	Depth (d)of		Area of	
			Embank-ment	Cut-ting	Embank-ment	Cutting
0	20.60	20.00	--	0.60	--	7.74
20	21.00	19.8	--	1.20	--	16.56
40	21.50	19.6	---	1.90	---	28.215
60	22.10	19.4	--	2.70	--	43.335
80	22.70	19.20	--	3.50	--	60.375
100	22.90	19.0	--	3.90	--	69.615
120	23.00	18.80	--	4.20	--	76.86

Earth work Calculations



a) Trepezoidol formulae:

Vol.of earth work in cutting

$$V = L\left[\left(\frac{A_1 + A_n}{2}\right) + (A_2 + A_3 + \dots\dots + A_{n-1})\right]$$

$$= 20\left[\left(\frac{7.74+76.86}{2}\right) + (16.56+28.215+43.335+60.375+69.615)\right]$$

$= 5208\ m^3$

b) Prismoidal formulae:

$$V = \frac{L}{3}[(A1 + An) + 4(\text{even areas}) + 2(\text{Odd areas})]$$

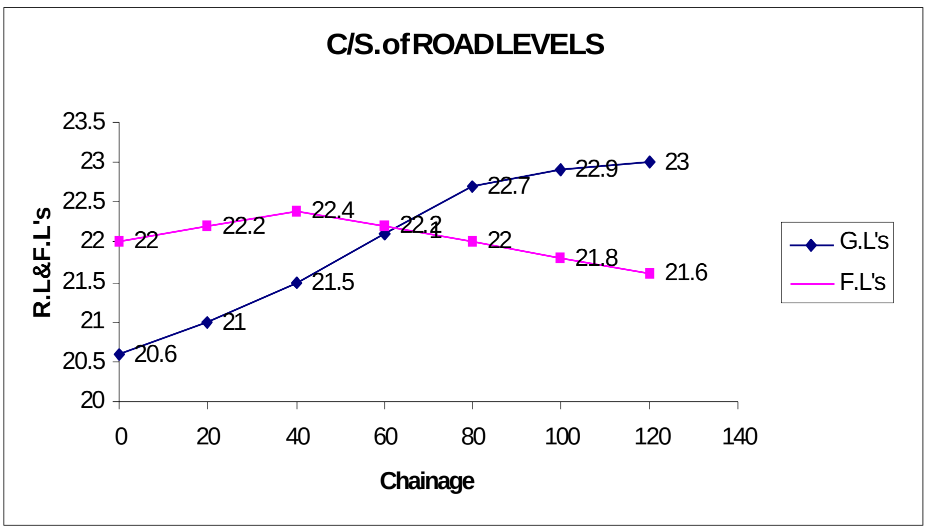
$$= \frac{L}{3}[(A_1 + A_7) + 4(A_2 + A_4 + A_6) + 2(A_3 + A_5)]$$

$$= \frac{20}{3}[(7.74+76.86) + 4(16.56+43.335+69.615) + 2(28.215+60.375)]$$

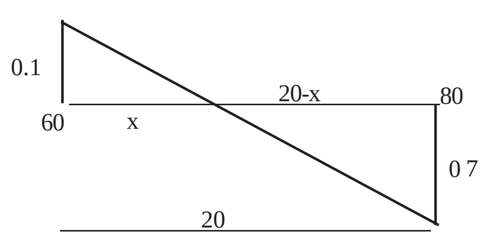
$= 5198.8\ m^3$

Example 7.8:- From the problem 7.5 if the gradient is 1 in 100 raising upto 40th chainage and 1 in 100 falling ragient from 40th Chainage to 120th chainage. Calculate the vol of earth work by using the formulas.

Chainage (m)	R.L.	F.L.	Depth (d)of .		Area of .	
			Embank-ment	Cutting	Embank ment bd+nd²	Cutting bd+nd²
0	20.6	22.0	1.40		19.74	
20	21.0	22.20	1.20		16.56	
40	21.5	22.40	0.90		12.01	
60	22.1	22.20	0.10		1.215	
62.5			0.00	0.00	0.000	0.000
80	22.7	22.00		0.70		9.135
100	22.9	21.80		1.10		15.015
120	23.0	21.60		1.40		19.74



From similer triangel properties



$$\frac{x}{0.1} = \frac{20 - x}{0.7}$$

$0.7x = (20\text{-}x)0.1$

$0.7x = 2\text{-}0.1x$

$0.7x+0.1x = 2$

$0.8x = 2$

$$x = \frac{2}{0.8} = \frac{20}{8} = 2.5$$

Earth work Calculations

vol of earth work in embankment

Chainage	0	20	40	60	62.5
Area	19.74	16.56	12.01	1.215	0.00

here the intervals are not equal so we have to take the seperate volumes from oth chainage to 60th chainage and 60th chainage to 62.5 chainage

$$V = \text{Vol}(0-60) + \text{vol}(60-62.5)$$

$$= 20\left[\left(\frac{19.74 + 1.215}{2}\right) + (16.56 + 12.01)\right] + 2.5\left[\frac{1.215 + 0.00}{2}\right]$$

$$= 782.46\text{m}^3$$

By Prismoidal

$$V = \frac{20}{3}\left[(19.74 + 1.215) + 4 \times 16.56 + 2 \times 12.01\right] + \frac{2.5}{3}\left[(1.215 + 0.00)\right]$$

$$= 742.44\ \text{m}^3$$

Vol of earth work in cutting

Chainage	62.5	80	100	120
Area	0.00	9.135	15.015	19.74

Volume (v) = vol (62.5-80)+Vol (80-120)

By Tripezoidal formula

$$V = 17.5\left[\frac{0 + 9.135}{2}\right] + 20\left[\left(\frac{9.135 + 19.74}{2}\right) + 15.015\right]$$

$$= 668.98\text{m}^3$$

By Prismoidal

$$v = \frac{17.5}{3}\left[0.9 + 135\right] + \frac{20}{3}\left[(9.135 + 19.74) + 4 \times 15.015\right]$$

$$= 646.18\ \text{m}^3$$