ESTIMATING PREPARATION & QUANTITY TAKEOFF

PREPARING A PRELIMINARY ESTIMATE

There are two methods to determine a preliminary estimate:

Method 1: Apply unit prices to the number of functional units.
Estimate Cost = Unit Price x Number of Functional Units

Method 2: Apply unit prices to different functional areas.
Estimate Cost = Unit Price x Functional Area

ESTIMATING NEW CONSTRUCTION JOBS

There are two types of new construction jobs, plans-specs jobs and design-build jobs.

- Plans-specs jobs are projects with complete drawings and specs available. Use the plans and specs to estimate the job.
- Design-build jobs are projects with almost no drawings or specs available. Communicate with everyone involved (owners, architects, engineers, subtrades, suppliers, bonding, insurance) to get a better, more clear idea of the project.

ESTIMATING RENOVATION JOBS

Renovation jobs have more uncertain factors than jobs that are new construction. To estimate a renovation job, visit the site and examine the current condition of the building. Follow the question list below to better gage the cost of the renovation project:

- Are old drawings or specs for the building available?
- Which contractor built the existing structure?
- Where are the existing utilities located?
- Is there readily accessible access to the utilities?
- Is the building poorly or well maintained?
- Are there any hazardous materials present in the building (asbestos, lead etc.)?
- Are there any unusual job conditions (ex. high ceilings, flooded basement, crawl space, occupant use)?
- Is there enough room to move tools, equipment and material around?
- Are existing fixtures, piping and equipment being relocated or removed?
- Are cutting and patching of existing surfaces included in the contract?
- Are there any dust control or noise abatement requirements?
- Will temporary shoring be required?
- Are there working hour restrictions?

MEASUREMENTS

LINEAR MEASUREMENTS

12 inches	1 foot	ft.
3 feet	1 yard	yd.
5½" yards	1 rod	rd.
40 rods	1 furlong	fur.
8 furlongs	1 mile	mi.

SQUARE MEASUREMENTS

144 square inches	1 square foot	sq. ft.
9 square feet	1 square yard	sq. yd.
30¼ square yards	1 acre	sq. rd.
160 square rods	1 acre	A.
640 acres	1 square mile	sq. mi.

ACRES

An acre equals 4,840 sq. yd. or 43, 560 sq. ft. In the form of a square, an acre is 208.71 yards on a side.

1,728 cubic inches (cu. in.)	1 cubic foot	cu. ft.
27 cubic feet	1 cubic yard	cu. yd.
128 cubic feet	1 cord	cd.
24¾ cubic feet	1 perch	P.

VOLUME: CUBIC YARDS

1 cu. yd.	27 cu. ft.	46,656 cu. in.

With water at its maximum density, 1 cubic foot weighs 62.427 lbs. and 1 gallon of pure water weighs 8.345 lbs.

For approximation: 1 cu. ft. of water is considered equal to 7½" gallons, and 1 gallon weighs 8-1/3 lbs.

The British Imperial Gallon (both liquid and dry) contains 2777.274 cu. in = 16046 cu. ft., and is equivalent to the volume of 10 lbs. of pure water at 650 F.

MEASURING BUILDING GROSS FLOOR AREA

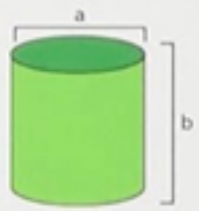
Use the following steps to measure the Gross Floor Area:

Step 1: Go around the building perimeter and measure areas from the exterior wall corners.
Step 2: Find out how many individual floors the job has (basement, main floor, upper floors etc.)
Step 3: Subdivide each floor into smaller segments that are easier to measure.
Step 4: Break down the areas into common shapes, such as rectangles, squares, triangles, circles & semicircles.
Step 5: Calculate the area of each shape separately and total them to the area for each floor.
Step 6: Add the areas of each floor to get the total building gross area.

TERM ALERT!

* **Takeoff:** taking the information off the documents and translating it into a list of items with quantities.

VOLUMES



$V = 3.1416 \times a/2 \times a/2 \times b$
$= 0.7854 \times a^2 \times b$

$V = 1/3 \times a \times b \times c$

$V = 1.0472 \times b^2 \times c$
or $V = 0.3518 \times a^2 \times c$

QUANTITY TAKEOFF PROCEDURE – 3 STEPS

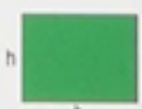
Step 1: Define takeoff scope.
- Study the plans and specs.
- Determine what needs to be taken off.

Note: If details are unclear in the plans and specs, ask the architect or owner for clarification.

Step 2: Measure each item.
- Use the dimensions specified.
- Do not scale drawing, unless necessary.
- Mark the drawings for the items that were taken off as they are taken off.

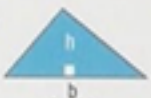
Step 3: Record quantities.
- Make detailed reference as to which sheet the items were found in and where they exist in the building.
- Record the quantities with drawing number, detail number and grid reference.
- Keep different items separate.

AREA FORMULAS

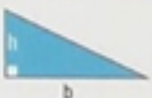


$A = bh$

$A = bh$

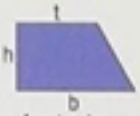


$A = \frac{bh}{2}$



$A = \frac{bh}{2}$

$A = s^2$



$A = \frac{t + b}{2} h$

$A = \pi r^2$ or $A = \frac{\pi d^2}{4}$

INFO YOU MUST KNOW!

- Takeoffs are concerned solely with materials.
- Takeoffs don't include the cost of installation or placement of materials.

ESTIMATING SITEWORK - DEMOLITION & EARTHWORK

ESTIMATING DEMOLITION

The earthwork contractor can include site demolition in the quote, but they typically don't include interior selective demolition.

ESTIMATING IN-PLACE, LOOSE & COMPACTED YARDS

To estimate earthwork, you will need to know the following 3 terms:

- **In-place yards:** the original volume of natural soils before disturbance; also called bank yards.
- **Loose yards:** the increased volume of loose soils after digging.
- **Compacted yards:** the decreased volume of soil after it is backfilled and compacted.

1.0 cubic yard (in-place yard)
= 1.2 cubic yard (loose yard)
= 0.85 compacted yard.

ESTIMATING DEMOLITION CHECKLIST

Use the following checklist for demolition takeoff (with measurement units):

- ☐ Demolish existing building (sf or l/s)
- ☐ Remove trees (ea)
- ☐ Remove fence (lf)
- ☐ Saw cut (lf)
- ☐ Remove asphalt paving (sy or cy)
- ☐ Remove curb (lf or cy)
- ☐ Remove concrete slabs and sidewalks (sf)
- ☐ Demolish concrete foundation, column, beams and staircases (cy)
- ☐ Demolish floors, walls, ceilings and roofs with finishes (sf)
- ☐ Demolish structural steel columns, beams and joists (ea)
- ☐ Demolish doors, windows, millwork, specialty items (ea)
- ☐ Cutting and patching (l/s)
- ☐ Temporary fencing (lf)
- ☐ Temporary partitions (sf)
- ☐ Shoring and engineering (l/s)
- ☐ Hazardous material removal (l/s)
- ☐ Dumping (l/s, cy or tons)

ESTIMATING EARTH - WORK CHECKLIST

Use the following checklist for earthwork takeoff (with measurement units):

- ☐ Clear and grub (acres)
- ☐ Dewatering (l/s)
- ☐ Topsoil removal (cy)
- ☐ Excavation (cy)
- ☐ Rough grading (sy)
- ☐ Shoring or underpinning (l/s)
- ☐ Backfill (cy)
- ☐ Import fill (cy)
- ☐ Place and compact (cy)
- ☐ Soil stabilization (l/s)
- ☐ Building foundation excavation (cy)
- ☐ Mechanical and electrical excavation (cy)
- ☐ Building slab prep (cy)
- ☐ Haul away and disposal (cy)
- ☐ Soil testing (l/s)
- ☐ Jacking, boring and piling (lf)
- ☐ Support and protection (l/s)
- ☐ Silt fence or turbidity barrier (lf)

COMMON UNIT ABBREVIATIONS

ABBREV.	MEANING
bf	board feet
cf	cubic foot
cy	cubic yard
ea	each
ft	feet
lb	pound
lf	linear foot
l/s	lump sum
sf	square foot
sfca	square foot of contact area
sy	square yard
sq	square

Unit abbreviation save time and help to clarify the meaning of takeoff quantities

Design Mix:

M10 (1 : 3.92 : 5.62)

Cement	:	210 Kg/ M^3
20 mm Jelly	:	708 Kg/ M^3
12.5 mm Jelly	:	472 Kg/ M^3
River sand	:	823 Kg/ M^3
Total water	:	185 Kg/ M^3
Fresh concrete density:		2398 Kg/M^3

M20 (1 : 2.48 : 3.55)

Cement	:	320 Kg/ M^3
20 mm Jelly	:	683 Kg/ M^3
12.5 mm Jelly	:	455 Kg/ M^3
River sand	:	794 Kg/ M^3
Total water	:	176 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2430 Kg/ M^3

M25 (1 : 2.28 : 3.27)

Cement	:	340 Kg/ M^3
20 mm Jelly	:	667 Kg/ M^3
12.5 mm Jelly	:	445 Kg/ M^3
River sand	:	775 Kg/ M^3
Total water	:	185 Kg/ M^3
Admixture	:	0.6%
Fresh concrete density:		2414 Kg/ M^3

Note: sand 775 + 2% moisture, Water 185 -20.5 = 164 Liters,
Admixture = 0.5% is 100ml

M30 (1 : 2 : 2.87)

Cement	:	380 Kg/ M^3
20 mm Jelly	:	654 Kg/ M^3
12.5 mm Jelly	:	436 Kg/ M^3
River sand	:	760 Kg/ M^3
Total water	:	187 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2420 Kg/ M^3

Note: Sand = 760 Kg with 2% moisture (170.80+15.20)

M35 (1 : 1.79 : 2.57)

Cement	:	410 Kg/ M^3
20 mm Jelly	:	632 Kg/ M^3
12.5 mm Jelly	:	421 Kg/ M^3
River sand	:	735 Kg/ M^3
Total water	:	200 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2400 Kg/ M^3

Note: sand = 735 + 2%, Water = 200- 14.7 = 185.30,
Admixture = 0.7%

M40 (1 : 1.67 : 2.39)

Cement	:	430 Kg/ M^3
20 mm Jelly	:	618 Kg/ M^3
12.5 mm Jelly	:	412 Kg/ M^3
River sand	:	718 Kg/ M^3
Water Cement ratio	:	0.43
Admixture	:	0.7%

Note: Sand = 718 + Bulkage 1%

M45 (1 : 1.58 : 2.26)

Cement	:	450 Kg/ M^3
20 mm Jelly	:	626 Kg/ M^3
12.5 mm Jelly	:	417 Kg/ M^3
River sand	:	727 Kg/ M^3+ Bulkage 1%
Water Cement ratio	:	0.43
Admixture	:	0.7%

M50 (1 : 1.44 : 2.23)

Cement	:	450 Kg/ M^3
20 mm Jelly	:	590 Kg/ M^3
12.5 mm Jelly	:	483 Kg/ M^3
River sand	:	689 Kg/ M^3 + Bulkage 12%
Water Cement ratio	:	0.36 (188 Kg)
Admixture	:	1.20%3
Micro silica	:	30 Kg

Super flow 6.7% of cement

WEIGHT OF MATERIALS

50 mm J bolt	:	751 No's / 52 Kg
40 mm J bolt	:	883 No's / 54 Kg
2" nails	:	385 No's / Kg
3" nails	:	118 No's / Kg
4" nails	:	72 No's / Kg
Binding wire	:	170 rings /Kg

SIMPLEX FORMULA:-

U = (N /L) x {(W x H) / (1 + S)} x Sq.rt {(L/50)}

U	=	Ultimate load in tones
N	=	Number of blows
L	=	Pile length in feets
W	=	Weight of hammer in tones
H	=	Height of fall in feet.
S	=	Set for 1 blows in Inch

Safe load = (ultimate load/ 2.5)
Factor of safety = 2.5
10 blows = below 10 MM

Thread couplers:- (For Column lapping)

Couplers for reinforcing bars 20 mm to 28 mm crimped sleeve

Slump IS 456

Lightly reinforced 25 – 75 mm

Heavily reinforced 75 – 100 mm

Trench fill (insitu & Tremie) 100 – 150 mm

(For Termie vibrator not required)

Durability:-

- The Environment
- Cover to Steel
- Type and quality of the constituent material
- Cement content and Water Cement ratio.
- Workmanship to obtain full compaction.
- Compaction and efficient curing.

Accuracy of measuring equipment in batching plant.

Cement	:	$\pm$ 2%
Aggregate	:	$\pm$ 3%
Admixture	:	$\pm$ 3%
Water	:	$\pm$ 3%
Mixing time	:	2 minutes for one mixing.(site Mixing)

TOLERANCE:-

Form work:-

In C/S for columns & Beams deviation is	= + 12mm more (or) - 6mm less in size
In footing plan	= + 50 mm more (or) – 12 mm less size
In depth	= $\pm$ 0.05 D (specified thickness).

Reinforcement:-

For effective depth D $\leq$ 200mm	= $\pm$ 10mm
For effective depth D > 200mm	= $\pm$ 15mm
For Cover to reinforcement	= + 10mm

Maximum freefall of concrete = 1.50 m height.

TOLERANCE ON DIA IN LENGTH:-

0-25mm	= ± 0.5 %
25-35mm	= ± 0.6 %
35-50mm	= ± 0.8 %

TOLERANCE ON WEIGHT PER METRE:-

0-10mm	= ±7%
10-16mm	= ± 5%
16 and above	= ± 3%

TOLERANCE FOR CUTTING LENGTH :-

A) When the specified length is not given = + 75mm (or) – 25 mm

B) When the min. length is specified = + 50 mm (or) – 0 mm

GENERAL:-

- Lapping is not allowed for the bars having diameters more than 36 mm.
- Chair spacing maximum spacing is 1.00 m (or) 1 No per 1 Sq.m
- For dowels rod minimum of 12 mm dia should be used.
- Chairs minimum of 12 mm dia bars to be used.
- Longitudinal reinforcement not less than 0.8% and more than 6% of gross C/S.
- Minimum bars for square column is 4 No's and 6 No's for circular column.
- Main bars in the slabs shall not be less than 8 mm (HYSD) or 10 mm (Plain bars) and the distributors not less than 8 mm and not more than 1/8 of slab thickness.
- Minimum thickness of slab is 125 mm
- Dimension tolerance for cubes ± 2 mm.
- Free fall of concrete is allowed maximum to 1.50m.
- Lap slices not be used for bar larger than 36 mm.
- Water absorption not more than 15 %.
- PH value of the water should not be less than 6.
- Compressive strength of Bricks is 3.5 N / mm^2
- In steel reinforcement binding wire required is 8 kg per MT
- In soil filling as per IS code 100 sqm should take 3 sample for core cutting test

DENSITY OF MATERIALS:-

Weight of Bricks	= 1600-1920 Kg/M^3
Weight of Block work	= 1920 Kg/M^3
Weight of R.C.C	= 2310 – 2700 Kg/M^3

CURING:-

Super Sulphate cement	: 7 days
Ordinary Portland cement OPC	: 10 days
Minerals & Admixture added cement	: 14 days

STRIPPING TIME (De-Shuttering):-

For columns, walls, vertical form works	: 16-24 hrs
Soffit formwork to slabs	: 3 days (props to be refixed after removal)
Soffit to beams props	: 7 days props to refix after removal.
Spanning up to 4.50m	: 7 days
Spanning over 4.50m	: 14 days
Arches spanning up to 6m	: 14 days
Arches spanning over 6m	: 21 days

CUBE SAMPLES:-

1 – 5 M^3	:	1 No.
6 – 15 M3	:	2 No's
16 – 30 M^3	:	3 No's
31 – 50 M^3	:	4 No's
Above 50 M^3	:	4 + 1 No of addition sample for each 50 M^3

TEST RESULTS OF SAMPLES:-

The test results of the samples shall be the average of the strength of three specimens.

The individual variation should not be more than $\pm$ 15 % of the average.

If more the results of the sample are invalid.

COMPRESSIVE STRENGTH:-

3 days	:	45 %
7 days	:	67 – 70 %
14 days	:	85 %
28 days	:	100% +

APPROXIMATE COST PER SQ.FT (MANTRI PROJECT)

HIGH RISE BUILDING:-

Structure (Concreting, Block work, Plastering, Flooring, Dado, painting)	= 979 / Sft
Electrical works (Modular switches)	= 172 / Sft
Plumbing (P.H.E)	= 93 / Sft
Fire Fighting	= 13 / Sft
Lift	= 34 / Sft
Common Area	= 94 / Sft
External development (Landscape, road works, drains etc.,)	= 87 / Sft

TEST FOR SILT & CLAY:-

- Take 200 ml measuring cylinder fill sand up to 100ml mark
- Add 150ml of water and shake well
- Allow it to settle for 3 hrs.
- Measure the total height and height of clay.
- Calculate the clay and silt in total sand
- Clay and Silt should not exceed 3% by weight (or) 8-10% by volume
- For crushed sand Clay and Silt should not exceed 15% by weight

ORGANIC IMPURITIES:-

- Don’t dried the specimen before testing
- Take 250 ml measuring cylinder.
- Add 75 ml of water with 3% of Sodium Hydroxide. Fill sand layer to 125 ml
- Make the volume up to 200ml by adding more of sodium hydroxide solution
- Shake well allow it to stand for 24 hrs
- If the solution becomes darker than straw yellow colour then the sand has to be tested for further by casing mortar cubes for 7 & 28 days is not less than 95%.

- If the solution is lighter or just straw yellow colour the sand can be used for concreting without any further test.

QUANTITIES REQUIRED:-

Plastering (CM 1:3)	= 1.50 bags / 10 m^2
Plastering (CM 1:5)	= 1.05 bags / 10 m^2
Ceiling Plastering (CM 1:3)	= 48 kg / 10 m^2
Brick work (CM 1:5)	= 86 Kg / 10 m^3
Brick work (CM 1:6) 9" thick	= 80.64 Kg / 10 m^3
Brick work (CM 1:3) 4½" thick	= 15.46 Kg / 10 m^3
Lime for white washing	= 10 Kg/100 m^2
Painting	= 10 ltr/ 100 m^2
Distemper 1st coat	= 6.5 Kg / 100 m^2
Distemper 2nd coat	= 5.0 kg / 100 m^2
Snowcem 1st coat	= 30 Kg / 100 m^2
Snowcem 2nd coat	= 20 Kg / 100 m^2
Paint ready mixed one coat	= 10 ltr / 100 m^2
Weathering Course	= 7.68 Kg / m^2
Flooring	= 8.10 kg / m^2
Pressed tiles for weathering course (CM 1:3)	= 7.68 Kg / 10 m^2
Granolithic floor finish	= 8.10 Kg / 10 m^2

WATER CEMENT RATIO:-

M20	=	0.55
M25	=	0.50
M30	=	0.45
M35	=	0.45
M40	=	0.40

SPACING OF BARS:-

- Provide the dia of the bar, if the dia of the bar are equal.
- Provide the dia of the larger bar, if the dia are unequal.
- 5mm more than the nominal maximum size of the coarse aggregate.

CONVERSION:-

1 Acre = 4046.72 m^2

1 cent = 40.4672 m^2

COVER TO MAIN REINFORCEMENT:-

Column	:	40 mm (D>12mm)
Column	:	25 mm (D= 12mm)
Beam	:	25 mm
Slab	:	15 mm (or) not less than dia of the bar.
Footing	:	50 mm
Sunshade (Chajja)	:	25 mm

CO-EFFICIENT FOR PAINTING:-

Partly paneled and glazed doors	: 0.80 times the door or window area.
Collapsible gates	: 1.50
Corrugated sheeted steel doors	: 1.25
Rolling shutters	: 1.10
Expanded metal hard drawn steel	: 1.00
Open palsied fencing and gates, brace, rails	: 1.00
Corrugated iron sheeting	: 1.14
A.C corrugated sheeting	: 1.20
A.C Semi corrugated sheeting	: 1.10
Wire gauged shutters	: 1.00
Paneled framed and braced doors, windows	: 1.30
Ledged and battened doors and windows	: 1.30
Flush doors	: 1.20
Partly paneled doors	: 1.00
Fully glazed doors	: 0.80
Fully louvered	: 1.80
Trellis work	: 2.00
Curved or enriched	: 2.00
Weather boarding	: 1.20
Wooded single roofing	: 1.10
Boarding with cover tilets and match boarding	: 1.05
Tile and slate battering	: 0.80

Plain sheeted steel : 1.10

Fully glazed steel : 0.50

Calculation of Materials:-

a) For 1 m^3 of concrete Mix 1:2:4 (M15)

Add 50% for wet concrete = 1.50 m3

= 1.50/(1+2+4) = 0.214 m^3

For 1 m^3 = 30 bags of cement required (1440/50) say 30 bags

Cement = 0.214 x 30 = **6.42 bags**

Sand = 0.214 x 2 = **0.428 m^3**

Aggregate = 0.214 x 4 = **0.856 m^3**

b) Wall plastering in CM 1:4 of 12 mm thick for 100 m^2:-

Volume = 100 x (12/1000) = 1.20 m^3

Add 30 to 35% as bulking of sand = 0.36 m^3

Add 20 as wastage of sand = 0.312 m^3

Total = **1.872 m^3**

= (1.872/1+4) = 0.374 m^3

Cement = 0.374 x 30 = **10.77 bags**

Sand = 0.374 x 4 = **1.496 m^3**

c) For 100 m^3 of solid Block masonry in CM 1:6 mix 8" thick:-

Volume = 100 x 0.2 (Thickness of wall)
= 20 m^3

No. of blocks required = 20/(0.4 x 0.2 x 0.2)
= 12502 No's

Volume of mortar = 20-{0.39 x 0.19 x 0.19 x 1250}
= 20 – 17.598
= 2.40 m^3

Note: 200mm – 10 mm for mortar thickness = 190 mm

Blocks =17.598/(0.4 x 0.2 x 0.2)
=1100 No's
Add 2% wastage = 22
Total = 1122 No's

Increase by 25% for dry mortar = 3 M^3

= 3/ (1+6)
= 0.429 M^3

Cement = 0.429 x 30 = 12.50 bags
Sand = 0.429 x 6 = 2.57 M^3
Blocks =1122 No's

STEEL:-

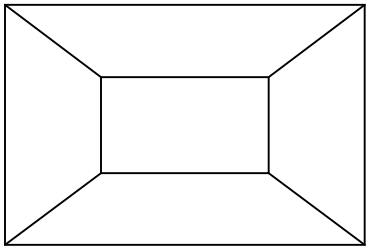
- Weight of rod per meter length = $\mathbf{d^2 / 162}$ where d in mm
- "L" for column main rod in footing is minimum of **300mm**
- Hook for stirrups is **9D** for one side
- For Cantilever anchorage length for main steel is **69D**
- No. of stirrups = (clear span/Spanning) + 1
- Design strength is M 40, target strength is 1.25 x 40 = **50 Mpa**

TRAPEZOIDAL FOOTING FORMULA:-

Volume, **V = (L x B x D) = H/3{A1 + A2 + sq.rt (A1+A2)}**

Where A1 = L x B

A2 = l x b
H = D-d (Overall depth of footing – depth of Rectangular footing)



THEROTICAL WEIGHT:-

Cement	=	1440 Kg/m^3
Steel	=	7850 Kg/m^3
Bricks	=	1600 – 1920 Kg/m^3
1 HP	=	745.7 watts

WEIGHT OF ROD PER METER LENGTH:-

DIA		**WEIGHT PER METER**
6mm	=	0.222
8mm	=	0.395
10mm	=	0.616
12mm	=	0.888
16mm	=	1.578
20mm	=	2.466
25mm	=	3.853
32mm	=	6.313
40mm	=	9.865

CMENT REQUIREMENTS:-

M10	:	210 Kg
M20	:	320 Kg

M25 : 340 Kg
M30 : 380 Kg
M35 : 410 Kg
M40 : 430 Kg
M45 : 450 Kg
M50 : 450 + M.S 7.5%

General Notes for civil Engineering

- Electrical conduits shall not run in column
- Earth work excavation for basement above 3 m Should be stepped form
- Any Back filling shall be compacted 95% of dry density at the optimum moisture content and in layers not more than 200mm for filling above structure and 300 mm for no structure
- F SOLING IS SPECIFIED THE SOLING STONES SHALL BE LAID AT45° TO 60° INCLINATION (AND NOT VERTICAL) WITH INTERSTICES FILLED WITH SAND OR MOORUM.
- Y REPRESENTS TOR STEEL GRADE - Fe-415 OF IS:1786. WITH CHARECTERISTIC YIELD STRENGTH OF 415 N/MM MINIMUM.
- Ø REPRESENTS MILD STEEL GRADE - 1 OF IS:432 (PART-1)
- ALL REINFORCEMENT SHALL BE FREE FROM MILL SCALES, LOOSE RUST & COATS OF PAINTS, OIL OR ANY OTHER SUBSTANCES.
- BY PROVIDING PROPER COVER BLOCKS, SPACERS, CHAIRS ETC.. ALL REINFORCEMENT SHALL BE PLACED AND MAINTAINED IN POSITION AS SHOWN IN STRUCTURAL DRAWING
- CEMENT SHALL BE 43 GRADE ORDINARY PORTLAND CEMENT CONFORMING TO IS:8112 OR53 GRADE ORDINARY PORTLAND CEMENT CONFORMING TO IS:12269-1987.

- CEMENT SHALL BE STORED IN DRY PLACES ON A RAISED PLATFORM ABOUT 200mm ABOVE FLOOR LEVEL AND 300mm AWAY FROM WALLS. BAGS TO BE STACKED NOT MORE THAN 10 BAGS HIGH IN SUCH A MANNER THAT IT IS ADEQUATELY PROTECTED FROM MOISTURE AND CONTAMINATION.

- WATER USED FOR BOTH MIXING AND CURING SHALL BE CLEAN AND FREE FROM INJURIOUS AMOUNTS OF OILS, ACIDS, ALKALIS, SALTS, SUGAR AND ORGANIC MATERIALS OR OTHER SUBSTANCES THAT MAY BE DELETERIOUS TO CONCRETE OR STEEL. THE pH SHALL BE GENERALLYBETWEEN 6 AND 8.

- CEMENT SHALL BE TESTED FOR ITS SETTING.

1. THE INITIAL SETTING TIME SHALL NOT BE LESS THAN 30 MINUTES.

2. THE FINAL SETTING TIME SHALL NOT BE MORE THAN 10 HOURS.

- SAMPLES FROM FRESH CONCRETE SHALL BE TAKEN AND AT LEAST A SET OF 6 CUBES OF 150mm SHALL BE PREPARED AND CURED. 3 CUBES EACH AT 7 DAYS AND 28 DAYS SHALL BE TESTED FOR COMPRESSIVE STRENGTH. THE TEST RESULTS SHOULD BE SUBMITTED TO ENGINEER FORAPPROVAL. IF RESULTS ARE UNSATISFACTORY NECESSARY ACTION/RECTIFICATION/REMEDIAL MEASURES HAS TO BE EXERCISED.
- A SET OF CUBE TESTS SHALL BE CARRIED OUT FOR EACH 30 Cum OF CONCRETE / EACH LEVELS OF CASTING / EACH BATCH OF CEMENT.
- WATER CEMENT RATIO FOR DIFFERENT GRADES OF CONCRETE SHALL NOT EXCEED 0.45 FOR M20 AND ABOVE AND 0.50 FOR M10 / M15 CONTRACTOR / MIX DESIGNER TO CARRY OUT THE NECESSARY INITIAL (PRELIMINARY) TESTS. FOR CONCRETE GRADES M20 AND ABOVE APPROVED ADMIXTURE SHALL BE USED AS PER MIX DESIGN REQUIREMENTS.

CONCRETE COVER

- CLEAR COVER TO MAIN REINFORCEMENT IN
    1. FOOTINGS : 50 mm
    2. RAFT FOUNDATION.TOP : 50 mm
    3. RAFT FOUNDATION.BOTTOM/SIDES : 75 mm
    4. STRAP BEAM : 50 mm
    5. GRADE SLAB : 20 mm
    6. COLUMN : 40 mm
    7. SHEAR WALL : 25 mm
    8. BEAMS : 25 mm
    9. SLABS : 15 mm
    10. FLAT SLAB : 20 mm
    11. STAIRCASE : 15 mm
    12. RET. WALL on earth : 20/ 25 mm
    13. WATER RETAINING STRUCTURES : 20 / 30 mm
- CONTRACTOR SHALL ALLOW FOR INDEPENDENT TESTING OF REINFORCEMENT STEEL FOR EACH DIA OF BAR FOR EVERY 50T AND AT CHANGE OF SOURCE.
- ALL BEAM REINF. TO BE ANCHORED FOR A MINIMUM LENGTH OF 46 x DIA OF BAR INTO COL / SUPPORTING BEAM U.N.
- BINDING WIRES SHALL BE 16 GUAGE 1.6mm SOFT ANNEALED STEEL WIRES FREE FROM RUST AND OTHER CONTAMINANTS.
- CONCRETE DESIGN MIX REPORT.
    1. CONCRETE DESIGN MIX REPORT ALONG WITH THE TEST RESULTS FOR CONCRETE CUBES SHALL BE

SUBMITTED IN ADVANCE FOR APPROVAL BEFORE RELEVANT CONCRETING. AND THE MINIMUM CEMENT CONTENT SHALL BE NOT LESS THAN 300 Kg/m

2. SLUMP SHALL BE 100 + 25mm.

- POURING OF CONCRETE.
  NO CONCRETING OPERATION SHALL BE CARRIED OUT DURING INCLEMENT WEATHER CONDITIONS LIKE HEAVY RAIN, STORM AND HIGH WINDS.

REPAIRS

- CONCRETE REPAIRS IN ANY STRUCTURAL ELEMENTS SHALL BE CARRIED OUT ONLY AFTER INSPECTION AND AS PER THE APPROVED METHOD. CONTRACTOR TO SUBMIT DETAIL METHOD STATEMENT FOR ENGINEER'S REVIEW AND RESPONSE
- CONCRETE FLOOR SCREED SHALL BE IN PANELS OF 3M x 3M WITH JOINTS SEALED WITH SEALANT TO MATCH WITH JOINTS IN SLAB. LOCATIONS TO BE APPROVED BY ENGINEER PRIOR TO CONCRETING.
- ALL CONCRETING MUST STOP AT A SHUTTERED SURFACE ONLY.
- AT ALL CONSTRUCTION JOINTS THE REINFORCEMENT SHALL BE CONTINUOUS.
- CONSTRUCTION JOINT IN RETAINING WALLS & WATER TANK SHALL BE PROVIDED WITH AN APPROVED SEALANT
- ALL DEEPER EXCAVATION BELOW THE GROUND LEVEL SLAB SHALL BE RETAINED BY A LOCALIZED SOIL AND WATER RETENTION SYSTEM, AS MAY BE RETAINED BY A LOCALIZED SOIL AND WATER RETENTION SYSTEM, AS MAY BE
- DEWATERING BY SUITABLE MEANS TO BE ADOPTED (ENSURING NO FINES ARE DRAWN OUT) TO KEEP THE FOUNDING STRATA COMPLETELY DRY AND SHALL BE CONTINUED UNTIL THE GROUND FLOOR SLAB / BEAMS ARE CAST AND CURED TO ACHIEVE SPECIFIED DESIGN STRENGTH.
- CEMENT PROPORTION: CONCRETE MIX IN ABOVE SUCH FOUNDATIONS SHALL CONTAIN 10 PERCENT EXTRA CEMENT THAN SPECIFIED.
- AT LOCATIONS OF ISOLATION / EXPANSION JOINT PROVIDE POLYSULPHIDE SEALANT WITH BACKER ROD POLYSTYRENE BOARDS.
- NO THROUGH BOLTS SHALL BE USED IN FORMWORK OF RETAINING WALL. AND WATER TANK WALLS.

FOUNDATIONS

- ALL LOOSE POCKETS AND SOFT SPOTS ARE TO BE FILLED IN MASS CONCRETE OF GRADE M-10.
- BACK FILLING BEHIND THE RETAINING WALL SHALL BE CARRIED OUT ONLY AFTER THEGROUND FLOOR SLAB IS CAST AND HAS ATTAINED DESIGN STRENGTH.

- THE SPACE BETWEEN HARD STRATA (TO ACHIVE A MINIMUM OF 25 MT/M2) AND BOTTOM OF RAFT/ FOUNDATION SHALL BE FILLED WITH PLUM CONCRETE.
- SIZE STONE MASONRY SHALL BE IN CM 1:6 UNLESS SPECIFIED OTHERWISE.
- CONTINUOUS WALL FOUNDATION SHALL BE STEPPED IN A RATIO OF 1 VERTICAL TO 2 HORIZONTAL WHEREVER LEVEL CHANGES ARE NECESSARY.
- SLOPED PORTION TO BE FINISHED SMOOTH WITH TROVEL WITHOUT USING MORTAR. COLUMN PORTION TO BE FINISHED SMOOTH WITH CONCRETE.
- GRADE OF CONCRETE SHALL BE AS PER FOOTING SHEDULE/ RAFT DETAILS.

SUPER STRUCTURE

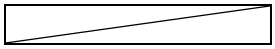
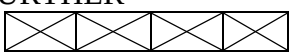
- ALL EXPOSED CORNERS OF COLUMNS AND BEAMS SHALL HAVE STRAIGHT EDGES AND SHALL BE CHAMPHERED IF SPECIFIED IN ARCHITECTURAL DRAWINGS.
- CONCRETING OF COLUMNS , BEAMS, FACIAS, AND THIN SECTIONS OF CONCRETE MEMBERS SHALL BE CARRIED OUT USING APPROVED PLASTICISER AS PER MANUFACTURERS SPECIFICATIONS.
- CONCRETE POURING , TESTING, REMOVAL OF FORMWORK AND ACCEPTANCE CRITERIA SHALL BE AS PER RELEVANT INDIAN STANDERD CODE OF PRACTICE.
- CENTERING OF CANTILEVER BEAMS AND SLAB PROJECTIONS SHALL NOT BE REMOVED UNLESS ROOF SLAB ABOVE IS CAST AND CURED AND SUFFICIENT BALANCING LOAD IS ATTAINED. PROVIDE PRE CAMBER TO CANT. BEAMS/SLABS
- BEFORE POURING FLOOR LEVEL CONCRETE, THE FLOOR SYSTEMS BELOW SHALL BE SUFFICIENTLY SUPPORTED BY MEANS OF PROPPING AND THIS SYSTEM SHALL BE APPROVED BY THE ENGINEER-IN-CHARGE.
- CONCRETE IN TOILET, KITCHEN, WATER BODY AREAS SHALL BE MIXED WITH APPROVED WATERPROOF COMPOUND AND WATERPROOFING OVER SLABS AND SIDES OF WALLS SHALL BE DONE AS PER ARCHITECTURAL DETAILS.
- CONTRACTOR SHALL CHECK ALL THE OPENINGS AS PER ARCHITECTURAL/SERVICE DRAWINGS AND SHALL PROVIDE NECESSARY TRIMMING BARS.NO ADDITIONAL OPENING SHALL BE DRILLED IN THE STRUCTURE UNLESS APPROVED.
- CONCRETE SHOULD BE PLACED IN THIN LAYERS WHICH CAN BE EFFECTIVELY COMPACTED AS THE PLACING PROCEEDS SAY IN 300mm.
- WHEN CASTING COLUMNS, WALLS OR BEAMS OF DEPTH 700mm OR MORE, A LAYER OF RICH CEMENT MORTAR SHOULD BE PLACED FIRST. THIS IS TO AVOID ACCUMULATION OF GRAVEL IN THE BOTTOM LAYER AND TO HAVE A BETTER BOND.
- COMPACTION OF CONCERTE SHALL BE DONE BY MECHANICAL VIBRATORS. PROPER CARE SHALL BE TAKEN TO AVOID SEGGREGATION AND HONEYCOMBING.

- CONTRACTOR SHALL SUBMIT SHOP DRAWINGS INCLUDING BAR BENDING SCHEDULE FOR APPROVAL PRIOR TO TAKING UP OF CONSTRUCTION.
- THE SECONDARY BEAM BARS SHALL BE PLACED OVER MAIN BEAM BARS WHEN THE DEPTH OF BEAMS ARE SAME AT JUNCTIONS.
- SHORT SPAN STEEL SHALL BE AT BOTTOM LAYER IN TWO WAY SLAB SYSTEM AND SPACERS BAR, CHAIRS TO TOP STEEL SHALL BE PROVIDED WITH ADEQUATE COVER.
- NO SPLICING OF BARS SHALL BE MADE AT THE POINT OF MAXIMUM TENSILE STRESSES.
- FOR SPLICES OF REINFORCEMENT, MINIMUM LAP LENGTH FOR BARSSHALL BE 50 X DIA OF BAR.
- NOT MORE THAN 1/3 OF MAIN REINFORCEMENT SHALL BE LAPPED AT ANY SECTION.
- SPLICES IF UN AVOIDABLE, MUST BE LOCATED FROM FACE OF THE COLUMN AT NOT CLOSER THAN TWICE THE BEAM DEPTH.
- SPLICES IN BEAMS SHALL BE CONTAINED BY ADDITIONAL STIRRUPS AT A SPACING NOT EXCEEDING 150MM OVER THE ENTIRE LENGTH OF SPLICES.
- STIRRUPS SHALL BE CLOSED TYPE WITH ENDS HOOKED AT 135 WITH 10 X BAR DIA EXTENSION (BUT NOT LESS THAN 75MM).
- SPACING OF STIRRUPS SHALL NOT EXCEED 200MM.

COLUMNS

- CONCRETE MIX SHALL BE AS PER SCHEDULE OF COLUMNS.
- P.V.C COVER BLOCKS TO BE USED WITH PRIOR APPROVAL OF ENGINEER.
- RINGS TO BE PROVIDED FOR FULL LENGTH OF MAIN RODS TOPREVENT DISLOCATION OF MAIN BARS WHILE CONCRETING, AT A SPACING AS SPECIFIED IN THE SHEDULE.
- Ld SHALL BE

1. M25 AND ABOVE 46 x DIA

- COLUMN STARTER TO BE SET BY TEMPLATE AND SHALL BE PROVIDED WITH NEXT HIGHER GRADE OF CONCRETE MIX OF COLUMNS.
- BEAM BOTTOM LEVELS ARE TO BE MARKED ON COLUMN RODS AND COLUMN TO BE STOPPED AT THIS LEVEL TO AVOID EXTRA SHUTTERING OF COLUMNS BELOW BEAM BOTTOMS.
-  INDICATES COLUMNS CONTINUING FURTHER
-  INDICATES COLUMNS STOPPING AT THIS LEVEL.

DESHUTTERING TIME

- IN NORMAL CIRCUMSTANCES WHERE AMBIENT TEMP. DOES NOT FALL BELOW 15 C & WHERE ORDINARY PORTLAND CEMENT IS USED & ADEQUATE CURING IS DONE. FOLLOWING STRIPPING TIME MAY DEEM TO SATISFY.

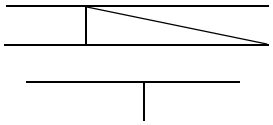
  i. VERTICAL FORMWORK TO COLUMNS, WALLS, BEAMS - 16 TO 24HRS
  ii. SOFFIT FORMWORK TO SLABS(PROPS TO BE REFIXED IMMEDIATELY AFTER REMOVAL OF FORMWORK) - 3 DAYS
  iii. SOFFIT FORMWORK TO BEAMS(PROPS TO BE REFIXED IMMEDIATELY AFTER REMOVAL OF FORMWORK) - 7 DAYS

- PROPS TO SLABS:
  a) SLABS SPANNING UPTO 4500 mm - 7 DAYS
  b) SLABS SPANNING OVER 4500 mm - 14 DAYS
- PROPS TO BEAMS AND ARCHES:
  a) BEAMS SPANNING UPTO 6000 mm - 14 DAYS
  b) BEAMS SPANNING ABOVE 6000 mm -21 DAYS

ROOF LEVEL CONCRETE.

FLOOR SHUTTERING LEVELS TO BE AS PER ARCHITECTURAL DRAWINGS. THE SHUTTERING SHOULD BE LEVELLED AND CONTAIN NO VOIDS TO PREVENT SLURRY LEAKAGE. THE EXTERNAL SHUTTERING TO BE MORE IN HEIGHT BY 75 mm THAN REQUIRED. DIAGONALS OF EACH RECTANGALES / SQUARES SHALL BE CHECKED.

- REINFORCEMENT FOR SLABS SHOWN THUS



AT TOP

AT BOTTOM

- DISTRIBUTION REINFORCEMENT FOR SLAB TOP RODS SHALL BE Y8@225CC UNLESS SPECIFIED OTHERWISE IN RELEVANT DRAWING

PIN RODS/CHAIRS

- SECOND LAYER AND THIRD LAYER REINFORCEMENT IN BEAMS TO BE TIED WITH PIN RODS OF Y20 / Y25 ONLY.
- CHAIRS TO BE PROVIDED TO SUPPORT TOP REINFORCEMENT IN SLABS USING SUITABLE DIA BARS WITH APPROVAL OF ENGINEER-IN-CHARGE

CONSTRUCTION JOINTS

- CONSTRUCTION JOINTS IN SLABS AND BEAMS ARE OFTEN PLACED EITHER AT POINT OF CONTRAFLEXTURE IN WHICH CASE THE CONCRETE MAY BE LEFT SLOPED OFF OR STEPPED OFF BY MEANS

OF STOP FORMS.CONSTRUCTION JOINTS LOCATED NEAR MINIMUM SHEAR SHALL HAVE STOP FORMS PERPENDICULAR TO THE ACTING FORCES. WHERE THE CONCRETE IS TO BE PLACED IN THE SECOND POUR, THE OLD CONCRETE SHALL BE THOROUGHLY ROUGHENED TO EXPOSE AGGREGATES.MOISTENED AND A LAYER OF RICH FRESH MORTAR SHOULD BE LAID MMEDIATELY BEFORE FRESH CONCRETE IS PLACED. IT SHOULD BE PLACED TO A THICKNESS OF 20 TO 30mm AND SHALL BE WORKED WELL INTO THE IRREGULARITIES OF HARDENED CONCRETE.

- ALL THE CONSTRUCTION JOINTS SHALL BE PRE-DETERMINED AS PER THE SEQUENCE OF OPERATION AND SHALL BE GOT APPROVED.
- CONSTRUCTION JOINTS SHALL BE IN ACCORDANCE WITH TYPICAL CONSTRUCTION JOINT DETAILS.
- EXPANSION JOINT DETAIL SHALL BE AS PER TYPICAL EXPANSION JOINT DETAILS.

CURING METHOD

- CURING OF SLABS AND BEAMS SHALL BE ACHIEVED BY PONDING ONLY, FOR A MINIMUM PERIOD OF 7 DAYS.
- CURING OF FOOTING TOPS,RCC WALLS,COLUMNS AND EXTERNAL BEAM FACES SHALL BE DONE BY COVERING THEM WITH GUNNY BAGS OR HESSIAN AND KEEPING WET CONSTANTLY FOR COMPLETE CURING PERIOD OF 7 DAYS.
- GROOVE CUTTING MACHINE SHALL BE USED FOR CHASING OF WALLS FOR ALL ELECTRICAL CONDUITS.
- 4" WIDE TO 7" WIDE EXPANDED METAL MESH SHALL BE USED BEFORE PLASTERING OF ALL CONDUIT CHASINGS IN WALLS.
- FOR COLUMN-WALL JUNCTIONS & BEAM-WALL JUNCTIONS 4" WIDE EXPANDED METAL MESH SHALL BE USED, BEFORE PLASTERING OF CONCRETE AND WALL JUNCTIONS.

WATER RETAINING STRUCTURE

- CONCRETE MIX M-25 SHALL BE USED FOR ALL WATER RETAINING STRUCTURE WITH 330Kg/CU.M OF CEMENT MINIMUM.UNLESS OTHERWISE SPECIFIED.
- DITCHTMENT D.M OR CONPLAST LIQUID ADMIXTURE SHALL BE USED WITH M-25 CONCRETE AT 150 ml PER BAG OF CEMENT.
- PLASTERING SHALL BE DONE WITH C.M 1:4 USING PUTZ DITCHMENT D.M OR CONPLAST LIQUID ADMIXTURE AT 150ml PER BAG OF CEMENT.

Thumb rule requirement of standard materials and standard calculation in high raised building

Steel	=3 to 5 kg / sft
Cement	=.5bags/ sft
RMC	=.05 m3/sft
Block	=12.5 nos /sqm
Electrical cast	= Rs 133/sft
Plumbing cost	= Rs 126/sft
Fire fighting cost	= Rs 40/sft
External development	= Rs 94.5/sft
Civil works-Structure	= RS 751.25/sft

Finishing works = RS 467.50/sft

200 mm in cm 1:6	.124Bags /sq*m*		
200 mm in cm 1:4		0.206	bags/sqm
150 mm in cm 1:6		0.093	bags/sqm
150mm in cm 1:4		0.144	bags/sqm
100 mm in cm 1:4		0.103	bags/sqm
Ceiling plastering		0.11	bags/sqm
Wall plastering		0.09	bags/sqm
Rough plastering		0.09	bags/sqm
Duct plastering		0.09	bags/sqm
External plastering		0.175	bags/sqm
lathen plastering		0.55	bags/sqm
stucco plaster		0.175	bags/sqm
100 mm plaster band		0.012	bags/rmt
pcc 1: 4: 8		3.4	bags/cum
pcc 1:5:10		2.52	bags/cum
pcc 1:3:6		4.2	bags/cum
pcc 1:2:4		6.02	bags/cum
230 mm brick		0.876	bags/cum
115 mm brick work		0.218	bags/cum
vdf 100 mm thick		0.82	bags/sqm
granolithic flo oring 40 mm		0.35	bags/sqm
granolithic flooring 20 mm		0.28	bags/sqm
anti-skid		0.28	bags/sqm
ceramic		0.28	bags/sqm
vertified tile flooring		0.28	bags/sqm
vertified tile dado		0.27	bags/sqm
cerami dado		0.27	bags/sqm
marble flooring		0.3	bags/sqm
100 mm heigh marble skerting		0.027	bags/rmt
marble glading		0.27	bags/sqm
terracota tle flooring		0.3	bags/sqm
mangalore tile		0.3	bags/sqm
Door frame fixing		0.17	bags/sqm
water proofing for sunken slab		0.23	bags/sqm
water proofing for walls		0.23	bags/sqm
water proofing for balcony/toilets		0.65	bags/sqm

- Ant terminate treatment chemical Name is chloropyrifoc 20% . Diluting 5 Lit of Chemical with 95 Lit of water and usage is 7.5 Sqm Per liter {Diluted} .To Provide 1" Dia hole And Deep1Foot.

Labour Productivity:

Brick work		1 mason 1 Men mazdoor 1 Women Mazdoor	1.25 cm
Wall Plastering		1 mason 1 Men mazdoor 1 Women Mazdoor	10 sqm
Ceiling Plastering		1 mason 1 Men mazdoor 1 Women Mazdoor	8 sqm
External Plastering		1 mason 1 Men mazdoor 1 Women Mazdoor	8 sqm
Blockk work	8"	1 mason 1 Men mazdoor 1 Women Mazdoor	10 sqm
Blockk work	6"	1 mason 1 Men mazdoor 1 Women Mazdoor	8 sqm
Blockk work	4"	1 mason 1 Men mazdoor 1 Women Mazdoor	8 sqm
Carpenter		1 Skilled 1 Un skilled	4 Sqm
Bar bender		1 Skilled 1 UN skilled	200Kg
Tile work		1 Mason 1M Mazdoor	10 Sqm
Painter skilled	OBD Emulsion	600 Sft 800 Sft	

Putty	600 Sft
Primer	800 Sft

One Sqm=10.763Sft
One Cum=35.314 Cft
One Acres=4046.873 Sqm=43560.17 Sft=4840.019Yards
One Cubic meter = 1000 litere
One Meter=3.280Feet
One Mile =1609.344 meter
One Acre = 100 cent
One ground =2400 Sft=5.51 cent
½ ground =2.75 cent
One Mile =8 Furlong
One cement bag=1.25 Cft

One Forma box =1*1*1.25 feet

External Painting

Ace-Low quality
Apex-Medium Quality
Apex ultima –High Quality

Interior walls

Darker shades may require an additional coat for proper hiding. The actual shade, especially for darker shades, can be observed only after the film is dry and not in the can or in the wet state.

Felt rolling is to be done only for Royale and Lustre finish. The darker shades are never to be felt rolled since this will cause foaming due to presence of more surfactants in them.

Solvent based paints (those using thinner other than water) should be given twice as long a drying time than given here in case of high humidity climate like monsoons.

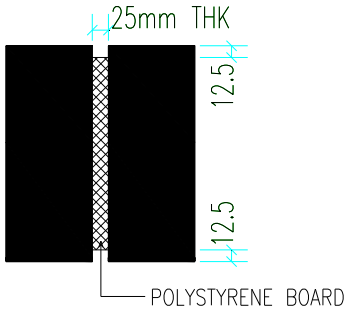
Putty can be applied to make the substrate smoother; however it has to be sandwiched between 2 coats of primer.

Recommeded dilution and application procedure for interior walls

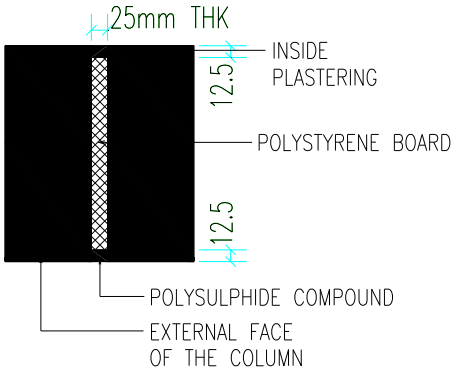
Sr. No.	Name of Paint	Thinner for 1 ltr/kg of paint In mls	Thinner	No of coats recommended and application	Undercoat applied	Recoating Time (hrs)
1	AP Apcolite	80 - 100	T - 101 or Mineral	2 - brushing	AP Decoprime Wall Primer(ST) or AP	8 - 10

	Premium Gloss Enamel		Turpentine Oil (MTO)		Metal primer (for metal surface) or AP Wood Primer (for wooden surface)	
2	AP Apcolite Premium Satin Enamel	150 - 200 350 - 400	T - 101 or MTO	2 - brushing 2 - spraying	AP Decoprime Wall Primer(ST) or AP Metal primer (for metal surface) or AP Wood Primer (for wooden surface)	6 - 8
3	AP Interior Wall Finish - Matt	70 - 90	T - 101 or MTO	2 - brushing Top coat rolling	AP Decoprime Wall Primer (ST)	8 - 10
4	AP Interior Wall Finish - Lustre	70 - 90	T - 101 or MTO	2 - brushing followed by rolling on every coat	AP Decoprime Wall Primer (ST)	8 - 10
5	AP Gattu Enamel	80 - 100	MTO	2 - brushing	AP Decoprime Wall Primer (ST) or AP Metal primer(for metal surface)or AP Wood Primer (forwoodensurface)	6 - 8
6	AP Luxury Ultra Gloss Enamel	60 - 100	MTO Or T - 101	2 - Brushing	AP Decoprime Wall Primer (ST) or AP Metal primer (for metal surface) or AP Wood Primer (for wooden surface)	8
7	AP Premium Semi - Gloss Enamel Water Based	150 - 250	Water	2 - Brushing 2 - Spraying	AP Decoprime Wall Primer (ST) or AP Metal primer (for metal surface) or AP Wood Primer (for wooden surface)	4 - 6
8	AP Royale Luxury Emulsion	400 - 450	Water	3 - for light shades and 4 - for dark shades. Brushing followed by rolling on every coat for scrap down / new job. Refinish jobs will have 1 coat lesser.	AP Decoprime Wall Primer (ST)	4
9	AP Premium Emulsion White Shades	600 - 700 500 - 600	Water	2 - for light shades. 3 - for dark shades Brushing followed by rolling of top coat.	AP Decoprime Wall Primer (ST) or AP Decoprime. Wall Primer (WT)	3 - 4

10	AP Tractor Emulsion	500 - 750	Water	2 - for light shades. 3 - for dark shades Brushing followed by rolling of top coat.	AP Decoprime Wall Primer (ST) or AP Decoprime Wall Primer (WT)	4
11	AP Tractor Acrylic Distemper	550 - 600	Water wt	2 - for light shades. 3 - for dark shades. Brushing followed by rolling of top coat.	AP Decoprime Wall Primer (ST) or AP Decoprime. Wall Primer (WT)	3 - 4
12	AP Tractor Synthetic Distemper	500 - 600	Water by wt	2 - for light shades. 3 - for dark shades. Brushing	AP Decoprime Wall Primer (ST) or AP Decoprime. Wall Primer (WT)	6

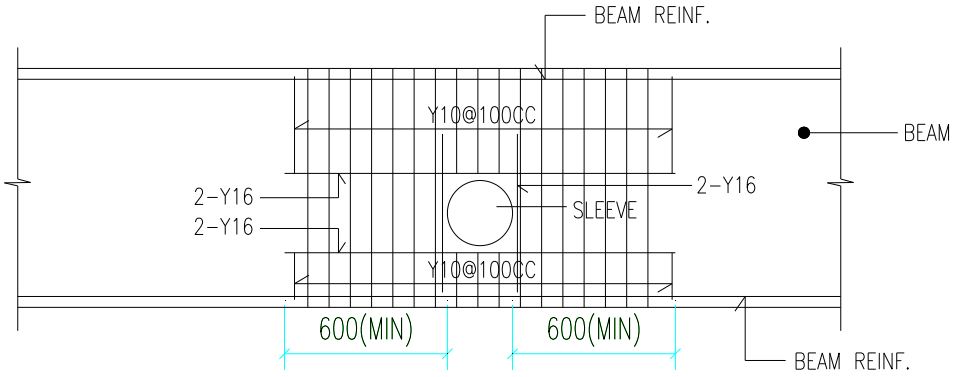


INTERNAL COLUMNS



EXTERNAL COLUMNS

TYPICAL EXP. JOINT (EJ) IN COLUMN
TYPICAL DETAIL-1

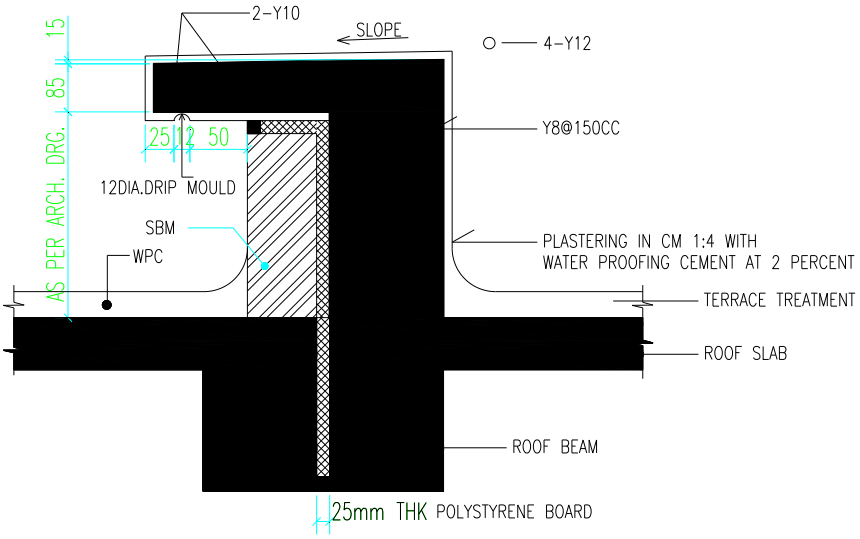


SLEEVE DETAILS IN BEAMS.

(FOR BEAMS ABOVE 450 DEPTH ONLY)

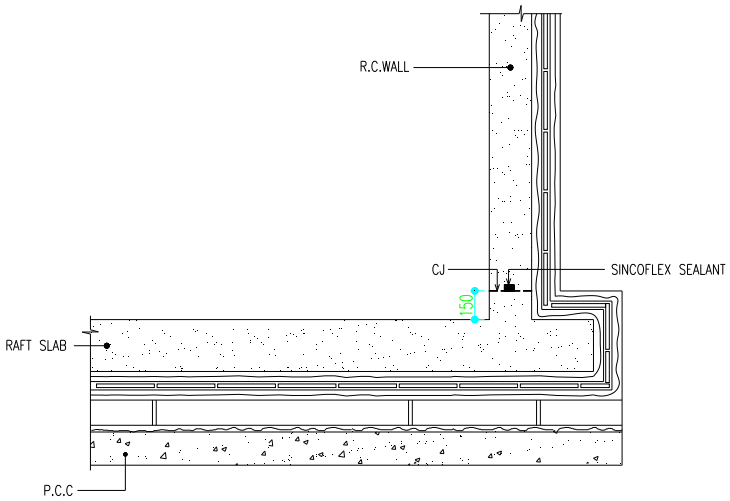
ONLY WITH PRIOR APPROVAL.

TYPICAL DETAIL-2



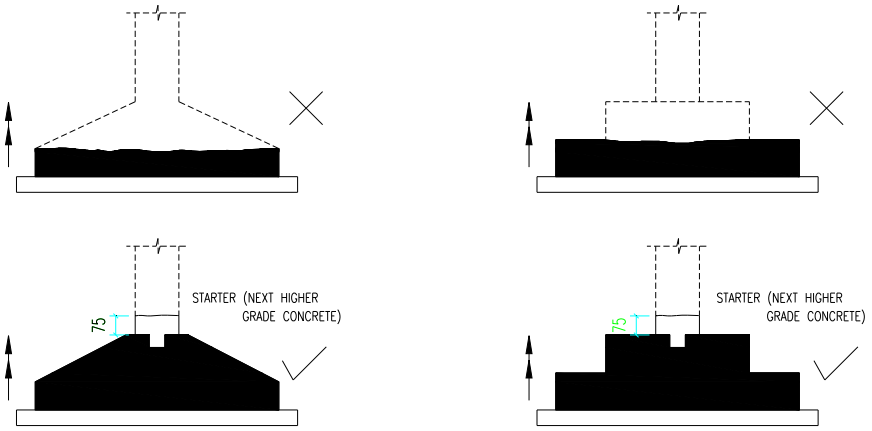
EJ DETAIL

TYPICAL DETAIL-3



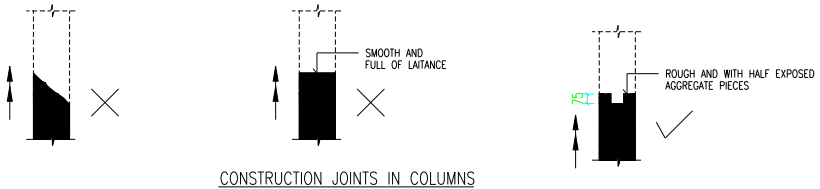
WATER-PROOFING DETAILS
(AS PER APPROVED DETAILS)

TYPICAL DETAIL-4



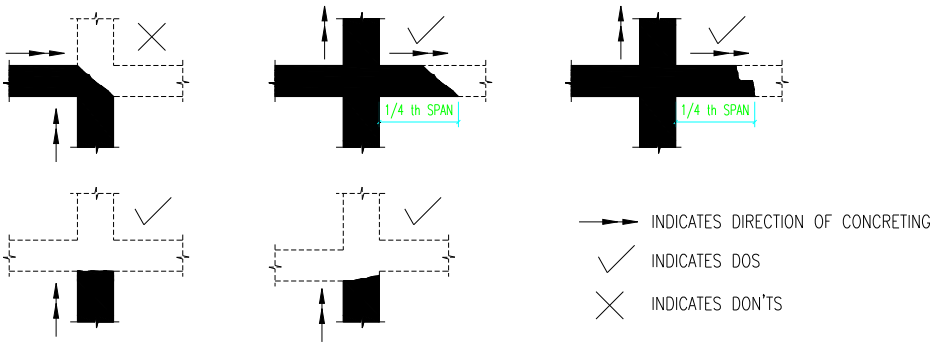
CONSTRUCTION JOINTS
CONSTRUCTION JOINTS IN FOOTINGS

TYPICAL DETAIL-5



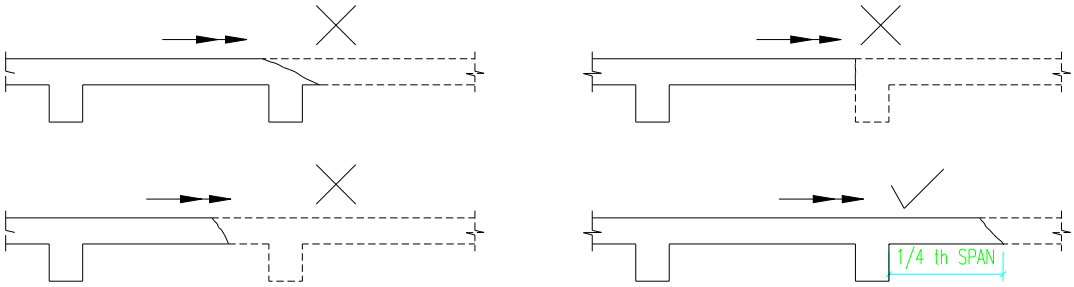
CONSTRUCTION JOINTS IN COLUMNS

TYPICAL DETAIL-6



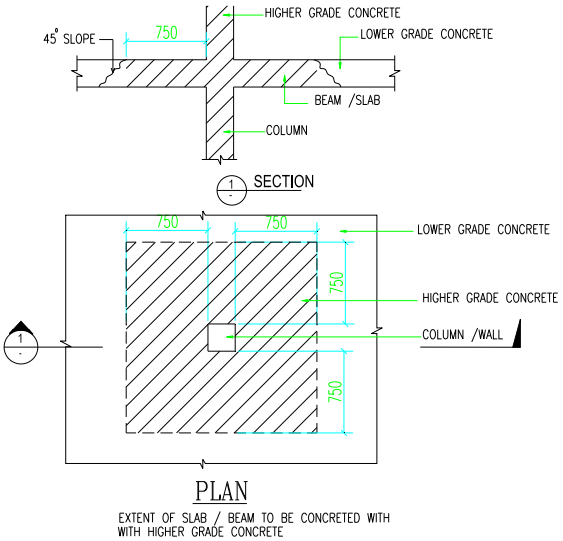
CONSTRUCTION JOINTS IN BEAMS / BEAM COLUMN JUNCTIONS

TYPICAL DETAIL-7



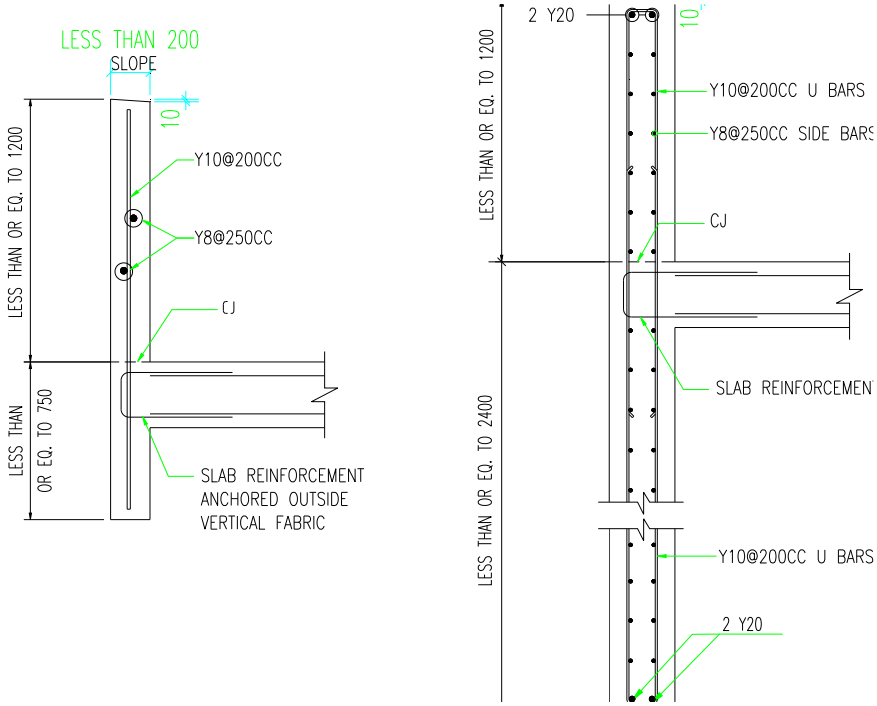
CONSTRUCTION JOINTS IN SALBS

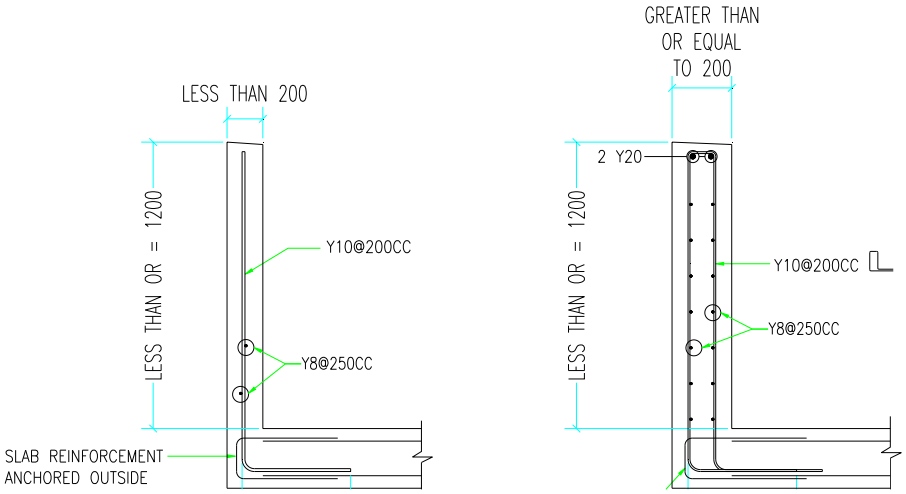
TYPICAL DETAIL-8

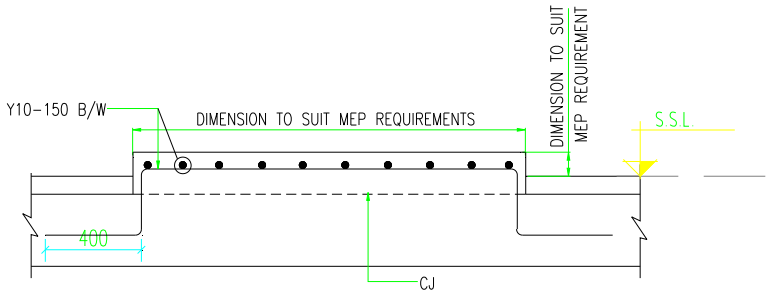


TYPICAL DETAIL–9

(BEAM / COLUMN JUNCTION DETAIL)



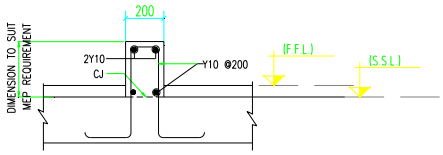




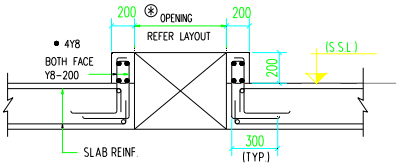
TYPICAL DETAIL-12

PLINTH DETAIL FOR EQUIPMENT BASE

(SCALE- N.T.S)



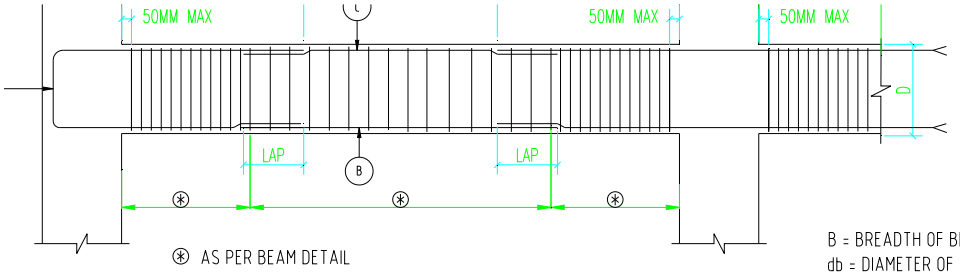
TYPICAL DETAIL-13
UPSTAND FOR EQUIPMENT SUPPORT (TYP)
(SCALE- N.T.S)



TYPICAL DETAIL-14
UPSTAND FOR MECH. EQUIPMENT WITH CUT OUT IN SLABS (TYP.)
(SCALE- N.T.S)

NOTES:

* DIMENSION TO BE AS PER APPROVED EQUIP. SUPPLIER'S REQUIREMENT.
* ALL EQUIP. TO BE PROVIDED WITH SUITABLE BASE ISOLATIONS TO AVOID TRANSMITTANCE OF DYANAMIC FORCES TO SUPPORTING STRUCTURE.



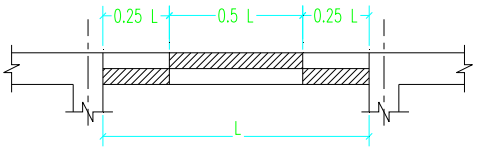
⊛ AS PER BEAM DETAIL

B = BREADTH OF BEAM
db = DIAMETER OF LONGITUDINAL BAR

etc. SEE BEAM DETAILS.
= 160mm.

SIDE REINFORCEMENT
FOR ALL BEAMS DEEPER THAN 750 (OVERALL) UNO

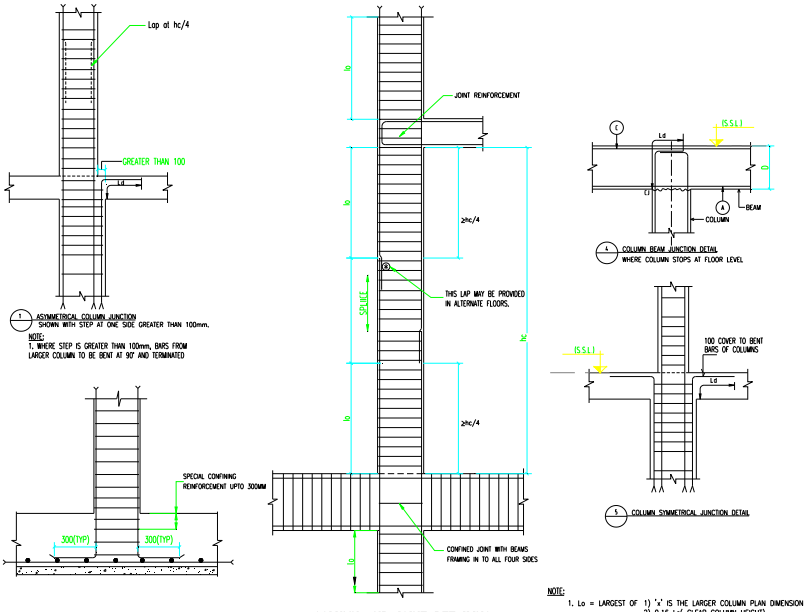
WIDTH OF BEAM	SIDE FACE REINF
200	Y12-250
300	Y12-200
400	Y12-150
500 OR GREATER THAN 500	Y16-200

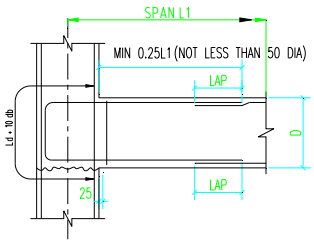


WHERE REINF IS TO BE DETAILED CONTINUOUSLY
LAPS IN REINF MAY OCCUR ONLY IN SHADED AREAS SHOWN

2 LAP LOCATIONS

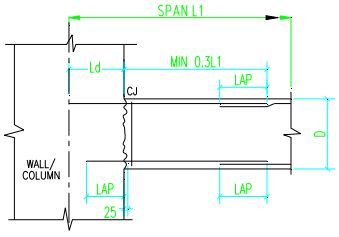
TYPICAL SUSPENDED BEAM DETAILS





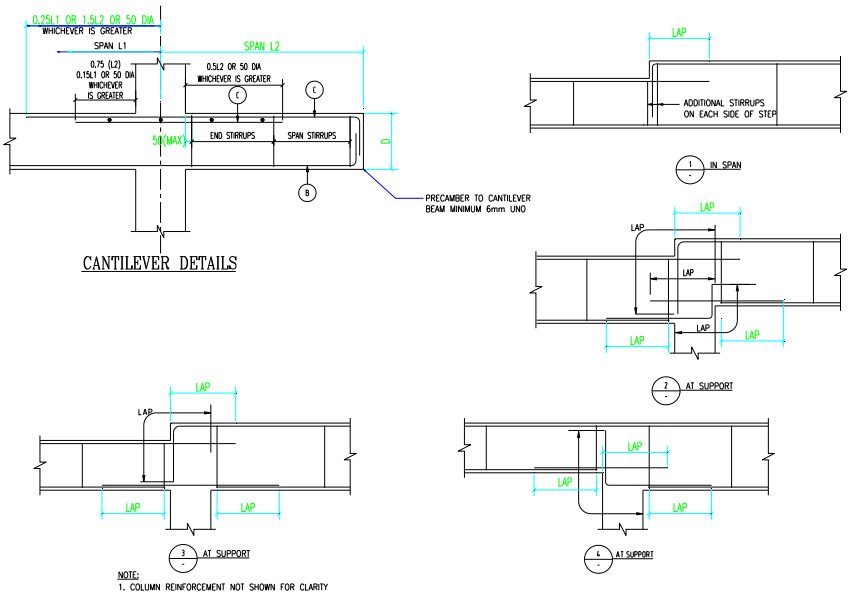
TYPE-2 : Ld TO BE ACHEIVED WITHIN BEAM
DEPTH WITH U-BAR (EDGE COLUMN)

Note;
Ld – DEVELOPMENT LENGTH
D – DEPTH OF BEAM
db – BAR DIAMETER



TYPE-4 : Ld TO BE ACHEIVED BY STRAIGHT
BARS (LONG COLUMNS / WALLS)

DETAILS OF COLUMN BEAM INTERSECTIONS

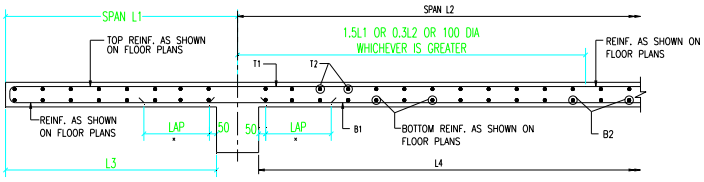


CANTILEVER DETAILS

NOTE:
1. COLUMN REINFORCEMENT NOT SHOWN FOR CLARITY

BEAM STEP DETAILS

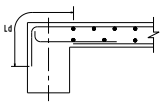
LAP = Ld = 50 x DIA OF BAR



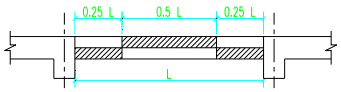
CANTILEVER SLAB

NOTES:

CANTILEVER SLABS TO BE CAST ALONG WITH THE MAIN SLABS IN ONE SINGLE POUR



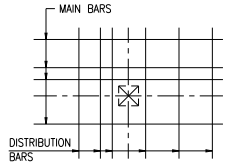
ALTERNATIVE END DETAIL



LAP LOCATIONS

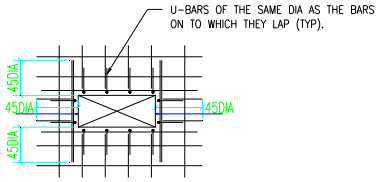
TYPICAL SOLID SLAB REINFORCEMENT DETAILS

NOTE:- PRECAMBER TO CANTILEVER SLAB MINIMUM 6mm UNO



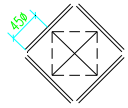
HOLE LESS THAN 150 mm

BARS MAY BE DISPLACED NO ADDITIONAL REFT NECESSARY



HOLE MORE THAN 150 mm AND LESS THAN 450 mm

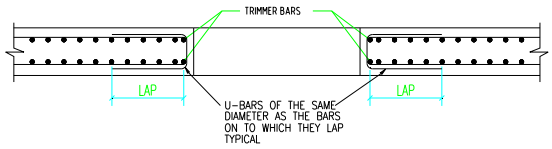
CUT BARS INTERUPTED BY HOLE, PROVIDE TRIMMER BARES OF SAME DIA. TYPE & NUMBER AS CUT BARS



HOLE MORE THAN 450 mm AND LESS THAN 900 mm

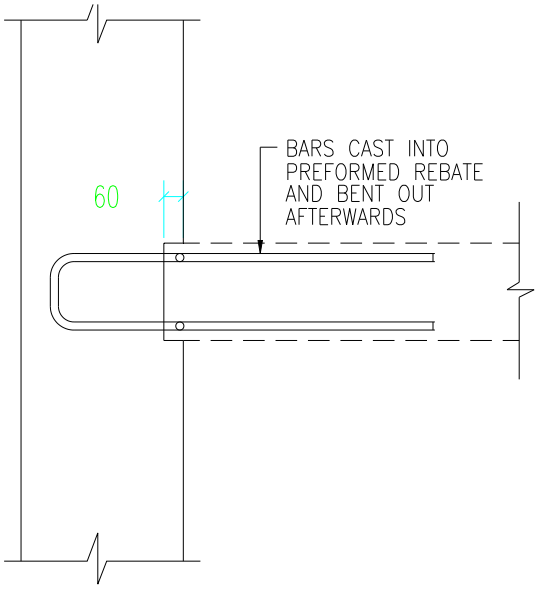
PROVIDE TRIMMER BARS IN ADDITION PROVIDE DIAGONAL TRIMMER OF SAME DIA, TYPE & NUMBER.

NOTES:
1. ALL REPLACEMENT AND DIAGONAL BARS SHOULD EXTEND AN ANCHORAGE LENGTH BEYOND THE EDGE OF THE HOLE BY 45 x DIA OF BAR.
2. HOLES LARGER THAN 900 mm IN ANY DIRECTION ARE DETAILED ON THE DRAWINGS

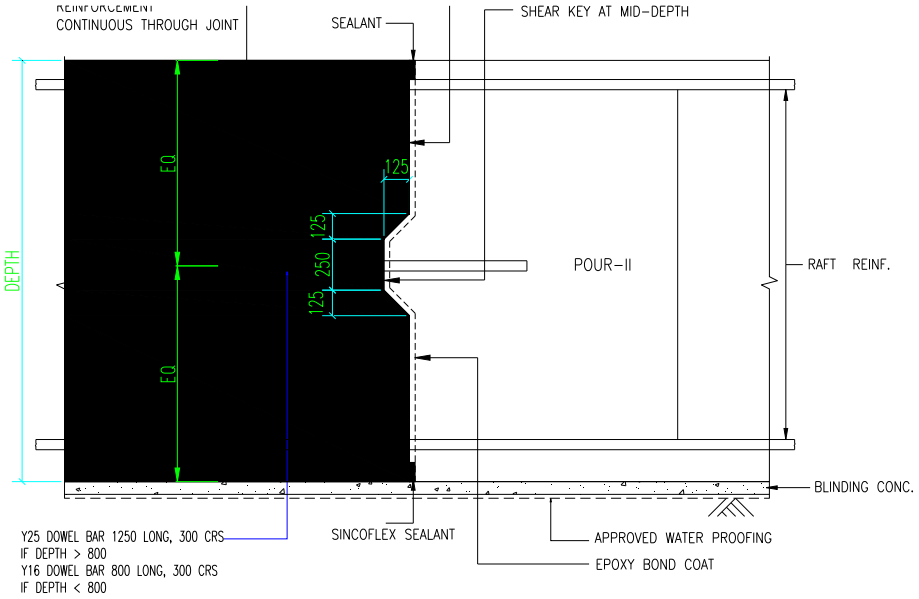


TRIMMING OF HOLES IN SLABS

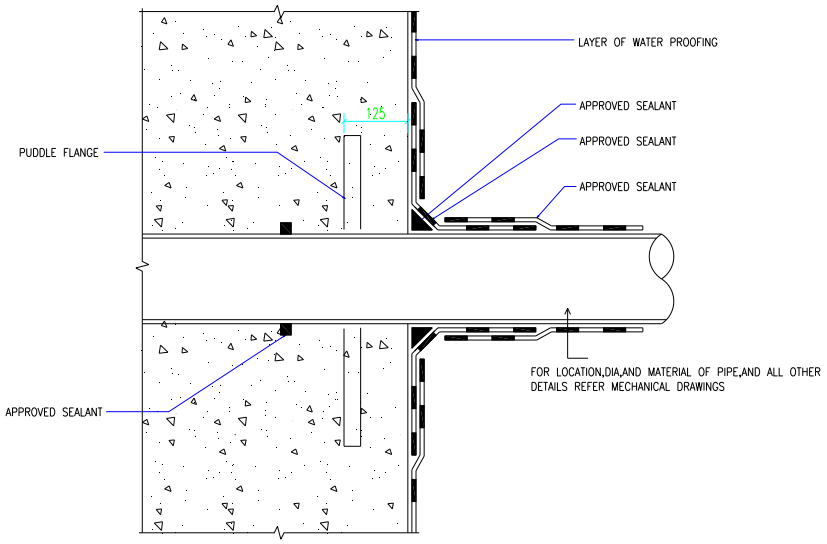
NOTE:- PRIOR APPROVAL TO BE OBTAINED FOR CUT OUT IF NOT SHOWN ON DRAWINGS.



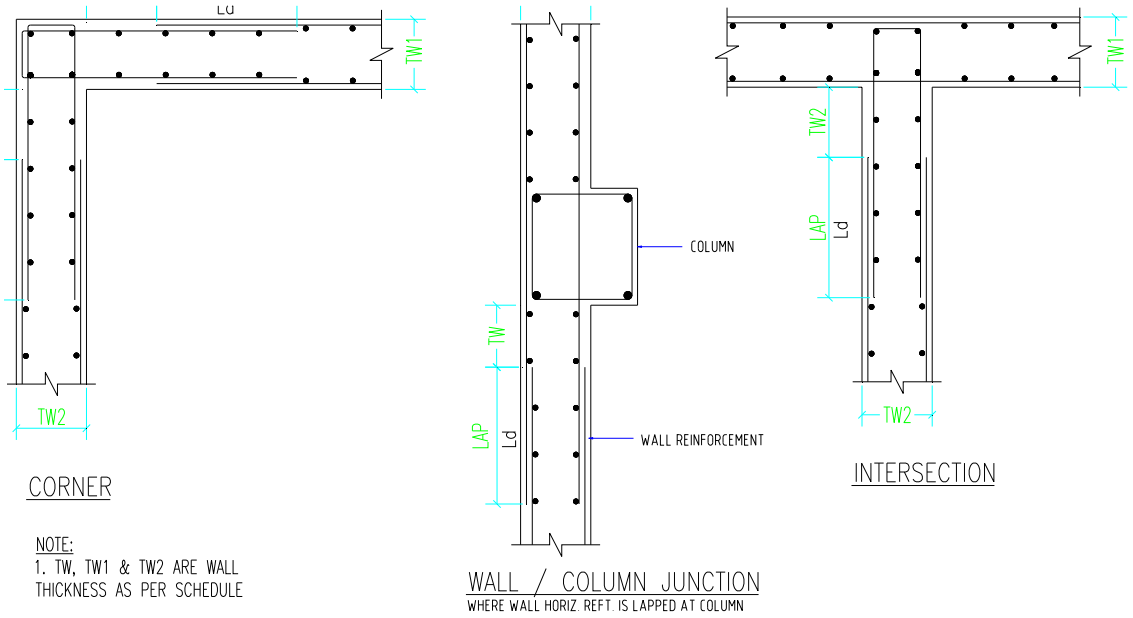
DETAIL OF BENT-OUT BAR



DETAIL AT CONSTRUCTION JOINT IN RAFT



DETAIL OF SERVICE ENTRY INTO RET.WALL



WALL JUNCTION DETAILS

Simple material calculations

Eg:
1.1000 Sqm Built up area

=1000/(0.9*0.6)
=1851 sheets
Span=1851sheet/5=370 spans
Props=370 span*2.5=925 props

TOWER	FLAT NOS. AS PER SALE PLAN	UNIT TYPE	CARPET AREA INCLUDING BALCONY/SITOUT	BUILT UP AREA INCL. BALCONY/SITOUT	TERRACES BUILT UP AREA	TOTAL BUILT UP AREA INCL. BALCONY (A)	COMMON AREA (B) (% OF A)	SHARED COMMON AREA (C) (% OF A)	TOTAL SBA D = (A+ B+ C)	CARPET AREA PER UNIT (E)	EFFICIENCY = (E/D)X100

Carpet Area is the area enclosed within the walls, actual area to lay the carpet. This area does not include the thickness of the inner walls. It is the actual used area of an apartment/office unit/showroom etc.

•Built up Area is the carpet area plus the thickness of outer walls and the balcony.

•Super Built Up Area is the built up area plus proportionate area of common areas such as the lobby, lifts shaft, stairs, etc. The plinth area along with a share of all common areas proportionately divided amongst all unit owners makes up the Super Built-up area. Sometimes it may also include the common areas such, swimming pool, garden, clubhouse, etc. This term is therefore only applicable in the case of multi-dwelling units.

---

carpet area is the actual usable area which the user gets to use. Built-up area consists of area outside your house, staircase, elevator, etc which can constitute upto 25% of the area.
Example if you buy a 1000 sq.ft built-up area, you will actually get to use only 750 sq.ft. Super built-up is area for the parapet, podium, garden,etc, all of which is charged at market price and can constitute upto 40% of the area.
It is ILLEGAL to sell property at anything other than carpet area because while developing the land, the developer is not charged FSI for the built-up area, garden, parking space,etc. So if anyone is charging you for anything other than carpet area you have a right to complain to a redressal forum like consumer protection.

1. Carpet area - The actual area you use. The area on which 'you can put a carpet'.

2. Built up area - Carpet area + area of walls and ducts. Around 10% more than the carpet area. A terrace is considered as half the actual area for calculating built up area. Some projects charge dry terrace same as internal rooms.

3. Super built up / Saleable area - Built up area + markup for common spaces like lifts and stairs. Usually 25% more than the built up area.

.

---

1. Take grid levels at 5-metre interval before the start of mass excavation.

2. Approved material shall be used for backfilling. Soil with liquid limit exceeding 65% and for plasticity index exceeding 35% cannot be used. High clay soil is not preferred for backfilling.
3. Imported fill shall be selected - graded hard granular fill with 100% free stones larger than 100mm, up to 50% passing 5mm mesh and not more than 20% passing a 75 micron sieve.
4. Insitu field densities of compacted material should be 95% of maximum dry density or as specified by the consultant. Test should be conducted 10m centre-to-centre and before the anti-termite treatment is done.
5. For volumetric calculations cater for 30% quantity more of loose backfill to compacted volume.

ANTI-TERMITE TREATMENT

6. Treatment shall be carried out according to the stipulations laid down by IS 6313 part II.
7. The chemical to be used is Chloropyriphous 20%, EC with ISI certification.
8. Dilute one part of Chloropyriphous 20% EC with 20 parts of water to get 1% emulsion.
9. For horizontal and vertical surface, the dosage rate is 7.5 litre/$m^{2.}$
10. For along the perimeter of building insert rod at intervals of 150mm and depth 300mm and pour the chemical directly into the hole.

SIZE STONE MASONRY / RUBBLE MASONRY

1. Use silt free (less than 5%) medium gritty clean sand for mortar.
2. Approved grade cement less than 1 month old should be used.
3. The mortar proportions shall be either 1:4 or 1:6. The mortar when mixed shall have a slump of 75mm
4. The thickness of mortar joints shall be 10 mm both horizontally and vertically
5. The height of wall to be done in a day's work shall be restricted to 1 metre.

Test results

Water absorption solid blocks

IS :2185-1979 part I (reaffirmed 1992)

Water absorption, being the average of three units when determined in the manner in appendix d .shall be nto more than 10% by mass .

Steel

Mechanical properties

Properties	Tor-40 Fe 415	Tor-50 Fe 500	Tor-55 Fe 550
.2 % proof stress/yield stress min (N/Sqm)	**415**	**500**	**550**
Elongation % on a gauge length of 5 times the nominal dia bar (min)	**14.5**	**12**	**8**
Tensile strength Min(N/sqmm)	**485or 10% more than actual .2 % proof stress but not less than 485**	**545or 8% more than actual .2 % proof stress but not less than 545**	**585or 6% more than actual .2 % proof stress but not less than 585**

Bend test: no transverse crack should be formed after bending the bar through 180 Degree around a mandrel of dia specified below

Bars up to and including 20 mm dia	4d	4d	4d
Bars over 20 mm dia	6d	6d	5d

Rebend test : no transverse crack should be formed after bending the bar through 45 Degree And reverse bending the same through 22.5 degree around a mandrel of dia specified belo

Bars up to and including 10 mm dia	4d	4d	4d
Bars over 10 mm dia	6d	6d	7d

Chemical composition

Constituents	Fe 415	Fe 500	Fe 550
Carbon % max	**.3**	**.3**	**.3**
Sulphur % max	**.06**	**.055**	**.055**
phosphorus % max	**.06**	**.055**	**.05**

Solid block test result

1. The maximum variation in the length of the units shall not be more than _+ 5 mm
2. In maximum variation in height and width oh unit not more than _+ 3 mm (Refer 2185-1)
3. Minimum compressive strength 4.00 n/mm2
4. % of water abortion acceptance shall be not more than 10% by mass

Cement (53 grade)

Chemical requirement

1. Lime saturation factor –not less than .80 and not greater than 1.02
2. Ratio of %ge of alumina oxide to that of iron oxide -not less than .66
3. Insoluble residue (% by mass) -not more than 3 %
4. Magnesia(% by mass) - not more than 6 %
5. Sulphuric anhydride(% by mass) - not more than 3 %
6. Total loss on ignition(% by mass) - not more than 4 %
7. Chloride content(% by mass) - not more than 0 .05 %

Physical requirement

1. **Fineness (m^2/kg) - Not less than 225 m^2/kg**
2. **Soundness**
   a.lechatlier expansion(mm) - not more than 10 %
   b.Auto clave expansion(%) - not more than 0.08 %
3. **Setting time (in minutes)**
   a.Intial -Not less than 30 minutes
   b.Final -Not greater than 600 minutes
4. **Compressive strength (MPA)**
   a.72+/-1 hours - Not less than 27 mpa
   b.168+/-2hours - Not less than 37 mpa
   c.672+/-4hours - Not less than 53 mpa

TOP DETAILS

SQ.PLATE WITH STIFFNER

ANGLE PLATE

SQUARE PLATE

Inner-48.30 mm O.D. Outer-60.30mmO.D.					
Type	**Outer Pipe mts.**	**Inner Pipe mts**	**Min Height mts**	**Max Height mts. ft**	
P 1.	1.5	2.0	2.0	3.2	10,-3"
P 2	2.0	2.0	2.0	3.7	12'-3"
P 3	2.0	2.5	2.5	4.2	13'-9"
P 4	2.0	3.0	3.0	4.7	15'-6"

ADJUSTABLE JACKS

ADJUSTABLE BASE JACK

ADJUSTABLE STIRRUP JACK

Available in solid & hollow design with various adjustment from 75 mm to 660 mm with malleable / cast iron nuts

STANDARD SIZES

- 32mm dia, 225mm adjustment
- 36mm dia, 350mm adjustment
- 36mm dia, 450mm adjustment

CUP-LOCK SYSTEM

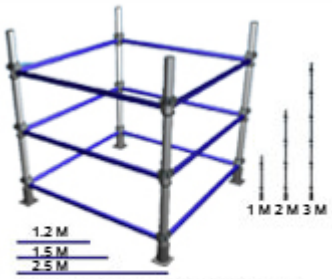
TOP CUP (LOCKING CUP & MOVES FREELY ON V.M)

LEDGER END (WELDING WITH A PIPE TO FORM H.M)

BOTTOM CUP (WELDING WITH V.M.)

VERTICAL MEMBER (V.M.) HORIZONTAL MEMBER(H.M.)

ROTATE THE TOP CUP BY HAMMERING



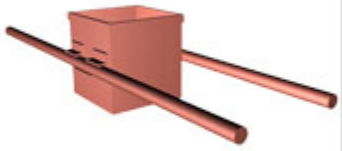
LEDGERS (H.M) & (V.M.)ARE AVAILABLE IN ABOVE SIZES.

1. Push the H.m. towards the V.m	1. Rotate the top cup by hammering.
2. Engage the H.m. into lower cup.	2. Pull the V.m. outwards to ensure perfect locking.
3. Lower the top cup for locking.	

SPAN & TROLLEYS

ADJUSTABLE SPAN

Type	Outer Body	Inner Body	Min. Span	Max. Span
S-1	1.83M 6'-0"	1,83M 6'-0"	1.9M 6'-3"	3.2M 10'-6"
S-2	2.5M 8'-0"	1,83M 6'-0"	2.5M 8'-3"	3.9M 12'-6"
S-3	2.5M 8'-0"	2.5M 8'-0"	2.6M 8'-3"	4.5M 14'-6"



FARMA (VOLUMETRIC SIZES)

20, 25, 30, 35, 40, & 45 litres

SLAB TROLLEY

WHEEL BARROW

SCAFFOLDING FITTINGS

BOARD RATAINING BRACKET

PUTLOG COUPLERS

TOW BOARD BRACKET

SELVEE COUPLERS

BEAM COUPLERS

PROP NUT (HEAVY DUTY)

TUBE CLIP

For connecting Waling

SWIVEL COUPLER

For connecting two

FIXED COUPLER

For connecting two tubes

tubes to wall panels

tubes at various degrees.

at right angles.

WING NUT & TIE ROD

4 WAY-HEAD

GO GO CLAMP WITH JACK

PIPE BARREL

H-FRAMES

ASSEMBLY OF H-FRAME

Type	H	W	L
1.	2 m	1 m	2 m
2.	2 m	1.25 m	2 m
3.	2.5 M	1.25 m	2 m

- H-Frames are manufactured from 40NB & 25NB medium class pipe as per IS : 1239 Part - I & Cross Bracings
- Bracings are made from 20 NB - Pipe or 35 mm Angle for 2/2.5m spacing betwween two H-Frames.

Sequence of earth works

Materials and Tools Used:

The following are the materials used for the earthwork for foundation.

1. Spade,
2. Kassi,
3. Pick Axe,
4. Crow Bar,
5. Rammer,
6. Wedge,
7. Boning Rod,
8. Sledge Hammer,
9. Basket,
10. Iron Pan,
11. Line and Pins

Drawings Required

1. Centerline Drawing

2. Layout Plan

Size of Foundation

a. For Main Walls 4'0" Depth

b. For Partition Walls 2'0" Depth

Scope of the work:

- Setting out of corner benchmarks.
- Survey for ground levels.
- Survey for top levels
- Excavation to approved depth.
- Dressing of loose soil.
- Making up to cut off level
- Constructing dewatering wells and interconnecting trenches.
- Marking boundaries of the building.
- Constructing protection bunds and drains

Working Procedure

- The extent of soil and rock strata is found by making trial pits in the construction site. The excavation and depth is decided according to the following guidelines in the site

i. For Isolated footing the depth to be one and half times the width of the foundation

ii. For adjacent footings with clear spacing less than twice the width (i.e.) one and half times the length

iii. 1.5m in general and 3.5 m in black cotton soils

In this site open foundation pits for columns and trenches for CR Masonry was carried out. The maximum depth was upto 3m.

Setting out or ground tracing is the process of laying down the excavation lines and center lines etc. on the ground before the excavation is started. The center line of the longest outer wall of the building is marked on the ground by stretching a string between wooden or mild steel pegs. Each peg may be projected about 25 to 50 mm form the ground level and 2m from the edge of the excavation. The boundary is marked with the lime powder. The center lines of other walls are marked perpendicular to the longer walls. A right angle can be formed by forming 3, 4 and 5 triangles. Similarly, outer lines of the foundation trench of each cross walls and are set out

Removal of Excess Soil

· Estimate the excavated stuff to be re-utilized in filling, gardening, preparing roads, etc.As far as possible try to carry excavation and filling simultaneously to avoid double handling. Select and stack the required material in such a place that it should not obstruct other construction activities. The excess or unwanted material should immediately be carried away and disposed off by employing any of the following methods.

- Departmental labour.
- Tractor.
- Trucks.

QUALITY CHECKS FOR EXCAVATION

- Recording initial ground level and check size of bottom.
- Disposal of unsuitable material for filling.
- Stacking suitable material for backfilling to avoid double handling.
- Strata classification approval by competent authority.
- Dressing bottom and sides of pits as per drawing with respect to centerline.
- Necessary safety measures observed.

QUALITY CHECKS FOR FILLING

- Recording initial ground level
- Sample is approved for back filling.
- Necessary marking/ reference points are established for final level of backfilling.
- Back filling is being carried out in layers (15cm to 20cm).
- Required watering, compaction is done.
- · Required density is achieved.

Brick work

Working Procedure

All the bricks to use in construction are soaked well in water so that they don't absorb water from the mortar. Mortar is spread on the top of the foundation course over an area to be covered by the edges of the wall. The corner of the wall is constructed first. The excess mortar from the sides will squeeze out, which is cleaned off with trowel. The level and the alignment are checked. If the brick is not in level, they are pressed gently further. After having laid the first course at the corner, mortar is laid and spread over the first course and the end stretcher is laid first and hammered it on the laid mortar. Perpends must be kept vertical. This should be checked, as the work proceeds with the help of straight edge and square. After having constructed the wall, jointing and pointing is done.

PCC

Materials and Tools used

- Auto level instrument – 1 Nos
- Wooden /Steel rammer – 1 Nos
- Mixer machine – 1 Nos

Scope of work

- Verifying levels and dimension
- Ramming the earth surface
- Placing the concrete.
- Ramming and finishing the concrete surface

Working Procedure

- Excavation levels and dimensions to be checked as per drawings. Remove all the loose earth from the pits. Do water sprinkling and ramming the cleaned surface of pit by mechanical rammer. Do the shuttering by planks and runners wherever if necessary. Mix the concrete with required proportion and water cement ratio by mechanical mixer machine and place the same in to pits. Poured surface to be rammed and finished smoothly

A READY RECKONER FOR QUANTITY SURVEYORS

Objective

This book is intended and designed for day to day reference mainly by quantity surveyors, contract managers, architects, estimators, site engineers and middle order executives of the construction industry who deals with quantity surveying, estimating, analysis of rates, drafting of specifications, supervision of works and checking of interim and final bills. Also it is useful in legal and financial aspects of quantity surveying and in preparing, defending claims, disputes etc.

Targeted People

Quantity Surveyors, Contract Managers, architects, Estimators, Site Engineers etc.,

Most Likely Users

Billing Engineers, Middle order Executives like QC Engineers , site supervisors, Contractors, Sub-contractors, and consultants and students.

CONTENTS

UNITS AND CONVERSION FACTORS

Conversion of Rates

Sno	To convert	Factor	To obtain
1	Rft	3.28	Rmt
2	Sq feet	10.764	Sqmt
3	Cubic feet	35.315	Cubic Mt
4	Lb(Pound)	2.2046	Kg
5	Cwt	1.9684	Quintal
6	Gallon	0.22	Lt
7	Tonn/Sqft	10.937	Tonne/Sqmt
8	Acre	2.471	Hectare

CONVERSION FACTORS				UNITS OF MEASURES	
Metric to British		British to Metric			
LENGTH					
1 CM	0.3937inch	1 inch	25.4 mm	1 mile	8 furlongs
1meter	3.2808 ft	1 ft	0.3048 m	1 furlong	10 chains
1meter	39.3696 inch	1 yard	0.9144 m	1 chain	22 yards
1 meter	1.0936 yard	1mile	1.609 km	1 nautical mile	6080 ft
1 KM	0.6214 mile	1 chain	20.1168 m		
AREA					
1 sqcm	0.1550 sqinch	1 sqinch	6.4516 sqcm	1 Acre	4840 sqyds
		1 sqft	0.0929 sqm	1 sqmile	640 Acres
1 sqm	10.76 sqft	1 sqyd	0.8361 sqm	1 hectare	10000 sqm
1 sqm	1.1960 sqyd			1 sqkm	10^6 sqm
1 hectare	2.4170 Acre	1 Acre	0.4047 ha	1 sqkm	100 ha
1 sqkm	0.3861 sqmile	1 sqmile	2.59 sqkm		
1 sqkm	247.1045 Acres	1 sqmile	259.0ha	1 sqm	10 sqdm
VOLUME					
1 cum	35.3147 cuft	1 cuft	28.3161 lt	1 cuft	1728 cuinch
1 cum	1.3080 cuyd	1 cuft	0.0283 cum	1 cum	1000 cudm
1 cum	219.97 gallon	1 cuft	28.3161 cudm	1 cudm	1 lt
1 cum	264.18 gallon	1gallon	4.5460 liters	1 cuft water	6.24 gallon
WEIGHT					

1 kg	2.2046 lb	1 lb	0.4536 kg	1 lb	16 oz
10 gm	0.322 oz	1 oz	31.1035 gm		
1 tonne	1000 kg	1 quintal	220.46 lb		
DENSITY (mass/volume)					
1 gm/cc	0.0361 lb/cuinch	1 lb/cuinch	27.699 gm/cc	1 cuft of water	62.4 lb
1 kg/cum	0.0624 lb/cft	1 lb/cft	16.0185 kg/cum		
1 tonn/cum	62.4 lb/cft	1 tonn/cum	0.7525 t/cuyd	1 tonn/cuyd	1.329 tonne/cum

***** Nautical mile is a distance on the earth's surface at the sea level of 1 min of arc(1/60 of degree) of longitude of earth at the equator. Equatorial diameter of the earth is 7926.72 miles.

Mensuration

WEIGHTS OF BUILDING MATERIALS

(Ret: IS: 1911-1967)

Material	Weight in kg per cubic
Acoustical material	240
Stag wood	270
Aggregate	
Broken stone, dry broken bricks:	1600 to 1870
Fine	1450
Coarse	1010
Foam slag aggregate	700
Sand, dry, clean	1540 to1600
Shingle, 3mm to 38mm	1460
Bricks	
Common burnt clay	1600 to 1920
Engineering bricks	2160
Pressed bricks	1760 to 1840
Refractory bricks	1760 to 2000
Cement	
Ordinary and aluminous	1440
Rapid hardening	1280
Cement concrete, plain	
Using stone aggregate	2240 to 2400
Light weight concrete	
Cellular ('Siporex' etc.)	640
With foam slag aggregate	960 to 1840
Aerated	760
Chemicals	
Gypsum powder	1410 to 1760
Salt, Common	960
Coal	
Coal	850
Coal dust	700
Coke, furnace or gas	500
Charcoal	300
Lime	
Slaked, fresh	580 to 640
Unslaked lime	1180

Material	Weight in kg per cubic
Slaked lime	1020
Metals	
Aluminum, cast	2580 to 2710
Aluminum, wrought	2640 to 2800
Brass	8550
Copper, cast	8790
Copper, wrought	8840
Iron, pig	7200
Iron, cast, gray	7030 to 7130
Iron, wrought	7700
Steel, cast	7850
Brick masonry	1920
Concrete	2420
Earth compacted	1750
Glass	2560
Rubber	960
RR masonry	2300
Hollow Block masonry	2500
Alum	1700
Flat Asbestos sheet	2.04 Kg / Sqm
Water	1000
Ice	910
Salt	1020

B) To know the weight of sheets of aluminum , copper, steel etc, We must know the thickness corresponding to gauges denoted. They are as under.

Standard Wire Gauge		Steel	Copper	Aluminum
24^{G}	0.63mm	4.94	5.54	1.7
22^{G}	0.80 mm	6.27	7.04	2.16
20^{G}	1.00 mm	7.84	8.8	2.7
18^{G}	1.25 mm	9.8	11	3.36
16^{G}	1.60 mm	12.55	14.08	4.32
14^{G}	2.00 mm	15.69	17.60	5.40
12^{G}	2.50 mm	19.61	22.00	6.75
10^{G}	3.15 mm	24.70	27.72	8.51
8^{G}	4.00 mm	31.36	35.2	10.8

C) Plates

Plate	Plain Steel Plates	Steel Chequred Plates
5 mm	39.2 Kg/Sqm	45.3 Kg/Sqm
6 mm	47.1 Kg/Sqm	53.2 Kg/Sqm
7 mm	54.9 Kg/Sqm	61.1 Kg/Sqm
8 mm	62.8 Kg/Sqm	68.9 Kg/Sqm
10 mm	78.5 Kg/Sqm	84.6 Kg/Sqm
12 mm	94.2 Kg/Sqm	100.3 Kg/Sqm

D) Details of Rounds, Fabric & Structural Steel Weight of M.S. Rounds & Torsteel:-

Size (mm)	Area(Cm^2)	Wt.(Kg/mt)	Length/ ton(mt)
6	0.283	0.222	4510
8	0.503	0.395	2532
10	0.785	0.617	1621
12	1.131	0.888	1125
16	2.011	1.578	633
18	2.545	2.000	500
20	3.142	2.466	405
22	3.801	2.980	336
25	4.909	3.854	260
28	6.157	4.830	207
32	8.042	6.313	159
36	10.179	7.990	125
40	12.566	9.864	101

E) Weight of Aluminum Sheets

SWG	Inch	MM	L.B./ SFT	Kg/ SFT	Kg 8'x4'	Kg 8'x3'	Kg 6'x3'
3/8"	0.375	9.53	5.29	2.399	76.740	57.540	43.17
3/0"	0.372	9.54	5.24	2.376	75.890	57.080	42.81
2/0"	0.348	8.84	4.91	2.227	71.210	53.430	40.05
1/0"	0.324	8.03	4.57	2.072	66.300	9.720	37.27
5/16	0.312	7.93	4.40	1.995	63.860	47.900	35.91
1	0.300	7.62	4.23	1.918	61.370	46.630	34.49
2	0.276	7.01	3.89	1.764	56.410	42.350	31.75
3	0.252	6.40	3.55	1.610	51.560	38.690	29.02
1/4"	0.250	6.35	3.52	1.596	51.166	38.380	28.74
4	0.232	5.89	3.27	1.483	47.480	35.600	26.39
5	0.212	5.48	2.99	1.356	43.370	32.510	24.40
6	0.192	4.88	2.71	1.229	38.280	29.480	22.08

3/16"	0.187	4.75	2.64	1.197	38.270	28.710	21.530
7	0.176	4.47	2.48	1.125	36.600	27.040	20.26
8	0.160	4.06	2.26	1.025	32.730	24.520	18.42
9	0.144	3.66	2.03	0.921	29.480	22.080	16.61
10	0.128	3.25	1.80	0.186	26.170	19.650	14.73
1/8"	0.125	3.18	1.76	0.798	25.570	19.190	14.37
11	0.116	2.95	1.64	0.744	23.720	17.830	13.32
12	0.104	2.64	1.47	0.667	21.250	15.950	11.96
13	0.092	2.34	1.30	0.590	18.810	14.090	10.60
14	0.080	2.03	1.13	0.512	16.320	12.240	9.210
15	0.072	1.83	1.02	0.462	14.730	11.050	8.380
16	0.064	1.63	0.902	0.409	13.090	9.830	7.130
17	0.056	1.42	0.792	0.359	11.480	8.610	5.430
18	0.048	1.22	0.677	0.307	9.830	7.330	5.520
19	0.040	1.02	0.564	0.255	8.160	6.116	4.610
20	0.036	0.914	0.508	0.230	7.33	5.520	4.110
21	0.032	0.813	0.451	0.205	6.520	4.409	3.650
22	0.028	0.711	0.395	0.179	5.720	4.300	3.190
23	0.024	0.610	0.388	0.153	4.810	3.640	2.720
24	0.022	0.559	0.310	0.141	4.470	3.340	2.480
25	0.020	0.508	0.232	0.128	4.060	3.080	2.280
26	0.018	0.457	0.254	0.115	3.650	2.740	2.030

F) Weight of Selected structural steel sections:

Designation	Weight/meter	Sectional area	Width/Flange
	W-Kg	A-Cm^2	B-mm
ISMB-100	11.5	14.60	75
ISMB-125	13.0	16.60	75
ISMB-150	14.9	19.00	80
ISMB-200	25.4	32.33	100
ISMB-300	44.2	56.26	140
ISMB-400	61.6	78.46	140
ISMB-450	72.4	92.27	150
ISMB-500	86.9	110.21	180
ISMB-600	122.6	156.21	210
ISMC-75	6.8	8.67	40
ISMC-100	9.20	11.70	50
ISMC-125	12.7	16.19	65
ISMC-150	16.4	20.88	75
ISMC-200	22.10	28.21	75
ISMC-225	25.9	33.01	80
ISMC-300	35.8	45.64	90

ISMC-400	49.4	62.93	100

G)Details of Various Angle sections:

Designation	Thickness (mm)	Sectional area (Cm^2)	Weight/meter
ISA 20X20	3.0	1.12	0.9
	4.0	1.45	1.1
25X25	3.0	1.41	1.1
	4.0	1.84	1.40
	5.0	2.25	1.80
30X30	3.0	1.73	1.40
	4.0	2.26	1.80
	5.0	2.77	2.2
35X35	3.0	2.03	1.60
	4.0	2.66	2.10
	5.0	3.27	2.6
	6.0	3.86	3.0
40X40	3.0	2.34	1.8
	4.0	3.07	2.40
	5.0	3.78	3.0
	6.0	4.47	3.5
45X45	3.0	2.64	2.10
	4.0	3.47	2.7
	5.0	4.28	3.4
	6.0	5.07	4.0
50X50	3.0	2.95	2.3
	4.0	3.88	3.0
	5.0	4.79	3.82
	6.0	5.68	4.5
55X55	5.0	5.27	4.10
	6.0	6.26	4.9
	8.0	8.18	6.4
	10.0	10.02	7.9
60X60	5.0	5.75	4.5
	6.0	6.84	5.4
	8.0	8.96	7.0
	10.0	11.00	8.60
65X65	5.0	6.25	4.9

	6.0	7.44	5.8
	8.0	9.76	7.7
	10.0	12.00	9.4
70X70	5.0	6.77	5.3
	6.0	8.06	6.3
	8.0	10.58	8.3
	10.0	13.02	10.2
75X75	5.0	7.27	5.7
	6.0	8.66	6.8
	8.0	7.38	8.9
	10.0	14.02	11.0
80X80	6.0	9.29	7.3
	8.0	12.21	9.6
	10.0	15.05	11.8
	12.0	17.81	14.0
90X90	6.0	10.47	8.2
	8.0	13.79	10.8
	10.0	17.03	13.40
	12.0	20.19	15.8
100X100	6.0	11.67	9.2
	8.0	15.39	12.1
	10.0	19.03	14.90
	12.0	22.59	17.7

Details of square boxes (closed structures –RHS/SHS, Reference IS -4923:1997)

Section	Depth in mm	Width in mm	Thickness In mm	Sectional area in sq-cm	Weight in kg/m
25x25	25	25	2.6	2.16	1.69
	25	25	3.2	2.53	1.987
30x30	30	30	2.6	2.68	2.1
	30	30	3.2	3.17	2.49
	30	30	4.0	3.75	2.94
32X32	32	32	2.6	2.88	2.26
	32	32	3.2	3.42	2.69
	32	32	4.0	4.07	3.19
35X35	35	35	2.6	3.2	2.51
	35	35	3.2	3.81	2.99

	35	35	4.0	4.55	3.55
38X38	38	38	2.6	3.51	2.75
	38	38	2.90	2.86	3.03
	38	38	3.2	4.19	3.29
	38	38	3.6	4.62	3.63
	38	38	4.00	5.03	3.95
40x40	40	40	2.6	3.72	2.92
	40	40	3.2	4.45	3.49
	40	40	3.60	4.91	3.85
	40	40	4.0	5.35	4.2
45x45	45	45	2.6	4.24	3.32
	45	45	2.9	4.67	3.66
	45	45	3.2	5.09	3.99
	45	45	3.6	5.63	4.44
	45	45	4.5	6.67	5.31
49.5x49.5	49.5	49.5	2.9	5.19	4.07
	49.5	49.5	3.6	6.28	4.93
	49.5	49.5	4.5	7.58	5.95
63.5x63.5	63.5	63.5	3.2	7.45	5.85
	63.5	63.5	3.6	8.29	6.51
	63.5	63.5	4.5	10.10	7.93
72x72	72	72	3.2	8.54	6.7
	72	72	4.0	10.47	8.22
			4.8	12.31	9.66
75x75	75	75	3.2	8.93	7.01
			4.0	10.95	8.59
			4.9	13.12	10.3
88.9x88.9	88.9	88.9	3.6	11.95	9.38
			4.5	14.67	11.52
			4.9	15.85	12.44
91.5x91.5	91.5	91.5	3.6	12.32	9.67
			4.5	15.14	11.88
			5.4	17.85	14.01
100x100	100	100	4.0	14.95	11.73
			5.0	18.36	14.41
			6.0	21.63	16.98
13.5x113.5	113.5	113.5	4.5	19.1	14.99

			4.8	20.28	15.92
			5.4	22.6	17.74
			6.0	24.87	19.53
125x125	125	125	4.5	21.17	16.62
			5.0	23.36	18.33
			6.0	27.63	21.69
132x132	132	132	4.8	23.83	18.71
			5.4	26.59	20.88
			6.0	29.31	23.01
150x150	150	150	5.0	28.36	22.26
			6.0	33.63	26.4
50x25	50	25	3.2	4.13	3.2
60x40	60	40	2.9	5.25	4.12
66x33	66	33	2.9	5.19	4.07
	66	33	3.6	6.28	4.93
			4.5	7.58	5.95
70x30	70	30	52.9	5.25	4.12
			3.2	5.73	4.5
			4.0	6.95	5.45
80x40	80	40	2.9	6.41	5.03
			3.2	7.01	5.5
			4.0	8.55	6.71
96x48	96	48	3.2	8.54	6.7
			4.0	10.47	8.22
			4.8	12.31	9.66
100x50	100	50	3.2	8.93	7.01
			4.0	10.95	8.59
122x61	122	61	3.6	12.32	9.67
			4.5	15.14	11.88
			5.4	17.85	14.01
127x50	127	50	3.6	11.89	9.34
			4.6	14.89	11.69
145x82	145	82	4.8	20.28	15.92
			5.4	22.6	17.74
172x92	172	92	4.2	23.83	18.71
			5.4	26.59	20.88

Weight of mild steel stips

Thickness In mm	1.6	1.8	2.0	2.24	2.5	2.8	3.15	3.55	4.00	4.50	5.0	6.0	8.0	10.0
Width in mm	Weight in kg/metre													
100	1.3	1.4	1.6	1.8	2.0	2.2	2.5	2.8	3.1	3.5	3.9	4.7	6.3	7.8
125	1.6	1.8	2.0	2.2	2.4	2.7	3.1	3.5	3.9	4.4	4.9	5.9	7.8	9.8
160	2.0	2.3	2.5	2.8	3.1	3.5	4.0	4.5	5.0	5.6	6.3	7.5	10.0	12.6
200	2.5	2.8	3.1	3.5	3.9	4.4	4.9	5.6	6.3	7.1	7.8	9.4	12.6	15.7
250	3.1	3.5	3.9	4.4	4.9	5.5	6.2	7.0	7.8	8.8	9.8	11.8	15.7	19.0
320	4.0	4.5	5.0	5.6	6.3	7.0	7.9	8.9	10.0	11.3	12.6	15.1	20.1	25.4
400	5.0	5.6	6.3	7.0	7.8	8.8	9.9	11.1	12.6	14.1	15.7	18.8	25.1	31.4
500	6.3	7.1	7.8	8.8	9.8	11	12.4	13.9	15.7	17.7	19.6	23.6	31.4	39.2
650	8.2	9.2	10.2	11.4	12.8	14.3	16.1	18.1	20.4	23	25.5	30.6	40.8	51
800	10.0	11.3	12.6	14.1	15.7	17.6	19.8	22.3	25.1	28.3	31.4	37.7	50.2	62.8
950	-	13.4	14.9	16.7	18.6	20.9	23.5	26.5	29.8	33.6	37.3	44.7	59.7	74.6
1050	-	-	16.5	18.5	20.6	23.1	26	29.3	33	37.1	41.2	49.6	65.9	82.4
1150	-	-	-	20.2	22.6	25.3	28.4	32	36.1	40.6	45.1	54.2	72.2	90.3
1250	-	-	-	-	24.5	27.5	30.9	34.8	39.2	44.2	39.1	58.9	78.5	98.1
1300	-	-	-	-	-	28.6	32.1	36.2	40.8	45.9	51	61.2	81.6	102
1450	-	-	-	-	-	-	35.8	40.4	45.5	51.2	56.9	68.3	91.1	113.8
1550	-	-	-	-	-	-	38.3	43.2	48.7	54.7	60.8	73	97.3	121.7

Weight of mild steel flats

Thickness In mm	3.0	4.0	5.0	6.0	8.0	10	12	16	18	20	25	32	40
Width in mm	Weight in kg/m												
10	0.2	0.3	0.4	0.5									
15	0.4	0.5	0.60	0.7	0.9								
20	0.5	0.6	0.8	0.9	1.3	1.6							
25	0.6	0.8	1.0	1.2	1.6	2.0	2.4						
30	0.7	0.9	1.2	1.4	1.9	2.4	2.8	3.8					
35	0.8	1.1	1.4	1.6	2.2	2.8	3.3	4.4	5.0	5.5			
40	0.9	1.3	1.6	1.9`	2.5	3.1	3.8	5.0	5.6	6.3			
45	1.1	1.4	1.8	2.1	2.8	3.5	4.2	5.6	6.4	7.1			
50	1.2	1.6	2.0	2.4	3.1	3.9	4.7	6.3	7.1	7.8	9.8		
55	1.3	1.7	2.2	2.6	3.4	4.3	5.2	6.9	7.8	8.6	10.8		
60	1.4	1.9	2.4	2.8	3.8	4.7	5.6	7.5	8.5	9.4	11.8	15.1	
65	-	-	-	3.1	4.1	5.1	6.1	8.2	9.2	10.2	12.8	`16.3	20.4
70	-	-	-	3.3	4.4	5.5	6.6	8.8	9.9	11	13.7	17.6	22.0
75	-	-	-	3.5	4.7	5.9	7.1	9.4	10.6	11.8	14.7	18.8	23.6
80	-	-	-	3.8	5.0	6.3	7.5	10.0	11.3	12.6	15.7	20.1	25.1
90	-	-	-	4.2	5.6	7.1	8.5	11.3	12.7	14.1	17.7	22.6	28.3
100	-	-	-	4.7	6.3	7.8	9.4	12.6	14.1	15.7	19.6	25.1	31.4
110	-	-	-	5.2	6.9	8.6	10.4	13.8	15.5	17.3	21.6	27.6	34.5

120	-	-	-	5.6	7.5	9.4	11.3	15.1	17	18.8	23.6	30.1	37.7
130	-	-	-	-	8.2	10.2	12.2	16.3	18.4	20.4	25.5	32.7	40.8
140	-	-	-	-	8.8	11.0	13.2	17.6	19.8	22.0	27.5	35.2	44.0
150	-	-	-	-	9.4	11.8	14.1	18.8	21.2	23.6	29.4	37.7	47.1
200	-	-	-	-	-	15.7	18.8	25.1	28.3	31.4	39.2	50.2	62.8
250	-	-	-	-	-	19.6	23.6	31.4	35.3	39.2	49.1	62.8	78.5
300	-	-	-	-	-	-	28.3	37.7	42.4	47.1	58.9	75.4	94.2
400	-	-	-	-	-	-	-	50.2	56.5	62.8	78.5	100.5	125.6

Specification for mild steel tubes and tubulars confirming to IS-1239(Part-I): 1990

Nominal bore (NB)		Class	Outside Diameter Max min		Thick-ness	SWG	Mass of Black tube		Black plain End		Calculated weight of Galvanised tube		Galvanised		
											Plain end	S&S			
MM	Inches		MM	MM	Mm		Kg/m	Kg/m	m/t	f/t	Kg/m	Kg/m	M/T	F/T	PCS/ BDLE
15	½"	L	21.40	21.0	2.0	14	0.947	0.956	1056	3465	0.999	1.008	992	3255	160
		M	21.80	21.0	2.6	12	1.21	1.22	826	2710	1.264	1.274	785	2575	130
		H	21.80	21.0	3.2	10	1.44	1.45	694	2277	1.494	1.504	665	2182	110
20	3/4"	L	26.90	26.4	2.30	13	1.38	1.39	752	2379	1.441	1.451	689	2260	112
		M	27.30	26.5											

Approximate weight of wire in kg per 1000 meter

		Steel	Copper
23/24 G	0.60 mm Φ	2.49	2.77
21/22 G	0.8 mm Φ	4.01	4.47
19/20 G	1.00 mm Φ	6.27	6.98
18 G	1.25 mm Φ	9.8	10.9
16 G	1.6 mm Φ	16.04	17.86
14 G	2.00 mm Φ	25.08	27.91
12 G	2.5 mm Φ	39.40	43.4
10 G	3.15 mm Φ	62.00	70.00

J) Hoop iron -20 G 20 mm width -13 kg/100 Metre
25 mm -19.4 kg/100 Metre

K) Weight of prestressing wires and strands

Cable size	Internal diameter of sheathing in mm	Weight of cable in kg / meter
12 nos 5 mm wire	30	1.850
12 nos 7 mm wire	39	3.625
12 nos 8 mm wire	42	4.735
13 mm strand	-	0.735

L) Nominal weight of plain galvanized sheet in kg /m2

Gauge	Thick-ness mm	Class I with 750 G zinc coating	Class II with 600 G zinc coating	Class III with 50 G zinc coating	Class IV with 378 G zinc coating
24 G	0.63	5.7	5.55	5.4	5.32
22 G	0.8	7.03	6.88	6.73	6.66
20 G	1.00	8.6	8.45	8.3	8.22
18 G	1.25	10.56	10.41	10.26	10.19
16 G.	1.60	13.31	13.16	13.01	12.94

M) **C.I S/S** Pipes Both centrifugally cast & vertically cast up to 750 dia and above this size only vertically cast

Details		Total weight of a pipe		
Nominal dia of pipe	Nominal length of pipe	LA class 20 kg/ cm2 test pressure	Class A of 25kg/cm2	Class B of 30 Kg/cm2
80 Φ	4.5 m	64 kg	69.5 kg	74.5 kg
100 Φ	5.5m	109	120	128
150 Φ	5.5m	177	194	209
200 Φ		259	281	304
300 Φ		450	492	533
400 Φ		690	754	814
450 Φ		832	914	986
600 Φ		1298	1417	1535
750 Φ		1876	2051	2225
900 Φ			2791	3024
1200 Φ			4623	4993
1500 Φ			7223	7833

N) Flange pipes vertically sand cast pipes

Nominal dia	Barrel weight kg of One metre		Approx wt of one Flange	Dia of Bolts in mm	No of Bolts
	Class A	Class B			
80 Φ	16.0	17.3	3.7	16 Φ	4
100 Φ	20.5	22.0	4.2	16 Φ	8
150 Φ	33.2	35.9	6.7	20 Φ	8
200 Φ	48.1	52.1	9.3	20 Φ	8
300 Φ	84.0	91.4	14.8	20 Φ	12
400 Φ	128.7	139.5	23.4	24 Φ	16
450 Φ	156.0	169.0	26.5	24 Φ	20
600 Φ	241.0	262	44	27 Φ	20
750 Φ	348.9	380.6	69.8	27 Φ	24
900 Φ	474.3	516.6	94.6	30 Φ	28
1200 Φ	783.1	851.6	173	36 Φ	32
1500 Φ	1222.1	1333.1	276.2	39 Φ	40

C.I rain water pipe (IS 1230:1957)

Internal Bore	Weight per pipe of 1.8 m Length
75 mm	11.0 kg
100 mm	14.0 kg
150 mm	26.0 kg

Weight of spirals (hard -drawn steel) in socket of R/R Joint RCC pipes of different Classes (kg/no)

Internal dia in mm of pipes	NP2 Class	NP 3 Class	NP 4 Class	P1 Class	P2 Class	P3 Class
1	2	3	4	5	6	7
80	.08	0.08	0.08	0.08	0.08	0.08
100	0.09	0.09	0.09	0.09	0.09	0.09
150	0.12	0.12	0.12	0.12	0.12	0.15
200	0.14	0.14	0.21	0.14	0.21	0.35
225	0.15	0.15	0.26	0.15	0.26	0.43
250	0.16	0.16	0.31	0.16	0.31	0.51
300	0.45	0.45	0.53	0.45	0.53	0.84
350	0.51	0.64	0.64	0.51	0.74	1.24
400	0.56	0.71	0.71	0.56	0.99	1.66
450	0.63	0.76	0.76	0.63	1.23	2.26
500	0.68	0.87	1.08	0.68	1.57	2.85
600	0.81	1.00	2.12	1.52	2.88	4.74
700	0.92	2.16	3.02	1.79	3.96	6.79
800	1.14	2.87	4.67	2.04	6.28	9.99
900	1.50	4.06	6.03	2.63	8.29	-
1000	1.91	-	-	3.33	1.29	-
1100	2.34	-	-	4.08	-	-
1200	2.8	-	-	4.9	-	-
1400	3.82	-	-	-	-	-
1600	5.64	-	-	-	-	-
1800	7.25	-	-	-	-	-
2000	11.78	-	-	-	-	-
2200	12.88	-	-	-	-	-

Note 1 Longitudinal Reinforcement shall be proportional to the length of socket cage

Note 2 If mild steel used for spiral reinforcement, the weight specified above shall be increased to 140/125.

Weight of concrete pipes

No	Material	Internal Dia in mm	Weight Kg/Rmt
1	Class NP 1 (unreinforced non pressure pipes)	80	19
		100	22
		150	31
		250	41
		300	71
		350	86
		400	97
		450	110
2	Class NP 2 (Reinforced concrete light duty, non pressure pipes)	80	20
		100	24
		150	33
		250	52
		300	75
		350	92
		400	104
		450	128
		500	141
		600	193
		700	223
		800	287
		900	358
		1000	438
		1200	620
		1400	834
		1600	1013
		1800	1283
3	Class NP 3 (Reinforced concrete heavy duty, non pressure pipes)	350	240
		400	269
		450	297
		500	325
		600	410
		700	470
		800	604
		900	754
		1000	829
		1100	1054
		1200	1140

4	Class P 1 (Reinforced concrete pressure pipes safe for 2 kg per cm2)	80	20
		100	24
		150	33
		250	52
		300	75
		350	92
		400	104
		450	128
		500	141
		600	193
		700	223
		800	287
		900	358
		1000	437
		1100	525
		1200	620
5	Class P 2 (Reinforced concrete pressure pipes safe for 4 kg per cm2)	80	20
		100	24
		150	33
		250	63
		300	103
		350	134
		400	170
		450	188
		500	230
		600	326
6	Class P 3 (Reinforced concrete pressure pipes safe for 6 kg per cm2)	80	20
		100	24
		150	34
		250	75
		300	117
		350	168
		400	208

Use of unreinforced and reinforced concrete pipes

Class	Description	Conditions where normally used
NP 1	Unreinforced concrete non-pressure pipes	For drainage and irrigation use above ground or in shallow trenches
NP2	Reinforced concrete, light duty, non-pressure pipes	For drainage and irrigation use for culverts carring light traffic
NP3	Reinforced concrete , medium duty , non-pressure pipes	For drainage and irrigation use for culverts carrying medium traffics
NP4	Reinforced concrete, heavy duty non-pressure pipes	For drainage and irrigation use for culverts carrying heavy traffic such as railway loading
P1	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.2 MPa ,(20m head)	For use on gravity mains , the site test pressure not exceeding 2/3 of the hydro static test pressure.
P2	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.4 MPa ,(40m head)	For use on pumping mains , the site test pressure not exceeding half of the hydro static test pressure.
P3	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.6 MPa ,(60m head)	-do-

Cast iron floor/Nahni traps (Ref IS 3989:1984)

Des-Creation	Designation Diameter / Size (Nominal Bore of Out let)	Diameter Of inlet Grating	Total depth	Weight (approx) of each trap
Cast iron Floor trap	50 mm	100 mm	175 mm	2.5 kg
	75	100	225	4.8
	100	200	296	7.5
Cast iron Nahni trap	50	165	175	5.5
	75	165	225	6.5

Barbed wire – 2 ply

Gauge	Gap b/w 2 barbs	Length in a bundle of ½ CWTor 25 kg
12 ^{G}	75 mm	153 m
14 ^{G}	75 mm	300 m

Galvanized steel barb fencing wire

Description	Weight of		Length/ ton
	100 yd	100 m	
12 SWG line wire	Lb	Kg	M
2 Point ordinary : Barbs round 1 wire only 5" apart	19	9.43	10602
2 Point ordinary : Barbs round 1 wire only 6"apart	18.5	9.18	10890
2 Point Thickset : barbs round 1 wire only 2.5" apart	21	10.42	9594
4 Point ordinary : Barbs round 1 wire only 6" apart	20	9.92	10080
4 Point Thickset : Barbs round 1 wire only 3" apart	25	12.40	8064
4 Point ordinary : Barbs round both wire only 6" apart	20	9.92	10080
4 Point Thickset : Barbs round 1 wire only 3" apart	25	12.4	8064
14 SWG line wire			
4 Point Thickset : Barbs round 1 wire only 3" apart	16	7.94	12600
4 Point Thickset : Barbs round 1 wire only 6" apart	13	6.45	15516

Minimum weight bitumen felt in kg

Bitumen felts are available in widths of 90 cm and 100 cm and in length of 10m or 20 m

Sno	Type of felt	For 10 M^2				
		Untreated base	Saturant	Contant	Bitumen content	Minimum wt of the finished bitumen felt in dry condition with mica powder
A	Fibre base					
	1) Type 1 under lay	4.0	3.6	-	3.6	7.6
	2) Type 2 Self Finished felt	5.0	4.5	12.9	12.0	22.6
B	Hessain base					
	1)Type 3 self Finished Felt grade 1	2.3	1.8	17.7	12.1	23.0
	2)Type3 Self finished felt Grade 2	2.3	1.8	31.8	20.2	37.1

Standard Wire Gauge

SWG Dia	Dia (Inch)	Dia Mm	SWG No	Dia (inch)	Dia Mm	SWG Dia	Dia (inch	Dia Mm
7/0	0.500	12.7000	13	0.092	2.2368	32	0.0108	0.2743
6/0	0.465	11.7856	14	0.080	2.030	33	0.0100	0.2540
5/0	0.432	10.9728	15	0.072	1.8288	34	0.0092	0.2347
4/0	0.400	10.1600	16	0.064	1.6256	35	0.0084	0.2134
3/0	0.372	9.488	17	0.056	1.4224	36	0.0076	0.1930
2/0	0.348	8.8392	18	0.048	1.2199	37	0.0068	0.1727
1/0	0.324	8.2296	19	0.040	1.0160	38	0.0060	0.1524
1	0.300	7.6200	20	0.036	0.9144	39	0.0052	0.1321
2	0.276	7.0104	21	0.032	0.8128	40	0.0048	0.1219
3	0.252	6.4008	22	0.028	0.7112	41	0.0044	0.1118
4	0.232	5.8928	23	0.024	0.6096	42	0.0040	0.0106
5	0.212	5.3848	24	0.022	0.5588	43	0.0036	0.0914
6	0.192	4.8168	25	0.020	0.5080	44	0.0032	0.0613
7	0.176	4.4704	26	0.018	0.4572	45	0.0028	0.0711
8	0.160	4.0640	27	0.0164	0.4166	46	0.0024	0.0610
9	0.114	3.6576	28	0.0148	0.3759	47	0.0020	0.0580
10	0.128	3.2515	29	0.0136	0.3454	48	0.0016	0.0406
11	0.116	2.9454	30	0.0214	0.3150	49	0.0012	0.0305
12	0.104	2.6416	31	0.0116	0.2946	50	0.0010	0.0254

THEORITICAL CEMENT CONSUMPTION

Sno	Description of item	Mix by Volume	Unit	Cement In Kg	Constant In bags
	Cement concrete				
1	Mixed cement concrete delivered on bunker	1:1.5:3	Cum	402.83	8.05
		1:2:4		308.53	6.17
		1:2:5		268.55	5.37
		1:2.5:4		253.18	5.06
		1:3:6		213.20	4.26
		1:4:8		161.95	3.24
		1:5:10		129.15	2.58
		1:7:12		104.55	2.09
2	Mixed cement concrete using all in aggregate delivered on bunker	1:5	Cum	312.63	6.25
		1:6		264.45	5.29
		1:8		206.03	4.12
		1:12		138.38	2.77
	MORTARS				
3	Cement and sand mortars	1:1	Cum	1058.82	21.18
		1:2		699.05	13.98
		1:3		493.03	9.86
		1:4		382.33	7.65
		1;6		254.20	5.08
		1:8		192.70	3.85
4	Gauged mortar(cement lime and sand mortar)	1:1:6	Cum	244.98	4.90
		1:1:8		189.63	3.79
		1:2:9		164.00	3.28
		1:5:10		147.60	2.95
		1:7:12		120.95	2.42
5.	**BRICKWORK**				
				Old size	Modular
	Brickwork in well burnt bricks straight on plan or to curve exe 6M mean inner radius, built in cement, built in gauged mortar	1:3	Cum	123.00	113.38
		1:4		95.84	87.96
		1:6		64.05	58.47
		1:8		47.98	44.32

6	**Stone masonry**				
	Walling of random or polygonal rubble uncoarsed or brought upto coarses well bonded bedded and solidly hearted in cement mortar	1:3	Cum	147.60	2.95
		1:4		114.80	2.29
		1:6		65.00	1.51
		1:8		58.94	1.18
7	Walling of random or polygonal rubble uncoarsed or brought upto coarses well bonded bedded and solidly hearted in gauged mortar	1:1:6	Cum	73.80	1.48
		1:1:8		114.80	2.29
		1:1:9		49.71	0.99
8	**Plastering**				
	10mm (1/2") th. Rendering or screeding on bricks or concrete surface in cement and sand mortar	1:2	Sqm	11.79	0.24
		1:3		8.41	0.17
		1:4		6.77	0.14
		1:6		4.66	0.09
9	10mm (1/2") th. Rendering or screeding on bricks or concrete surface in cement and gauged mortar	1:1:8	Sqm	3.38	0.07
		1:2:9		2.82	0.06
10	10 mm (1/2") th. Rendering or screeding on stone masonry surfaces or lathing in cement and sand mortar	1:2	Sqm	15.68	0.31
		1:3		11.17	0.22
		1:4		8.41	0.17
		1:6		5.64	0.11
11	10 mm (1/2") th. Rendering or screeding on stone masonry surfaces or lathing in cement and gauged mortar	1:1:8	Sqm	4.20	0.08
		1:2:9		3.64	0.07
		1:4		2.51	0.05
12	Add to or deduct from serial item no. 8 &10 for each 5mm(1/4") th. In CM over or under 10 mm (1/2") on concrete, brick, lathing or stone masonry surfaces	1:2	Sqm	4.77	0.10
		1:3		3.38	0.07
		1:4		2.51	0.05
		1:6		1.69	0.03
13	-ditto- item no.9&11 in gauged mortar	1:1:8	Sqm	1.38	0.03
		1:2:9		1.13	0.02

14	**POINTING**				
	Raking cut joints to a depth of 10 mm and flush keyed or stuck pointing on brick work	1:2	Sqm	2.51	0.05
		1:3		1.69	0.03
		1:4		1.39	0.03
15	Raking cut joints to a depth of 10 mm and flush keyed or stuck pointing on random rubble masonry, uncoarsed or brought to coarses, with 20mm thick joints in CM	1:2	Sqm	2.51	0.05
		1:3		1.69	0.03
		1:4		2.83	0.06
16	Struck, keyed or flush pointing to squared rubble coursed or uncoursed walling in cement mortar	1:2	Sqm	1.39	0.03
		1:3		1.13	0.02
		1:4		0.85	0.01
17	Bastard tuck or manson's V-joint pointing to squared rubble coursed or uncoursed masonry in cement mortar	1:2	Sqm	5.02	0.10
		1:3		3.64	0.07
		1:4		2.82	0.06
18	Bastard tuck or manson's V-joint pointing to random rubble masonry uncoursed or brought to coarses in cement mortar	1:2	Sqm	5.02	0.10
		1:3		3.64	0.07
		1:4		2.82	0.06
19	**Brick Flooring**				
	Hard burnt brick floors, laid flat jointed and pointed flush in cement and sand mortar	1:3	Sqm	11.17	0.22
		1:6		5.64	0.11
20	- ditto- but bricks laid on edge ditto	1:3	Sqm	15.68	0.31
		1:6		8.41	0.17
21	**Surface finishing to concrete floors**				
	Flooring with wool or steel hand float as ordered cement concrete floor surface to fair and even surface using extra cement		Sqm	1.38	0.03
22	**Granolithic Flooring**				
	30 mm thick granolithic concrete floor tapping	1:1:2	Sqm	16.09	0.32

	spread over ordinary concrete floors etc, including floating or troweling to an even and fair surface				
23	10 mm (3/8") thick layer of terrazzo (consisting of one part of mixture of cement and marble powder to 1.5 parts of approved crushed stone chipping, 4 to 7 mm size laid level or to false including cut and polished finish	1:1:5	Sqm	8.71	0.17
24	**Terrazzo flooring**				
	10 mm thick layer of terrazzo (consisting of 3 parts of cement mixed with one part of marble powder by weight; and one part of such mixture by volume mixed with 1.5 parts by volume of crushed marble or other approved stone chippings laid to levels or false	1;1:2	Sqm	8.71	0.174

Consumption of Building Materials
Mortars : Estimation of quantity of materials

Sl no	Mortar Mix (unit 1 M^3)	Unit	Requirement of materials			
			Sand (M^3)	Cement		Lime (M^3)
				M^3	Bags	
1	1 cement : 1 fine/ coarse sand	1 Cum	0.7125	0.7175	20.4	
2	1 cement : 2 fine/ coarse sand	- do-	0.95	0.475	13.6	
3	1 cement : 3 fine/ coarse sand	- do-	1.07	0.357	10.2	
4	1 cement : 4 fine/ coarse sand	- do-	1.07	0.268	7.6	
5	1 cement : 5 fine/ coarse sand	- do-	1.07	0.214	6.2	
6	1 cement : 6 fine/ coarse sand	- do-	1.07	0.178	5.0	
7	1 cement : 1 lime putty : 6 sand	- do-	1.07	0.178	5.0	0.178
8	1 cement : 2 lime putty : 9 sand	- do-	1.07	0.119	3.4	0.238

Note : one quintal of un slaked lime will yield approximately 0.158 cum of lime putty . one quintal of unslaked lime occupies 0.129 cum by volume.

Masonry : Estimation of quantity of materials .

Sl no	Masonry type (unit 1 M^3)	Mortar requirement	Mortar mix	Bricks (no)	Sand in M^3	Quantity of cement	
						M^3	Bags
1	Brickwork	25 %	1: 6 `	494	0.27	0.045	1.3
2	Brickwork	25 %	1:5	494	0.27	0.054	1.6
3	Brickwork	25 %	1: 4	494	0.27	0.067	1.9
4	Brickwork	25 %	1: 3	494	0.27	0.089	2.6
5	Random rubble Stone masonry	30 %	1:6	Stone 1 cum bond stones 7 no	0.35	0.059	1.7
6	Coursed rubble Stone masonry	33 %	1 : 6	Stone 1.21 cum bond stone 7 no	0.32	0.054	1.5

Concrete : Estimation of quantity of materials

Sl no	Concrete mix	Coarse aggregate (M^3)	Sand (M^3)	Cement	
				M^3	Bags
1	1 :1 :2	0.85	0.43	0.425	12.2
2	1 :1.5 :3	0.85	0.43	0.283	8.0
3	1 :2 :4	0.89	0.45	0.223	6.4
4	1 :3 :6	0.92	0.46	0.154	4.4
5	1 :4 :8	0.95	0.48	0.118	3.4
6	1 :5 :10	0.97	0.46	0.091	2.6

- Cement bag weighing 50 kg has volumetric content of 0.035 cum

RCC : Estimation of quantity of reinforcement

Reinfocement as % of concrete volume	Volume of steel (M^3)	Quantity of steel (kg)	For rough estimation of reinforcement in RCC the following rule of thumb may be adopted	Quantity of steel in kg/ M^3 of concrete volume
1	0.01	78	Lightly reinforced structures (slabs etc)	70
2	0.02	157	Medium reinforced structures (beams etc)	80-90
3	0.03	235	Heavily reinforced structures (columns, T beams ,etc)	110-120

Plastering : Estimation of quantity of materials

Thickness of plaster (mm)	Mortar quantity (M^3)	Cement : sand(1:3)		Cement :sand (1:4)		Cement : sand(1: 6)	
		Cement (Bags)	Sand(M^3)	Cement (Bags)	Sand(M^3)	Cement (Bags)	Sand(M^3)
6	0.072	0.73	0.077	0.55	0.077	0.37	0.077
10	0.12	1.22	0.128	0.91	0.128	0.61	0.128
12	0.144	1.47	0.154	1.10	0.154	0.73	0.154
15	0.172	1.75	0.184	3.31	0.184	0.88	0.184
18	0.216	2.2	0.231	1.65	0.231	1.1	0.231
20	0.224	2.29	0.240	1.71	0.240	1.14	0.240

Pointing : Estimation of quantity of materials

Item (unit 10 M^2)	Mortar (M^3)	Sand (M^3)	Quantity of cement	
			Cum	Bags
Brick masonry walls	0.03	0.032	0.0107	0.31
Brick masonry walls*	0.046	0.049	0.016	0.47
Brick Flooring	0.02	0.022	0.0072	0.2
Brick tile work	0.046	0.049	0.016	0.47
Stone work	0.023	0.025	0.008	0.24
Stone work *	0.038	0.41	0.014	0.039
Sand stone slab pavement	0.015	0.016	0.0053	0.16

Note : The above estimate of quantities is for mortar mix 1: 3 The estimate of quantities is for raised and cut pointing

Flooring : Marble stone : Estimation of quantity of materials

Item (unit 10 M^2)	Under layer			Marble slab (M^2)	White cement (kg)
	Bedding mortar(M^3)`	Coarse sand(M^3) `	Cement (kg)		
Marble stone flooring with 20 mm thick marble stone over 20 mm avg thick base and jointed with grey cement slurry including rubbing and polishing	0.224	0.24	85.7 + 44.0 *	11.5 incl of 15 % wastage	6.0 for grouting joints

complete with base mortar of 1: 4					
30 mm thick marble slab in risers of steps, skirting , dado , walls and pillars laid on 12mm thick (avg) base of cement mortar 1: 3 and jointed with grey cement slurry including rubbing and polishing complete	0.144	0.154	73.4+44.0	11.5 including wastage	6.0 for pointing

***I**nclusive of grey cement for slurry @ 4.4 kg/sqm

Painting and Polishing

Pain preserves, protects and decorates surfaces and enables them to be cleaned easily.

Types of paints: There are seven types of paints, used commonly are :

i) Oil paints: These are the traditions type having a linseed oil medium. Finishes vary from flat to oil-gloss. Oil paints dry by evaporation of the solvent and by oxidation, synthetic paints have replaced them.

ii) Synthetic paint: The medium for these is a chemical compound, one type being oil-modified alkyd resin. They have the advantage over oil paints in setting more qu9ickly and offering greater durability where corrosion is a main concern. They also have better flow and are easier to apply.

iii) Water paints: Known also as distempers they are used mainly on internal walls and ceilings and most of them give a flat finish. They have a drying oil or varnish medium emulsified in water. They are prepared on the site by adding water to make a paste. Emulsion paint has super ceded water paint.

iv) Emulsion Paints: These are mostly used on wall surfaces. Oil bound distemper is a type of emulsion paint. An emulsion paint has the pigments and medium dispersed as small globules in water. Oil, synthetic resin and bitumen are the common mediums. Among different emulsion paints are alkyd, bitumen, polyvinyl acetate and styrene emulsion paints. The finish obtained is flat to egg shell gloss.

v)Varnishes: These are of two kinds, oil varnish and spirit varnish. They are used to give a transparent film to a surface. The relative proportion of the oil and the resin control the usage; if the oil is predominant a more elastic varnish results for external work. If the solvent is the major ingredient, a high gloss, which dries rapidly, is obtained for internal work. Spirit varnishes are solution of shellac and other spirit resins dissolved in commercial alcohol (methylated spirits). They are only suitable for internal surfaces like furniture (e.g. is French polishing). Poly urethane varnish is a type of resin varnish producing a very durable finish.

***vi) Cellulose Paints*:** They are mostly used as spray paints in car industry because they dry very quickly by evaporation of solvents. They are not satisfactory for general building work but can be used for furniture and fittings in houses.

vii) Special paints: Among the many kinds are aluminum paints, bituminous paints, chlorinated rubber paints, fire-resistant paints, heat-resisting paints, fungicidal paints, texture paints etc., These are used for special applications and manufacturer's instructions should be followed for thinning and applications of the required number of coats.

Schedule for painting New Surfaces:

Sno	Type of finish	Primer coat	Under coat	Finishing
1	White wash	1 coat of white wash	-	2coats
2	Color wash	1 coat of color wash	-	2coats
3	Dry distemper	Clear Cole, size, etc	Filler to be used if required	2coats
4	Oil bound distemper	1 coat of alkali resistant cement primer	-do-	2coats
5	Emulsion paint	1 coat of emulsion paint	-do-	2coats
6	Flat/ semi gloss paint	1 coat of alkali resistant cement primer	-do-	2coats
7	Acrylic emulsion	1 coat of alkali resistant cement primer	-do-	2coats
8	Cement paint	1 coat of cement paint	Nil	2 coats

Spreading Capacity of Different Paints

Type of finish	**Covering capacity (New work)**
Internal finishes:	
Lime for white washing	33-34 m^2 / quintal for 3 coats
Plastic emulsion paints on primed and puttied smooth surfaces by brushing	30-35 m^2 / lt/coat 19-20 m^2/ lt for 2 coats 13-14 m^2/ lt for 3 coats
Washable oil bound distemper, spreading by brushing	20-25 m^2/ kg per coat 12-15 m^2/ kg per 2 coats 7-8 m^2/ kg for 3 coats
Cement primer	20-25 m^2/ lit coat

Exterior wall finishes	
Acrylic emulsion paints	5.5-6.0 m^2/lit for 2 coats
Cement paints	2 – 4 m^2a/kg for 2 coats for Cement-sand plaster, depends on its texture
Metal/ Wood finishes	
Synthetic enamel paint	15-22 m^2/ lit /coat 10-12 m^2/lit for 2 coats
Aluminum paint (dual pack)	20-22 m^2/lit / coat
Metal primer	18-20 m^2/ lit /coat
Wood Primer	18-20 m^2/ lit /coat
Clear Wood Finishes	
Copal varnish	10-13 m^2/ lit /coat
French polish (ready mixed)	12-15 m^2/ lit /coat
Melamanised finishes	8-10 m^2/ lit /coat by brushing 5-6 m^2/ lit /coat by spraying
Poly urethane clear wood finish by brushing	8-10 m^2/ lit /coat
Sealer	8-10 m^2/ lit /coat by brushing

Measurements: Equivalent Plain Areas of Uneven surface

SN	Description of work	How measured	Multiplying co-efficient
1	Paneled or framed and braced doors, window, etc	Measured flat[$]	1.3 (each side)
2	Flush doors	-do-	1.2(each side)
3	Part paneled and part glazed or gauzed doors, windows, etc.,	-do-	1.0(each side)
4	Fully glazed or gauzed doors, windows etc	-do-	0.8(each side)
5	Fully venetioned or louvered doors, windows etc	-do-	1.8(each side)
6	Trellis(or jaffri) work one way or two way	Measured flat[#]	2 for painting all over
7	Carved or enriched work	Measured flat	2(each side)
8	Wood shingle roofing measured flat	1.0(each side)	
9	Boarding with cover fillets	Measured flat	1.05(each

	and match boarding		side)
10	Tiles &slate battering	Measured flat,#	0.8 for painting all over
	Steel work, doors, windows etc		
11	Plain sheet steel doors &windows	Measured flat	1.1(each side)
12	Fully glazed or gauzed steel doors and windows*	Measured flat	0.5((each side)
13	Partly paneled and partly glazed or gauzed doors and windows	Measured flat	0.8(each side)
14	Corrugated sheet steel doors and windows	Measured flat	1.25(each side)
15	Collapsible gate measured flat	measured flat	1.5 for painting all over
16	Rolling shutters of interlocked laths	Measured flat	1.1(each side)
17	Expanded metal , grill work, MS bars in window frame, railing, palisade fencing, balustrade gates inc, standards, braces, stays etc in timber or steel	Measured flat#	1(for paint all over)
18	CGI sheathing in roof, side cladding etc.,	Measured flat(not girthed)	1.14(each side)
19	AC corrugated sheeting in roofs, side cladding, etc	-do-	1.2(each side)
20	Wire gauze shutters including painting of wire gauge	-do-	1.0(each side)

$- Measured flat (Not girthed) including chowkat or frame, edges, chocks, cleats etc shall be deemed to be included in the item.
- No deduction for open spaces, supporting members shall not be measured separately.
*- Excludes painting of wire gauge portion

Essentials for proper welding procedures

1 Correct electrode size
2 Correct current
3 Correct arc length or voltage
4 Correct travel speed
5 Correct electrode angle

Besides the steady sizzling sound that correct arc procedures, the shape of the molten pool and the movement of the metal at the rear of the pool serve as a guide in checking weld quality. In a correctly made deposit the ripples produced on the bead will be uniform and the bead will be smooth , with no over lap or under cut.

1. Correct electrode size

The correct choice of electrodes size involves consideration of a variety of factors, such as the type , position , and preparation of the joint , the ability of the electrodes to carry high current values without injury to the weld metal or loss of deposition efficiency ,

The mass of work metal and its ability to maintain its original properties after welding, the characteristics of the assembly with reference to effect of stresses set up by heat application the practicability of specific requirements as welding quality and cost of achieving the desired results.

2. Correct current

If the current on equipment is too high or low, you are certain to be disappointed in your weld, if too high the electrode melted too fast and your molten pool is large and irregular .If too low, there is not enough heat to melt the base and your molten pool will be too small, will pile up, and look irregular.

3. Correct arc length

If the arc is total long or voltage too high the metal melts off the electrode in large globules which wobble from side to side as the arc wavers, giving a wide, spattered and regular bead with poor fusion arc is too short, or voltage too low, there is not enough heat to melt the base metal property and the electrode quite sticks to the work, giving a high, uneven bead, having irregular rippled with fusion

4. Correct Travel speed

When your speed is too fast your pool does not last long enough, impurities and gas are locked in. The bead is narrow and ripples are pointed. When speed is too slow the metal piles up, the bead is high and wide, with a reference straight ripple

5. Correct electrode angle

The electrode angle is of particular importance in fillet welding and deep groove welding

Generally speaking When making a fillet weld ,the electrode Should be held so that It bisects the angle between the plates (as shown at right) and is perpendicular to the line of weld. If under cut occurs in the vertical member, lower the angle of the arc and direct the arc towards the vertical member.

Causes and cures of common welding troubles

Porous welds why

1. Excessively long or short arc length
2. Welding current too high
3. Insufficient or damp shielding gas
4. Too fast travel speed
5. Base metal surface covered with oil grease, moisture, rust, mill scale, etc
6. Wet unclean or damage electrode

What to do

1. Maintain proper arc length
2. Use proper welding current
3. Increase gas flow rate & check gas purity
4. Properly maintain and store electrodes
5. Reduce travel speed

Cracked welds Why

1. Insufficient weld size
2. Excessive joint restraint
3. Poor joint design and/or preparation
4. Filler metal does not match base metal
5. rapid cooling rate
6. Base metal surface covered with oil grease, moisture, rust, dirt or mill scale

What to do
1. Adjust weld size to part thickness
2. Reduce joint restraint through proper design
3. Select the proper joint design
4. use more ductile filler
5. Reduce cooling rate through preheat
6. Properly clean base metal prior to welding

Undercutting why
1. Faculty electrode manipulation
2. Welding current too high
3. Too long an arc length
4. Too fast travel speed
5. Arc blow

What to do
1. Pause of side of the bead when using a weaving technique
2. Use proper electrode angles
3. Use proper welding current for electrodes size]
4. Reduce arc length
5. reduce travel speed
6. reduce effects of arc blow

Distortion why
1.Improper tack welding and /or faulty
2.Improprer bead sequence
3.Improprer set up and fixturing
4. Excessive weld size

What to do
1. Tack weld parts with allowance for distortion
2. Use of bead sequencing
3. Tack or clamp parts securely
4. Make welds to specified size

Spatter why
1. Arc below
2. Welding current too high
3. Too long an arc length
4. Wet unclean or damaged electrode

What to do
1. Attempt to reduce the affect of arc below
2. Reduce welding current
3. Reduce arc length
4. Properly maintain and store electrodes

Lack of fusion why
1. Improper travel speed
2. Welding current too low
3. Faulty joint preparation
4. Too large an electrode diameter
5. Magnetic arc below
6. Wrong electrode angle

Overlapping why
1. Too slow travel speed.
2. Incorrect electrode angle.
3. Too large an electrode.

What to do
1. Increase travel speed.
2. Use proper electrode angles.
3. Use a smaller electrode size.

Poor penetration why
1. Travel speed to fast.
2. Welding current too low.
3. Poor joint design and/or preparation.
4. Electrode diameter too large.
5. Wrong type of electrode.
6. Excessively long arc length.

What to do
1. Decrease travel speed.
2. Increase welding current.
3. Increase root opening or decrease root face.
4. Use smaller electrode.
5. Use electrode with deeper penetration characteristics.
6. Reduce arc length.

Magnetic arc blow why

1. Unbalanced magnetic field during welding.
2. Excessive magnetism in parts of fixture.

What to do

1. Use alternating current.
2. Reduce welding current and arc length.
3. Change the location of the work connection of the work piece.

Inclusion why

1. Incomplete slag removal between passes.
2. Erratic travel speed.
3. Too wide a weaving motion.
4. Too large an electrode.
5. Letting slag run ahead of arc.
6. Tungsten spitting or sticking.

What to do

1. Completely remove slag between passes.
2. Use a uniform travel speed.
3. Reduce width of waving technique.
4. Use a smaller electrode size of better access to joint.
5. Increase travel speed or change electrode angle or reduce arc length.
6. Properly prepare tungsten and use proper currents.

Handling:

Normally the packing used by manufactures is strong enough to sustain normal handling; Average weight of one wooden case is 50 to 60 kgs. Including the weight of case (The weight can be handled manually also.) with the new developments in materials handling systems, it would not be difficult for nay industry to handling this weight. However, mishandling is going to damage the packing and also the electrodes coating.

What are the main trouble spot, where mishandling is likely

1. Loading & unloading of material. Usually this job is done by persons attached to transporting agencies and neither the supplier nor the receiver has direct control over stage, there can be two alternatives.

i) To reduce the weight to 20/25 kgs.

ii) To increases the weight to 300/400 kgs.

This first alternative can ensure that a person can easily carry the case, and there is less temptation to throw it. Second alternative will mean only mechanized handling, where safer handling can be expected.

But reducing weight per case will result in increased packing cost. On the other hand bulk packing will require suitable mechanized systems an additional investment. Because of these reasons the packing of 50-60 kgs. Electrodes per case reduced to 20/25 kgs.

Storage:

The place where electrodes are stored should have relative humidity below 50% and normal room temp. say 30-35°C. These are ideal conditions. It is also necessary that electrodes are stored in a separate area where oil, grease, and other similar hazardous items are not stored.

Higher humidity results in absorption of moisture by electrode coverings. This moisture is the source for Hydrogen. As we all know, hydrogen can have adverse effects on weldments. For this reason proper storage, handling and conditioning of electrodes in necessary.

AWS A 5.1 recommends the following storage conditions:

AWS Class	Temp.	Relative Humidity
i) E 6010, E6011	Ambient	----------
ii) E 6012, E6013 E 7016, E7018 etc.	30°C +10°C	Max 50%

Electrode manufacturers provide a certain degree of moisture resistant packing by using polythene bags. Numbers of bags used per packet vary from 1 to 3, depending upon the type of

covering and permissible limit of moisture contents in the flux coating.

Coating moisture contents requirements have been specified in AWS / A 5.5 which are reproduced here.

AWS CODING (As per AWS A 5.5)	COATING MOISTURE Maximum percent (after reconditioning)
E 7015 E 7016 } E 7018	0.40
E 8015 E 8016 } E 8018	0.20
E 9015 E 9016 } E 9018	0.15
E 100 E 110 } E 120	0.15
E 12018 Ml	0.10

Since the possibilities of moisture pick up in transportation and storage can not totally eliminated, there is a need for re drying or re baking of electrodes before use. In other words conditioning of the electrodes.

AWS / A 5.1 (Table) recommends re drying of electrodes for conditioning electrode. Manufacture also may be consulted for any special conditioning, procedure required for their products.

A) Cellulosic type electrodes conforming to E6010 and E6011 need no re drying as the moisture picked up by coating has no adverse effect on welding. It has been observed that moisture pick up improves performance.
B) Retile type electrodes conforming to E6012, E6013, E7024 and High iron Oxide/iron Powder type coating electrodes do

not pick up much moisture and hence can be dried to 135°C for 1 hour to drive out the moisture.

C) Low Hydrogen (LH) type electrode coatings are most susceptible to absorption of moisture.

All critical properties like Gr 1 radiography, toughness at subzero temp, resistance to delayed cracking etc. can be obtained by use of LH type of electrodes Hence the proper conditioning of electrodes is very important.

The ideal re drying temperature and time is as follows:

	Temp.	Time
	350°C	1 hour.
Or	250°C	2 hours.

Once the electrodes are re dried, they should be transferred to holding Ovens where temperature should be maintained around 60°C. A few electrodes should be taken at a time from this holding oven. This procedure will ensure that the amount of hydrogen is controlled to desired level.

Failure to control the level of hydrogen will result in serious defects in weldment, such as porosity, cold cracking, reduced toughness etc, these problems increase as the parent metal strength, harden ability and joint restrain increase. Based on the experiment carried out on the 'MOISTURE PICK UP' by LH type, electrodes, it is observed that the 'Coating moisture content' can go as high as 3.2% if the electrodes are exposed to 75% Relative Humidity for a week. If these electrodes are not conditioned before use, they might evolve diffusible hydrogen to the extent of 17/18, ml per 100 gm weld deposit against the acceptable level which vary from, 2 ml to 10ml/100 gms.

From these observations, it is clear that storage & handling play very vital role in obtaining best or worst results. Hence the consumers must strictly follow the recommendations for storage and conditioning of electrodes to avoid tragic consequences in terms of defects, failure and rectifications costs.

Notes on rock and blasting

While Granite and Deccan Trip being of ligneous originate of harder varieties lime stone, sand stone and shale are softer varieties particular of some varieties of rock.

Variety	Sp. Gravity(g/cc)	Solid density Tonne/m^3	Bulk density Tonne/m^3
Basalt	2.8-3.0	3.02	2.00
Dolomite	2.8-2.9	2.87	1.85
Granite	2.6-2.9	2.72	1.78
Lime stone	2.4-2.9	2.64	1.68
Quartzite	2.0-2.8	2.57	1.68
Sand stone	2.0-2.8	2.42	1.52
Shale	2.4-2.8	2.57	1.68
Trap Rock	2.6-3.0	2.78	1.85

It is important to maintain proper records of the following salient points.

1. Blasting ratio: Normally 8 to 10 t/kg. or 3 to 4 m^3 /kg of 80% gelatin with 4 detonators and 1.83 meter of fuse wire.(Qty. of rock broken per kg. of explosive)
2. drilling ratio: 0.42 to 1.5 m^3 /per drill meter of 25mm cartridge.(Qty. of rock broken per mt. of drilling)
3. Secondary blasting: Avg. charge ratio is on 25mm x 200mm cartridge of S.G. 80% for every 2 cu.m. (kg. of explosice/100 cu.m of rock)
4. **Typical charges for primary blasting in hard variety.**

Dia. of hole(mm)	Dia. of cartridge(mm)	Depth of hole(m)	Burden(m)	Spacing(m)	Solid vol. of rock/hole(m^3)	Charge /hole. Kg.	Charge/ratio m^3/ kg.
32	25	1.0	0.6	0.7	0.42	0.14	3.00
		1.5	0.8	1.0	1.20	0.42	2.87
		2.0	1.0	1.1	2.20	0.70	3.14
		2.5	1.1	1.3	3.58	1.12	3.10
		3.0	1.2	1.3	4.68	1.54	

Drill speed & jack Hammers

	In hard rock	In soft rock
Manually	2m/day	4m/day
Mechanical (pneumatic)	4m/hour	8m/hour
Life of steel drill	300m	600m
Life of jack hammer	30,000 Drill meter	

Information on Explosives.

Explosive is a mixture of a mixture of substance whose stable equilibrium is upset if subjected to severe shock resulting in a violent release of energy in the form of shock wave accompanied by rapid conversion of the explosive in to a large volume of gases at high temp. and pressure. In practice the necessary shock is provided by a detonator or detonating fuse.

Blasting Accessories:

1. Exploder
2. Ohm meter
3. Shot-firing cable twin core 300mm long & each core consisting of conductor of atleast 4 copper wires of not less than 0.46mm dia.
4. Wooden stemming rod.
5. Scraper of brass, aluminum or wood to pick the cartridge prior to inserting the detonator or detonating fuse.
6. A crimpier of nonferrous non-sparking material is required for crimping the detonator to the fuse.

Code of good practice in shot-firing:

1. Explosives and detonators should always be separately kept or transported.
2. To deal with explosives only non-sparking materials like wood or brass should be used.
3. To check the shot hole with a scraper or stemming rod before insertion of cartridge.
4. Not to force a detonator to a cartridge.

5. Remove all surplus explosives, vehicles, cover or remove equipment, remove all persons from the site to a safe distance.
6. Install red flag all around at a safe distance with guards to prevent people to enter inside the red zone till all clearance is given by the shot fire.
7. Test the exploder before use.
8. While straightening the lead wires, do not hold the electric detonator by the tube. Grip the wires about 10cm from the detonator with one hand and smooth them out with other. This will avoid any pull on the fuse head.
9. To avoid misfires, avoid damaging the insulation on the lead wires of the electric detonator.
10. To avoid misfires the conductors should be thoroughly cleaned free of grease or dirty wires. While making connections the brae ends of the conductors should be twisted to gather tightly for a length of about 3 cms.
11. Twin core cables have two conductors. Strand of one conductor should not touch the other. Good practice is to stagger the exposed ends in relations to each other.
12. To ensure good insulation and avoid short circuits in wet conditions, use insulating tapes.
13. All connections should be done by shot-firer only. Exploder key should never be parted by him. key should be removed after blaster and cable connection disconnected from the exploder and cable short circuited by twisting together the bare ends of the two conductors.
14. Exploder should be kept in a dry place and similarly the bare conductors.
15. All precautions should be taken against stray currents while blasting near electrically operated machine or high voltage power line.

Procedure for establishing a magazine (for storing explosives)

An application in form 'C' should be made to the regional Controller of Explosives together with six copies of site plan and magazine construction details who will send the applicant a copy of form 'D' showing safety distances. The applicant will send form again to Regional Controller giving actual safety distances who will forward all the documents to Chief Controller of

Explosives (CCE).CCE will then issues a form 'E' plus a draft copy of the license 'L' and will also pass on one copy of site plan to District Magistrate who will issue a 'No Object Certificate'. Based on this, CCE will allow the applicant to proceed ahead with the construction of the magazine and also issue a license in form of 'L'. On completion of the building the Regional Controller will inspect the magazine and endorse the license. The license must be renewed annually. If the Quantity to be stored does not exceed 100 kg. The applicant should obtain a 'No Objection Certificate' from District Authority and forward this along with form 'C' and the necessary plans as in case of large magazine. For storage up to 5 kg. of nitro compounds, 200 detonators and reasonable quantity of safety fuse, an applicant can be. Made direct to the local authorities who are empowered to issue 'J' form license.

Use of Gun powder

a. Up to 10lbs. of Gun powder and fuse wire-no license required in form no 'J' for procurement and storing but blasting license reqd. in form no. 'N'
b. Not more than 8 holes at a time.
c. A tampering rod should be of wood only & not iron.
d. Signaling for warning 200yds. Distance.
In small blast ½ kg. of powder will loosen 2 tons.
In huge blast ½ kg. of powder will loosen 3 tons.

Table of service powder to fill borings:

Dia. of pipes	12Φ	16Φ	19Φ	22Φ	25Φ
Wt. in kg/m	0.12	0.20	0.30	0.40	0.50

Output of plant and machinery (brief notes)

Calculation of output of production/ construction equipments

Production estimating:

The performance of any equipment in terms of output per hour is assessed on the basis of the time required to perform each work cycle. This work cycle can be analysed in terms of fixed element and variable element of time factor.

The production rate in per cum can be worked out on the following basis.

Out put per hour in cum =

$$\frac{60 \text{ minutes} \times \text{Pay load capacity}}{\text{fixed time + variable time (min)}} \times \text{efficiency factor}$$

Ex- working out output of a tipper :

Pay load capacity= 5 cum(9 T of stone metal)

Fixed time = 12 min

Variable time = 15 min Efficiency factor =0.85

Therefore output/ hour = $\frac{60 \times 0.85 \times 5}{15+12}$ =9.44 cum /hr

Hauling equipment

Rear dumper tipper and Rear dumper trailer are generally used as highway hauling units:

Description	Payload capacity Kg	Capacities			
		Stuck (SAE)Kgs	Heaped 3:1 m3	Heaped2:1 (SAE) m3	Fuel consu mption Lt/hr
Dumper Gross engine 320 HP Fly wheel 303 HP Cylinder 6	25410	13.63	15.73	16.97	23.0
Dumper Gross engine 320 HP Fly wheel 303 HP Cylinder 6	22700	12.30	15.00	16.00	22.0

Loader

Output details – Flywheel power loader – Engine capacity -112HP- Payload 2722kg(1.53m3 heaped capacity)

One way distance in mt	Average speed Km/hr	Cycle time in Min	Production /Hr		
			No. of work cycle	Heaped capacity m3	Production in M3
7.5	5	0.5	120	1.53	183.60
15	7	0.57	105	1.53	160.65
22.5	8	0.64	93	1.53	142.29
30	9	0.70	85	1.53	130.05

45	11	0.8	75	1.53	114.75
60	13	0.88	68	1.53	104.04

Bull dozer

Blade types

A) Straight B)Angle

C) U-type D) Cushion type

Output-track type tractor bulldozer with straight blade in cum /hr

Flywheel- HP	One-way haul distance in meters			
	15m	30m	45m	60m
50-75	220	115	78	73
75-125	375	195	132	123
125-200	514	266	180	169
200-275	705	360	246	229

The production of the **spreading equipment** can be worked out by the following formula

$$\text{Time for completing the job (hr)} = \frac{\text{NO of passes x Distance in km}}{\text{Avg.speed(km/hr) x eff. factor}}$$

The production per hour of the compacting equipment can be worked to be reasonable accuracy level with the following formula

Compacted soil /sub base / Asphalt concrete in m 3

$$= \frac{W \times S \times L \times 0.83}{P}$$

W= Effective rolling with width of the compactor in m

S=average speed of compactor in m/hr

L= Compacted thickness of material in m

0.83= Efficiency factor

P= Number of Passes required to achieve desired compaction

Method of computing owning and operating cost of an equipment

In order to work out the cost of the equipment per hour.; it is necessary to understand the various elements constituting

owning and operating cost. To work out owning and operating of any equipment, typical example is given below.

Description of the loader, Fly wheel power 112 HP
Equipment: Rated pay load 2722 kg

A. Landed cost at site i.e. 1.53 m3 GP bucket (for earth)	Rs.15,00,000.00
Less : Tyre replacement cost	Rs. 40,000.00
Landed price less cost of tyre	Rs 14,60,000.00
Less : Resale value	RS 1,50,000.00
B. Net value for depreciation	RS 13,10,000.00

C. Owning cost

1. Depreciation : $\frac{\text{Net depreciated value}}{\text{Life in hr}}$
: 13,10,000/16,000 = 81.88/hr
Estimated Annual use in hrs:16,000 hrs
2. Interest at 12 % and insurance at 1 % =
$\frac{\text{Landed price x \% investment x total annual rate}}{\text{Annual use in hrs}}$
$= \frac{15,00,000 \text{ X } 55\text{X } 13 \text{ X } 1\text{X } 1}{1600 \text{ X } 100 \text{ X } 100} = 67.03$ /hr
Repair cost
3. Tyres : $\frac{\text{Replacement cost}}{\text{Estimated life}} = \frac{40,000}{3200} = 12.50$ Rs
4. Normal repair $\frac{\text{90 \% of landed cost – Tyre cost}}{\text{Total hours}}$
$\frac{0.9 \text{ X } 15,00,000 – 40,000}{16,000} = 81.88$ /hr
Service cost
Fuel : 11 X 4.00 = RS 44 /hr (a)
Lubricant grease Etc : LS = Rs 10 /hr (b)
5. Total service cost : 44+ 10 =Rs 54 /hr
6. Operators salary : Rs 80/8 = Rs 10 /hr
Total owning and
Operating cost /hr : 1.88 + 67.03 +12.50 +81.88 + 54 +10
=Rs 307.29 /hr

List of construction equipments

1. Asphalt batch mix plant (60 – 240 TPH)
2. Asphalt drum mix plant (up to 150 TPH)
3. Asphalt pavers finishes (up to 9 m width)
4. Wet mix macadam plant (300 TPH)
5. Concrete Kerb line machine
6. Bitumen crusher distributors
7. Road marking machine
8. Controls and auto machine for asphalt plant
9. Port handling equipment – Ship loader, grab type un-loader level loafing cranes, surface mining equipment like bucket wheel excavators, spreaders, mobile transfer conveyors.
10. Crushers Jaw crusher ,Cone crusher , VSI
11. Screens - horizontal , inclined
12. Mobile plants – Wheel mounted, Crawler mounted.
13. Weigh batching and mixing plants-120 m3 ,60 m3 30 m3
14. Types of plants – Stationary mixer , Batching star or Lincar bins for storage of aggregates
15. Tower cranes
16. Transit mixer – 4 m3, 6 m3
17. Bull dozer – 180 HP, 165 HP, 90 HP, 66 HP.
18. Hydraulic excavators -0.44- 1.26 m3, 0.44 – 0.7 m3, 0.3 m3.
19. Motor graders 280 HP, 173 HP, 145 HP.
20. Bach hoe loader – 1 cum Loader, 0.24 cum Back hoe.
21. Hydraulic piling rig – 45 Tons (machine class)
22. Telescopic handler – (similar to hydraulic loader)
23. Vibratory soil compactor
24. Pneumatic tyred roller
25. Plate compactors /Tampers
26. Walk behind rollers
27. Tandem compactors
28. Refuse compactors
29. Tandem rollers
30. Tandemibratoryroller

Excavator
Shovel and Back hoes: Output Table

Description	HP of Engine	Fuel Consu-mption/Hr	Width In m	Nature Of Soil	Bucket Capacity M^3	Struck Capcity M^3	Efficiency factor	Cycle time In Min	No Of Work Cyle	Ourpur inno
Hydraulic excavator	275/295	30/31	1.68	Loose soil	3.0	2.4	0.8	2.5	24	46.08
			1.58		2.70	2.16	0.8	2.5	24	41.47
			1.6		2.50	2.000	0.8	2.5	24	38.40
			1.40		1.7	1.36	0.8	2.5	24	26.11

LABOUR AND MATERIAL CONSTANTS (IS 10067-1982) NORTH ZONE

Recommended labour out put constants for building work:

S.no.	Description of work	Unit	Labour	Recommended constant in days.	Remarks.
1)	Excavation over areas (hard/dense soil),depth up to 1.5m and removal (up to one meter from edge)	M^3	Mate Mazdoor	0.06 0.62	_ _
2)	Excavation in trenches (soft/ loose soil),for foundations not exceeding 1.5m in width and for shafts,wells,cesspits and the like, not exceeding 10m3 and on plan, depth up to 1.5m and removal(up to one meter away from edge)	M^3	Mate Mazdoor	0.05 0.50	_ _
3)	Returning, filling and ramming of excavated earth in layers not exceeding 20 cm in depth,watering,well ramming and leveling, lead up to 50m	M^3	Mate Mazdoor Bhisti	0.02 0.25 0.02	_ _ _
4)	Concrete : Mixing by machine (mixer) at	M^3	Mazdoor Bhisti	0.50 0.10	_ _

	banker, cement concrete (with 20mm graded coarse aggregate)		Mixer operator Mixer	0.07 0.07	_ _
5)	Mixer mixed cement concrete	M^3	mason mazdoor bhisti mixer operator mixer vibrator	0.10 1.63 0.70 0.07 0.07 0.07	_ _ _ _ _ _
6)	Reinforced cement concrete in situ in foundations,footings,bases for columns,etc excluding form work and reinforcement	M^3	mason mazdoor bhisti mixer operator mixer vibrator	0.17 2.00 0.90 0.07 0.07 0.07	The constants for items include mixing, pouring, consolidating and curing. This does not include fair finish.
7)	Reinforced cement concrete in situ in suspended floors/roofs excluding form work, and reinforcement.	M^3	mason mazdoor bhisti mixer operator mixer	0.24 2.50 0.90 0.07 0.07 0.07	_ _ _ _ _ _

			vibrator		
8)	Mortars : Mixing by hand, cement mortar of any mix/proportions	M^3	Mazdoor Bhisti	0.75 0.07	Labour required will be approximately same for different mix proportions.
9)	Brick work (straight walls) : Brick work in walls exceeding one brick thick, in cement / lime mortar	M^3	mason mazdoor bhisti	0.94 1.80 0.20	The constants include labour involved in scaffolding.
10)	Brick work in walls, one brick thick, in cement/lime mortar	M^2	mason mazdoor bhisti	0.25 0.40 0.10	The constants could be adopted for brick work with any mix or mortar.
11)	Form work : a) fabrication and erection with all supports, struts, braces, etc, and dressing with oil as cleaning of formwork : 1) rectangular column and walls	 M^3 M^2	Carpenter Mazdoor Carpenter Mazdoor Carpenter Mazdoor	0.25 0.20 0.23 0.20 0.30 0.20	_ _ _ _ _ _

	2) suspended floors/roofs 3) sides and soffits of beam	M^2			
12)	Reinforcement: Bar reinforcement including cutting to length, hooked ends, cranking or bending, hoisting and placing in any position, binding wire and holding firmly so as not to be disturbed while placing and ramming of concrete	Quintal	Bar bender Mazdoor	1.00 1.00	_ _
13)	Plastering and pointing : a) 15mm thick cement plaster to ceiling including mixing of mortar. b) 15mm thick cement plaster on brick walls (exterior) including mixing of mortar c) tuck pointing to random rubble masonry in cement mortar including mixing mortar.	M^2 M^2 M^2	mason mazdoor bhisti mason mazdoor bhisti mason mazdoor bhisti	0.08 0.10 0.10 0.06 0.10 0.10 0.10 0.15 0.10	_ _ _ _ _ _ _ _ _
14)	Damping proof course : a) Laying damp proof course 40mm thick cement concrete including form work and fair finishing to edges and mixing.	M^3	mason mazdoor bhisti	0.10 0.10 0.01	_ _ _

Material constants in mortars:

s.no.	Item(mix by volume)	Constants per m3 of mortar			
		Cement (bags)	Slaked Lime M^3	Surkhi M^3	Sand M^3
1	Cement mortar 1:4 (1 cement : 4 sand)	6.79	_	_	0.9
2	Cement mortar 1:6 (1 cement : 6 sand)	4.65	_	_	0.99
3	composite mortar 1:1:6 (1 cement: 1 lime : 6 sand)	4.48	0.16	_	0.96

Material constants in concrete:

s.no.	Item (mix by volume)	Fineness modulus		Size of course (normal gauge)	Constants per M^3 of mortar		
		Fine agg.	Coarse agg		Cement (bags)	Sand M^3	Shingle M^3
1.	Cement concrete 1:1.5:3 (1 cement : 1.5 sand :3 shingle)	2.87	6.5	20mm	7.33	0.39	078
2.	Cement concrete 1:3:6 (`1cement : 3sand :6shingle)	2.87	6.5	40mm	4.05	0.43	0.86
3.	Cement concrete 1:4:8 (1 cement : 4 sand :8 shingle)	1.26	6.9	40mm	3.2	0.45	0.90

Material constants for Brick work with modular bricks :

Sl no	Description of item	Constants per m3 Frog up			Frog down		
		No of bricks	Cement (bags)	Fine sand M^3	No of bricks	Cement (bags)	Fine sand M^3
1	Brick work on cement mortar 1:4 (1 cement :4 sand)	5.17	1.41	0.200	517	1.26	0.178
2	Brick work on cement mortar 1:6 (1 cement :6 sand)	517	0.96	0.204	517	0.87	0.182
3	Half brick masonry in cement 1:4 (1 cement :4 sand)	506	1.08	0.153	506	0.94	0.133

Material constants for cement concrete flooring

Sno	Description of item	Constants for 10 M^2		
		Cement (bags)	Sand (coarse) M^3	Coarse aggregate M^2
1	75 mm thick cement concrete flooring 1: 2:4 (1 cement : 2 sand :4 Shingle20 mm nominal gauge) finished with a floating coat of neat cement	4.81	0.31	0.62
2	40 mm thick cement concrete flooring 1: 2:4 (1 cement : 2 sand :4 Shingle20 mm nominal gauge) finished with a floating coat of neat	2.80	0.164	0.328

	cement			

Material constants for plastering

Sl no	Description of item	Constants for 10 M^2			
		On traditional brick work		On modular brick work	
		Cement bags	Sand (fine) M^3	Cement bags	Sand (fine) M^3
1	12 mm cement plaster 1:4 (1 cement : 4 sand)	0.98	0.138	0.95	0.134
2	12 mm cement plaster 1:6 (1 cement : 6 sand)	0.67	0.143	0.78	0.139
3	20 mm cement plaster 1:4 (1 cement : 4 sand)	1.53	0.217	1.51	0.213
4	20 mm cement plaster 1:6 (1 cement : 6 sand)	1.05	0.224	1.03	0.220

Reference of IS codes :

IS no	DESCRIPTION OF WORK
5-1978	Color for ready mixed paints & enamels (3 rd revision)
73-1961	Paving Bitumen
206-1981	Tee & strap hinges (3 rd revision)
208-1979	Door handles (3 rd revision)
217-1961	Cut back bitumen (revised)
226-1975	Structural steel (std quality) (5 th revision)
269-1976	Ordinary & low heat Portland cement (3rd revision)
277-1985	Galvanized steel sheets
278-1978	Galvanized steel barbed wire for fencing
303-1975	Ply wood for general purposes
383-1970	Coarse aggregate & fine aggregate from natural sources for concrete
401-1982	Code of practice for preservation to timber
427-1965	Distemper , dry color as reqd (revised)
428-1969	Distemper oil emulsion , color as reqd (1 st rev)
432-1982	Mild steel & Medium tensile steel bars (3rd rev)
455-1976	Portland slag cement
456-1978	Code of practice for plain & reinforced concrete (3 rd rev)
458-1971	Concrete pipes (with & without reinforcement)
516-1959	Methods of test for strength of concrete

525-1968	Varnish, finishing exterior & general purposes
651-1980	Salt glazed Stone ware pipes & fittings
702-1988	Industrial Bitumen
774-1984	Flushing cisterns for water closets &urinals valve ness symphonic action
777-1970	Glazed earthen wave tiles
800-1984	Code of practice for Structural steel in general building constructions
814-1974	Covered Electrodes for metal arc welding of structural steel
816-1969	Code of practice for use of metal arc welding for general construction in mild steel
822-1970	Code of procedure for inspection of welds
1081-1960	Code of practice for fixing & glazing of metal doors (aluminum & steel) windows & ventilators
1195-1978	Bitumen mastic for flooring
1239-1979	Mild steel tubes
1239-1982	Mild steel tubular * other wrought steel pipe fittings
1254-1975	Specifications for Corrugated aluminum sheet
1489-1976	Port land pozzlona cement
1542-1977	Sand for plaster
1566-1982	Hard drawn steel wire fabric for concrete reinforcement
1592-1980	Asbestos cement pressure pipes
1597-1967	Code of practice for construction of stone masonry
1786-1985	High strength deformed steel bars and wires for concrete reinforcement
2065-1983	Code of practice for water supply in building
2202-1983	Wooden flush door ,shutters ,ply wood faces , panels
2386-1963	Methods of test for aggregate for concrete

2645-1975	Integral cement water proofing compounds
2720-1980	Method of test for soils
2911-1985	Code of practice for design and construction of pile and pile foundations
2932-1974	Enamel,synthetic,exterior,under coating and finishing
3043-1987	Code of practice for earthing
3117-1965	Bitumen emulsion for roads
3461-1980	PVC asbestos floor tiles
3764-1966	Safety code for excavation work
4014-1967	Code of practice for steel tubular scaffolding , safety regulations for scaffolding
4648-1968	Guide for electric layout in residential buildings
5410-1969	Cement paint, color as required
6313-1981	Anti Termite measures in building ,constructional measures
6313	Anti Termite measures in building preconstruction chemical treatment measures
6313-1981	Anti Termite measures in building treatment for existing building

Measurement of materials (IS:1200)

Name of material	How measured
Aggregate Bricks/stones of 40mm nominal size and above	In M^3 after making a deduction of 7.5 percent from stack measurements and as per type.
Brick/stone aggregates of less 40mm size cinder, sand, moorum, fly ash, pozzulana, stone, stone dust.	In M^3 of gross stack measurements according to nominal size and type.
Aluminium flats	In kg, stating size
Aluminium strip and edging	In running meter stating size
Asbestos cement products	
Bare boards	Enumerated, stating size.
Ridge	In pairs, according to size and type
Gutters	Enumerated, stating size, type and length
Roof lights, north light curves	Enumerated, stating size and type
Ventilators, eaves fillers, apron pieces,louvers,cowls,ridge finials, septic tanks	Enumerated and described
Bitumen products	
Bitumen felt	In M^3,stating type, grade and width
Bitumen hot sealing compound	By weight, in kg. grade and type
Bitumen road tar	In tones, stating type
Joint filler (sealing compound)	In kg.
Boards	
Plywood,etc	In M^3,stating type and thickness
Brick/brick tiles	Enumerated, stating class and size.
Blocks building (clay, cement, stone, etc.)	Enumerated stating size, type and grade , if any

Cement/lime pozzulana mixture	In kg, stating type
Distemper	In kg.
Doors/windows/ventilators frames	In liner meter and described (outside dimensions measured)
Doors/windows/ventilators (excluding fittings and finishes)	In M^2 and described
Fiber glass felt	In M^2 stating thickness and grade
Filler, fibrous/non fibrous	In $M^2$and described
Fillings for doors and windows	Enumerated
Galvanized steel barbed wire	In kg, stating type and size
Galvanized steel sheets(corrugated/plain)	In quintal or enumerated, stating type and size
Glass sheets(plain/pin head/frosted/wired/splinter proof)	In m2, stating type, thickness and size.
Glass strips	In running metres, stating thickness and width.
Jali (cement concrete/clay)	In M^2,stating thickness and type
Lead for caulking	In kg.
Lime	In kg, stating class
Marble chips	In quintal, stating size and described
Marble dust	In kg.
Marble pieces	In kg, stating colour
Marble slab	In m2,stating thickness and type
Metal beading	In running metres, stating type and size.
Paints, emulsions and thinners	In litres, stating type and class
Paint (stiff) and pigment	In kg, stating type and class
Pipes and accessories	
Pipe fittings	Enumerated and described
Pipes (except mild steel)	In running metres and described

Rope manila	In kg and described
Rubber rings for pipes	Enumerated and described
Steel	
Mild steel sheets	In tones, stating size and thickness
Mild steel expanded metal	In m2 and described
Wire fabric/chain fabric	In m2 and described
Hoop iron/bolts/rivets/structural sections/rails/mild steel pipes	In kg or tones and described
Stone	
Boundary stone/kilometer stone	Enumerated, stating size and type
Kerb stone	Enumerated, stating size
Floor stone slabs	In $M^2$and described
Soiling stone,boulder,rubble	In M^2, after making a deduction of 15 % from gross stack measurements, stating nominal size and type.
Sanitary fittings	
Cisterns/clamps/cocks/ferrules/ footrests/grating/hydrants/traps /bath tubs/urinal/valves/wash basins/WC pans/showers/towel rails/bidets	Enumerated and described
Tiles	Enumerated, stating type and size.
Timber	
Blocks/baulks	Enumerated, stating type and size
Ballies	Enumerated, specifying diameter and described (diameter shall be measured at 1.5m from the thick end)
Bamboos	Enumerated and described
Scantlings/planks/battens	In m3, stating type and size
Tiles (other than sanitary)	In m3, stating type and size
Wall tiles/false ceiling tiles/roofing tiles	Enumerated, stating type and size.
Water proofing compound	In kg

Water proofing paste/emulsion/liquid	In litres
Wire	In kg and described
Wire rope	In running meter and described

Measurement reinforced/plain concrete – recast component

Sn	Classification	Method of measurement
1	Wall panel, floor/roof slabs	In m2.
2	Beams unit and columns, trusses, etc	In running metre or numbers
3	Channel unit and purlins	In running metres or numbers
4	String or lacing course, coping, bed plates, anchor blocks, plain window sills, shelves louvers, steps, staircases, etc.	In running metres or numbers
5	Kerbs, edgings, etc	In running metres or numbers
6	Solid block work	In cubic metres or square metre.
7	Hollow block work	In cubic metres or square metre.
8	Light weight partitions	In square meters stating the thickness
9	Door/window frames	In running meters stating the thickness
10	Waffle units	In square metres or numbers
11	Water tank	In numbers
12	Fallies	In square meters of opening fitted stating thickness
13	Fencing posts	In numbers or cubic metres
14	Folded slab	In cubic metres.

Measurement of plinth and carpet areas of buildings
(Reference IS: 3861 - 1975)

Plinth area shall mean the covered built up area at the floor level of any storey or at the floor level of the basement.

Carpet area shall mean the cover area of the usable rooms at any floor level.

Mezzanine floor – an intermediate floor in between two main floors having minimum height of 2.2 m (or minimum 1.8m where rules of the local bodies permit) from the floor and having proper access to it.

Stairs cover (mumty) is the roofed space over a stair case and its landing, built to enclose only the stair for the purpose of providing protection from weather and not used for human habitation.

Loft is an intermediate storage area in between two main floors.

Porch is a covered surface (with roof supported on pillars or otherwise), used for the purpose of pedestrian or vehicular approach to a building.

Measurement - measure lengths to the nearest 0.01m.work out areas to the nearest 0.01sq.m.

The areas of each of the following categories shall be measured separately:-
(a) Basement (b) floor without cladding (stilted floor) (c) floors including top floor which may be partly covered (d) mezzanine floor, and (e) garage.

Measurement of plinth area – following areas shall be include where occurring in each category of plinth area

(a) Area of the wall at the floor level excluding plinth offsets it any. When the building consists of columns projecting beyond the cladding, the plinth area shall be measured up to external face of the cladding (in case of corrugated sheet cladding outer edge of

corrugation shall be considered) (b) internal shaft for sanitary installations and garbage chute, provided these do not exceed 2 sq.m in area, vertical duct for air conditioning, and lift well including landing (c) stair cover (mumty) (d) machine room, and (e) porch.
The following shall not be included in the plinth area:-

(a)Additional floor for seating in assembly buildings/theatres and auditoriums (b) cantilevered porch (c)balcony (d) area of loft (e) internal sanitary shaft and garbage chute provided these are more than 2 sq.m in area (f) area of architectural band, cornice.,etc., (g) area of vertical sun breaker or box louver projecting out and other architectural features for example slab projection for keeping flower pots (h) open platform (j) terrace at floor one (k) spiral staircase including landing, and (m) towers, turrets domes projecting above the terrace.

Wall area means the area on plan occupied by walls (including thickness of finishing/dado if the height of such finish is more than 1 m from floor finish) on any particular floor and qualifying for inclusions in the plinth area.

The following shall be excluded from the wall area:

(a) Pilaster along wall not exceeding 300 sq.m in area, and

(b) Chullah platform projecting beyond the face of the wall.

Carpet area shall mean the plinth area less the area of following portions:
(a) wall area (b) verandah (c)corridor and passage (d)entrance hall and porch (e) staircase and stair-cover i.e. mumty (in a hall or basement the area of portion up to 1m beyond the last step of staircase shall be treated as part of the staircase) (f)lift shaft and machine room for lift (g) bath room and lavatory (h) kitchen and pantry (j) store (k) canteen (m) air conditioning duct and plant room (n) shaft for sanitary piping (p) stilled floor and garage.

Brief on Specification writing

What is a specification for?
To be read by the contractor's estimator as the only information available on which to prepare a competitive tender.]

To be read by quantity surveyor to enable a bill of quantities to be prepared as a basis for such competitive tenders.
To be read by the clerk of the works and contractor's agent during the progress of the contract as architect's instructions for carrying out the work.

Specification as a basis for tenders

Contractors prepare the tender from drawings and specifications only. Estimators take their own measurement of the work from the drawings and build up their estimates relying on the specification for a full description of quality, materials and workmanship. Besides this, drawings and specifications, when read together, must indicate everything required to be included in the estimate. If any thing is omitted, some thing that is required is not mentioned or shown, or very obviously necessary or implied, such work will not be part of the contract. If it's carrying out is insisted upon, the contractor will be entitled to extra payment.

Specifications for the Quantity Surveyor

Quantity Surveyor may prepare the bill, instructions must be given by the architect as complete as those required by the contractors when taking their own measurements, and these instructions conveyed in a specification. In this case the architect's specification may not become a contract document. Whilst such a specification should be as complete as possible, omissions are not valid as vital as in the first case. So that the quantity surveyor will find the gaps while preparing the quantities, because every stage in the erection of the building has to be visualized, and questions will arise when ever further information is required to complete the specifications preambles. These preambles should be in CAWS (Common Arrangement of Work Sections for building works) order to enable to easy reading with the measured items. The preambles must convey the specification information to enable the bills to fully describe and accurately represent the quantity and quality of the required work as required by the standard method of measurement.

Note: Essentials in drafting a specification

1. To know what one requires
2. To be able to express it clearly.

Simple definitions – Quantity surveying

Estimate: It is defined as the process of calculating the quantities and costs of the various items required in connection with the work. It is prepared by calculating the quantities, from the dimensions on the drawing for the various items required to complete the project and multiplied by unit cost of the item concerned. To prepare an estimate ,drawings consisting of the plan , elevation and the sections through important points, along with a detailed specification giving specific description of all workmanship , properties and proportion of materials , are required.

Detailed estimate : It includes detailed particulars for the quantities, rates and costs of all the items involved for satisfactory completion of a project. Detailed estimates is accompanied by
(a) Report (b) Specifications (c) Detailed drawings showing plans, different sections, key or index plan .etc, (d) Design data and calculations (e) Basis of rates adopted in the estimate .

Preliminary or approximate or rough estimate : This is an approximate estimate to find out an approximate cost in a short time and thus enables the authority concerned to consider the financial aspect of the scheme.

Bill of quantities : The purpose of the Bill of quantities is to provide a complete list of quantities necessary for the completion of any engineering project and when priced gives the estimated cost of the project.

Revised estimate: A revised estimate is a detailed estimate for the for the revised quantities and rates of items of works originally provided in the estimate. Without material of a structural nature from the design originally approved for a project.
Supplementary estimate: While a work is in progress, some changes or additional works due to material deviation of a structural nature from the design originally approved may be

thought necessary for the development of a project. An estimate is then prepared to include all such works is known as supplementary estimate.

Complete estimate: this is an estimated cost of all items which are related to the work in addition to the main contract or to the detailed estimate.

Annual maintenance or repair estimate: After completion of the work it is necessary to maintain the same for its proper function and for the same, an estmate is prepared for the items which require renewal, replacement, repairs etc, in the form of a detailed estimate.

Specifications:

General specifications: In general specifications the nature and class of the work and names of the materials that should be used or described and it forms a general idea for the project.

Detailed specifications: Detailed specifications describe every item of the work in the estimate. These specify the qualities, quantities and proportion of the materials, workmanship, and the method of preparation and execution for different items of works in a project.

Contingencies: the term contingencies indicates the incidental expenses of a miscellaneous character which can not be reasonably predicted during preparation of the estimate.

Work charged establishment: the work charged establishment will include such temporary establishments as or employed for the execution or the immediate technical supervision or departmental stores and machinery in connection with a specific work.

Tools and Plants(T&P) : For the large projects the cost of tools and plants should be considered an amount of 1% to 1.5% of the estimated cost is provided in the estimate.

Supplementary Items: these are the extra substituted items of the works having no approved rates in the contract required for the satisfactory completion of a project, without affecting the drawing and the designs.

Schedule of Rates: To facilitate the preparation of estimates, and also to serve as a guide in settling rates in connection with contract agreements, a schedule of rates for each kind of work commonly executed should be maintained by different engineering departments or authorized organizations and kept up to date.

Re casting of estimate: After an estimate has been technically sanctioned, it may be decided tot make a change in the method originally contemplated for the execution of the work . In such a case, the original abstract should be re-casted for a construction work individually.

Prime cost: Prime cost is the net cost purchased cost of an articles at shop, and refers to the supply of the articles only and not to the carrying out the work. the fitting and fixing charges paid separately. In order to execute such items of work a reasonable amount is provided in the estimate.

Day work: These are paid on the basis of the actual quantity of materials and labour hours required to complete the job and are denoted as day work.

Provisional sum: It is an amount arbitrarily provided by an experienced estimator in the total estimated const of a project to carry out a special type of work whose details cannot be known at the time of preparing the estimate.

Contract value: this is the total amount provided for all schedule items of the work provided in the estimate. And that is the estimated value for the work excluding the amount for the contingencies, work charged establishments, tools and plants etc.,

Contract: An agreement enforceable by law is contract. Invariably follows a proposal from one party and its acceptance by the other.

Tender: Tender is a written offer submitted by the contractors in pursuance of the notification given, to execute certain work or supply of some specified articles or transport of materials at certain rates with terms and conditions laid down in tender documents.

Tender Form: Tender form is a printed standard form of contract giving standard conditions of the contract , general rules and directions for guidance of contractors and also it consists of estimated cost, earnest money, security deposit, time allowed for the work form date of written order to commence, column for signature of contractor before submission of tender.

Different types of contract :

Item rate contract: Contractors are required to quote rates for individual items of work on the basis of schedule of quantities furnished by the department.
Percentage rate contract: The contractors are required to offer to carry out the work at par with the rates shown in the specific price schedule or percentage above or below the rates indicated in the schedule of work attached to the tender.
Lump sum Contract: Contractors are required to quote a fixed sum for execution of a work complete in all respect that is according to the drawing, design and specification supplied to them with the tender within the specified time
Labour contract: Contractors are required to quote rates for item work exclusive of the element of materials which are supplied by the department free of cost.
Materials supply contract: Contractors have to offer the rates for the supply of the required quantity of the materials inclusive of the all local tax, carriage and delivery charges to the specified stores within the time fixed in the tender.
Cost plus percentage contract: In tendering for a 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.
Turnkey contract: The owner contemplating a construction project desires to deal with only one party for all services, both engineering and construction, in connection with the work.
Conditional contract : a Contract is said to be conditional if its performance depends upon some future or uncertain events or contingencies.

Earnest Money: Earnest money is an assurance or guarantee in the form of cash on the part of the contractor to keep open for the offer for consideration and to confirm his intentions to take up the

work accepted in his favour for execution as per terms and conditions in the tender.

Security Deposit: It is an amount of money which shall be deposited by the contractor whose tender has been accepted in order to render himself liable to the department to pay compensation amounting to the part or whole of his security deposit if the work is not carried out according to the specification, time limit and conditions of contract.

Retention Money: When ever any claims for payment of a sum of money arises out of or under the contract against the contractor, the engineer incharge is entitled to withhold and have lien to retain sum in whole or in part from security deposit till finalization or adjustment of any such claim.

Liquidated Damages: It is an amount of compensation payable by a contractor to the owner or vice versa due to delayed construction having no relationship with real damage.

QUICK METHODS FOR ESTIMATING MATERIAL AND LABOUR REQUIREMENTS (CBRI)
Statistical relationships for residential buildings (building portion only)
(A = plinth area of one dwelling in sq.m)

Material/labour	Units	Statistical relations		
		Single storey	Double storey	Four storey
		Load bearing construction (including foundation)		RCC framed construction (including foundation)
Material				
Bricks	100 no.s	2.26A+66.8	2.51A+63	2.56A-0.0096A2-26.2
Cement	Tonne	0.153A+0.57	0.145A+0.54	0.2024A-0.364
Steel	Kg	21.3A-314	21.97A-305	102.46A-0.401A2-1662
Sand	Cu.m.	0.47A-5.6	0.43A-5.6	0.397A-0.38
Coarse aggregate:				
(i) 20mm and down	Cu.m	0.176A-0.21	0.178A-0.21	0.366A-0.76
(ii) 40mm and down	Cu.m	0.145A+1.5	0.075A+0.78	0.0027A+0.0001A2+0.45
Brick aggregate	Cu.m	0.113A-0.83	0.056A-0.42	0.021A+0.01
Timber for :				
(i) frames and shutters	Cu.m	0.019A+0.23	0.019A+0.23	0.02A+0.11
(ii) shuttering	Cu.m	0.0042A	0.0042A	0.0097A-0.03
Ballies for form work	M	0.504A	0.504A	0.936A-2.35
Lime	Q	0.145A-0.35	0.083A-0.17	0.063A-0.08

Surkhi	Cu.m	0.052A-0.37	0.026A-0.18	0.01A
Bitumen	Kg.	1.836A-9	0.918A-0.18	0.357A+0.14
Glass panes	Sq.m	0.047A	0.047A	0.047A
Primer for oil paint	Litre	0.048A	0.048A	0.045A+0.56
Oil paint	Litre	0.08A+0.27	0.08A+0.27	0.075A+0.93
Stone rubble	Cu.m	-	-	0.032A
Labour				
Mason	Day	1.335A+28	1.335A+6	1.593A-2
Carpenter	Day	1.184A-9	1.194A-9	1.66A
Painter	Day	0.19A	0.19A	0.19A
Blacksmith	Day	0.269A-4	0.274A-1.4	1.11A-0.0043A2-17.6
Mazdoor	Day	4.769A+32	4.91A+13	5.833A-9.2

Statistical relationships for office buildings (building portion only)
(A = plinth area of all storeys added up, in sq.m)

Material/labour	Unit	Statistical relationship	Material/labour	units	Statistical relationship
Cement	Tonne	0.1925A+18.52	Steel windows	Sq.m	0.1117A+93.26
Fine sand	Cum	0.03A+105.50	Glass(for glazing)	Sq.m	
Coarse sand	Cum	0.2592A-80.94	Primer for painting Oil paint	Litre Litre	0.0256A+9.7 0.0322A+7.24
Course aggregate :					
(i) 20mm size	Cu.m	0.2728A-48.50	Lime	Q	0.0754A-51.21
(ii) 10mm size	Cu.m	0.1164A-20.74	Surkhi	Cu.m	0.0204A-18.39
(iii) 40 mm size	Cu.m	0.0151A-73.91	Marble chips	Q	0.1338A-48.52
Brick ballast	Cu.m	0.0426A-38.37	Marble powder	Cu.m	0.0012A-0.36
Timber for :					
(i) form work	Cu.m	0.0050A+11.19	LABOUR		
(ii)joinery	Cu.m	0.0024A-0.53	mason	Day	1.1314A-407.40
			Carpenter	Day	0.7094A+449.09
Ballies (centering)	m	0.5507A+797.75	Glazier	Day	0.0122A+10.31
Bricks	100 No.s	1.1829A-524.23	Painter	Day	0.0905A+37.26
Seel	Tonne	0.0479A	Blacksmith	Day	0.479A
Flush doors	Sq.m	0.0636A-17.07	Mazdoor	Day	6.055A-2024.37

Material and Labour ratio for various trades of building construction

Sl no	Description of the trade	Material	Labour
1	Excavation and earth work in solis	-	100%
2	Concrete	80%	20%
3	Brick work	75%	25%
4	Wood work (including form work) and joinery	72%	28%
5	Bilders hard ware	85%	15%
6	Steel and iron work	82%	18%
7	Roof covering	85%	15%
8	Pavings and floor finishes	75%	25%
9	Plastering	65%	35%
10	Glazing	88%	12%
11	Paintitng, white colour wash and distempering on walls and ceiling	65%	35%
12	Water supply	85%	15%
13	Electrifications	85%	15%
14	Sanitary fittings and plumbing	84%	16%
15	Fire fighting installation including connections plumbing items	85%	15%
16	Central air conditioning installation including ducting etc	87%	13%
17	Lifts	86%	14%

Formulae used in Valuation of property

1. Amount of re.1.00

To find the amount that will accumulate at the end of N years if re 1.00 is invested today at the rate of interest of i % per annum

Amount of re 1.00 = $(1+ i)^n$

Where i is the rate of interest viz. 0.03 for 3 %, 0.05 for 5 % etc and n is the No of the years

2. Present value of re 1.00

To find the present value of re 1.00 payable at the n years at the rate of interest of i percent/annum

Present value of re 1.00 = $1/ (1+ i)^n$

Where n is the no of years and I is the rate of rate of interest viz. 0.03 for 3 % rate of interest

3. Amount of re 1.00 per annum

To find the amount that will accumulate at the end of n years if re. 1.00 is invested at the end of every year at the rate of interest of 1 percent per annum.

Amount of re 1.00 per annum = $\frac{(1+ i)^n - 1}{i}$

Where n is the number of years and i is the rate of interest viz. 0.03 for 3% rate of interest.

4. Annual sinking fund

To find the amount should be invested every year at the rate of interest of i percent per annum so that it will accumulate to re 1.00 at the end of n years.

Annual sinking fund = $i/(1+ i)^n – 1$

Where i is the rate of interest viz. 0.03 or 3%, and n is the no. of years.

5. Present value of re 1.00 per annum (single rate). (this is also called as the year's purchase (single rate) for n years).

To find the present value of the total accumulation at the end of n years if re 1.00 is proposed to be invested at the end of every year at the rate of interest of i percent per annum.

Here, i.e. in single rate calculations, it is assumed that the invested capital (present value) can be redeemed by paying in to sinking fund an annual amount which will accumulate at

compound interest at the percent at which the annual payment of re 1.00 will be invested.

Present value of re 1.00 per annum (single rate) (i.e. year's purchase(single rate) for n years).

$$\frac{[1 - 1/(1+ i)^n]}{i}$$

Where i is the rate of interest per annum viz. 0.03 for 3% and n is the no. of yea

6. Present value of re 1.00 per annum (Dual Rate)

To find the present value of the total accumulate at the end of n years if re 1.00 is proposed to be invested at the end of every year at the rate of interest of i per annum and where allowance is to be made foe invested capital (i.e. the present value) to be redeemed at the end of n years by paying in to an annual sinking fund at a different rate percent, usually much lower than i.

Present value of re 1.00 per annum (dual rate) (i.e. year's purchase (dual rate) for n years).

$$1 - V/i - (V \times d)$$

Where V = Present value of re 1.00 received at the end of n years at the rate percent at which an annual sinking fund can be invested.

d = Difference between interest on re 1.00 for year at the two given rates per cent.

i = the rate of interest on the yearly investments that is to be allowed.

LEGAL ASPECTS

Brief on contracts

Types of Procurement Systems

Traditional:- Item rate, Percentage Rate and Lump sum contracts
Non-traditions:- Construction Management and Project management
Single source: Design and construct, Turnkey, BOOT and variations
Collaborative: Partnering, Joint venture and Allianzing

Traditional: Benefits:
Client involvement in the design and construction is limited.
Control systems, documentation and organization of a large industry players are setup to manage in this way
Where designs are completed prior to tenders being invited, the client can have a high degree of confidence in the contract price.
The provision of detailed drawings, specifications, quantities provides a basis for better completion and facilitates quicker evaluation of tenders.
The contract provides for variations/ extra items necessitated during execution
Where a quantity surveyor is engaged in the project, a high level of cost control and monitoring can be achieved.

Non-Traditional: Construction Management
Client engages an architect and a construction manager
A Team approach is created
Client is contracted to the architect, construction manager and the individual trade contractor through separate contract
The construction manager is usually engaged as an agent to the client on a fee.

Non-Traditional: Project Management
A Project Manager is appointed by the client as the first manager of the project team
A Project Manager may be required to work with the representatives of the client's organization
The client enters separate contract with the Project management, Design Consultant and the Builder.
The project manager is required to take the lead in the overall management of the design process though there is no direct contra ct between him and the designer.

Design and Build
Design and Build and Turnkey procurement methods are closely aligned
The contractor is singularly responsible for both the design and the construction
It is the client's responsibility that the concept design and / or performance specifications are prepared.

A Variation to the design and build may include design, innovate and build strategy.

Turnkey

The builder undertakes all the components of a project.
It faces all He design, construction and performance responsibility under a single entity.
Turnkey projects can be done by lead company which subcontracts out the different aspects of the project, or the principle participant join in a consortium or joint venture agreement

BOT family of Contracts

BOOT : Build Own Operate and Transfer
BOT : Build Operate and Transfer
BOO : Build Own and Operate
BTO : Build Transfer and Operate
BT : Build Transfer
BLT : Build Lease and Transfer
ROT : Rehabilitate Operate and Transfer

The client normally provides a detailed performance criteria
The bids are normally required to include information relating to the following fundamentals of the project

1. Design concept
2. Contract firm
3. Transfer Period
4. Level of Service to be provided during the operation period

Financial security to complete and operate the facility
Operational cost of the facility upon transfer

Collaborative

Partnering: Partnering involves the commitment of two parties to establish a cooperative relationship that promotes a spirit of goodwill and fair dealing with the common view towards the success of a project and is therefore a strategy that is very strongly focused on the win/win principle

Joint Ventures: A joint venture is the project-specific joining of firms, on a temporary basis, through combined investment of

capital and expertise to undertake the works. It is defined as the legal binding of two companies for the purposes of providing a competitive advantage that would be difficult to attain alone.

Strategic Alliances: Strategic alliances take the partnering concept one step further, promoting not only cooperative relationships but focusing on the benefits of long-term relationships or alliances between the contracting parties. Effectively strategic alliances can be described as an extension of a partnering agreement to encompass a number of projects in order to attain the common long-term goals of both parties.

The law relevant to the building and construction industry.

- Indian Contract Act, (9 of 1872)
- Arbitration Act, (10 of 1940)
- Rules of Arbitration of the Indian council of Arbitration, (ICA Rules)
- Constitution (Forty sixth Amendment), Act, (1982)
- (Popularly known as the works Contract Act)
- Sale of Goods Act, (3 of 1930)
- Transfer of property Act, (4 of 1882 as amended by 21 of 1929)
- Limitation ACT, (36 OF 1963)
- Architects (professional Conduct) regulation, (1989)
- Explosives Act, (4 of 1884)
- Explosives Substance Act, (6 of 1908)
- The Explosives Rules, (1983)
- Forest Act, (16 of 1927)
- Forest Conservation Act, (69 of 1980)
- Mines and Minerals (Regulation and Development) Act,
- (67 of 1957)
- Minimum Wages Act, (11 of 1948)
- Workmen's Compensation Act, (8 of 1923)
- Workmen's Compensation Rules, (1924)
- Contract Labour (Regulation and Abolition) Act, (37 of 1970)
- Employment of Children Act (26 of 1938)
- Equal Remuneration Children Act, (25 of 1976)
- Payment of Wages Act, (4 of 1936)
- Employer's Liability Act, (24 of 1938)
- Companies Act, (1 of 1956)
- Income – tax Act, (43 of 1961)

- Partnership Act, (9 of 1932)
- Prevention of Corruption Act, (2 of 1947)
- Specific Relief Act, (47 of 1963)
- Co-operation Societies Act, (2 of 1947)
- Official Societies Act, (19 of 1923)
- Cantonments Act, (2 of 1924)
- Cantonments (Amendment) Act, (15 of 1983)
- Electricity Act, (9 of 1910)
- The Indian Electricity Rules, (1956)
- Motor Vehicles Act, (4 of 1939)
- Personal Injuries (Compensation Insurance) Act, (37 of 1963)

ARBITRATION

Arbitration is a process of dispute resolution between parties.

Definitions

Rule 1 (i) these rules may be called the "Rules of arbitration of the Indian Council of Arbitration".

(ii) These rules shall apply where parties have agreed in writing that (a) a dispute has arisen or (b) a dispute which may arise between them in respect of a defined legal relationship whether contractual or not shall be settled under the rules of arbitration.

Rule 2: in these rules, the following words have the following meanings:

- **"**Arbitral Tribunal**"** means an arbitrator or arbitrators appointed for determining a particular dispute or difference.
- **"**Arbitral Award**"** includes an interim award.
- "Committee" means the arbitration Committee of the Council as provided for hereinafter.
- **"**Council**"** means the Indian Council of Arbitration.
- **"**Governing Body**"** means the Governing Body of the council.

- **"**Guidelines**"** means the guidelines for arbitrators and the parties to arbitration for expeditious conduct of the arbitration proceedings given in the Annexure to these Rules.
- "International Commercial Arbitration" means an arbitration relating to disputes arising out of legal relationships, whether Contractual or not, considered as commercial under the law in force in India and where at least one of the parties is (i) an individual who is a national of, or (ii) a body corporate which is incorporated in any country other than India; or (iii) a company or an association or a body of individuals whose central management and control is exercise in any country other than India; or (iv) the Government Undertaking.
- "Party" means a party to an arbitration agreement. it shall include any individual, firm, company, Government, Government organization or Government Undertaking.
- "Panel" means that panel of arbitration maintained by the Council.
- "Registrar" means that the Registrar for the time being appointed by the Committee and includes such other person as the Committee may nominate for carrying out duties of the Registrar under these rules.
- "Rules" means the Rules of Arbitration of the Council.
- "Fast Track Arbitration" means arbitration in accordance with Rule 82.
- Words importing the singular number include, where the context admits or requires, the plural number and vice versa.

"Disputes are inevitable", reasons for many of the disputes are:

*Drafting of contract agreement is not simple
*Confusing words *Unreasonable decisions
*Incomplete specifications *Incorrect specifications

Essential requirements for Arbitration:

Existence of Arbitration agreement in writing either as a clause in contract or as a separate agreement.

Who can be an arbitrator:

- Persons spelt out in the Arbitration agreement
- Persons form Indian Council of Arbitrators

- Persons from Panel of Arbitrators
- Persons appointed by Court
- Even judges, Advocates in the panel of arbitrator can be appointed.

Number of Arbitrators (Sec 10)

a) No. as agreed by both parties, should be odd number.
b) If nothing is agreed, the no should be one.

Appointment (Sec-11)

a) Parties are free to agree for their own procedure.
b) If three arbitrators, then one arbitrator each by each party and third arbitrator by the two arbitrators already selected who will act as presiding arbitrator over two.
c) Time for such appointments are 30 days of receipt of request by either party to the appointing authority.
d) If the appointing authority fails, then the appointment of arbitrators or 3rd arbitrator shall be done by Chief Justice of high court(or any person or institution designated by him)

Jurisdiction of Arbitral Tribunals (Sec 16)

- Arbitral Tribunal can decide its own jurisdiction
- Objection to jurisdiction should be raised not later than submission of defense statement.
- If objection not accepted by Arbitral Tribunal, then objection can be filed in court under section 34.

Conduct of Arbitration Proceedings

- Parties shall be given full opportunity
- Parties free to decide procedure for arbitration proceedings
- If no consent by the parties, then Arbitral Tribunal shall conduct proceedings in the manner it considers appropriate.

Hearings
a) **Mode:** Parties can agree on the procedure

If no consent, the Tribunal can decide whether oral or only document

b) Place: Parties can agree for place of hearing
If no consent, place to be decided by Arbitration Tribunal considering circumstances of the case and convenience of parties

Rules For Award:
Award to be decided in accordance with the terms of contract, using trade practice and substantive law in India.

Arbitral Award
- It should be reasoned or speaking, in writing and signed.
- It should state rate of future interest or else it shall be 18%.
- Cost of Arbitrator shall be fixed by Arbitral Tribunal.

Correction of Award

Request for computational errors/ typographical errors by any party within 30 days of receipt of award. The Arbitral Tribunal may make correction on its own.

Setting aside Arbitration Award

Award may be set a side only if :
- A party was under some in-capacity
- Arbitration Agreement is not valid under law
- Party was not given adequate opportunity to present his case
- Award deals with dispute not included in the terms of reference.
- If the Arbitral award is in conflict with the Public policy of India.
- Application for objection within 90 days

Enforcement
The Arbitral Award is as good as decree of court.

INDIAN CONTRACT ACT
Definitions

a) Proposal: When one person signifies to another his willingness to do or abstain from doing anything, with a view to obtaining the

assent thereto such as or abstinence, he is said to make a proposal.

b) Promise: When the person to whom the proposal is made signifies his assent there to, the proposal is said to be accepted. A proposal when accepted becomes a promise.

c) Promissor and Promisee: The person making the proposal is called the promisor, and the person accepting the proposal is called promise.

d) Consideration: When, at the desire of the promisor, the promise or any other person has done or abstained form doing, or does, or abstains from doing, or promises to do or abstain from doing, something, such act or abstinence of promise is called consideration for the promise.
e) Agreement: Every promise and every set of promises, forming the consideration for each other is an agreement.
f) Void Agreement: An agreement not enforceable by law is said to be void.
g) Contract: An agreement enforceable by law is a contract.
h) Voidable Contract: 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 is a voidable contract.
i) Void Contract: A contract which ceases to be enforceable by law becomes void when it ceases to be enforceable.

Various Kinds of Agreements:

1. Valid Agreement: An agreement is one which is enforceable by law.
2. Void Agreement: An agreement not enforceable by law is said to be void. It has no legal existence at all and is devoid of any legal effect.
3. Enforceable Agreement: An agreement enforceable by law is a contract.
4. Voidable Agreement: A voidable agreement is one 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.

5. Unenforceable Agreement: An unenforceable agreement is valid in law but is incapable of proof because of some technical defect.

Contract: Contract is a combination of agreement and enforceability. The test to distinguish between an agreement and a contract is whether it is enforceable by law or not. If it is enforceable by law, it is a contract.

Free Consent: Parties to a contract must give their free consent. The parties must be a ad idem, i.e. both the parties must agree upon the same thing in the same sense.

An Agreement becomes a contract:

- Parties to the contract must be competent.
- Parties to the contract must exercise free consent.
- Agreement must be for lawful consideration with a lawful object.
- Agreement must not be expressly declared to be void.

FINANCIAL ASPECTS

Accounting Methods

The main theme of contractor's accounting system centers around the determination of income and expense from each of its construction projects i.e., to say each contract is treated as a separate profit center.

The cash method and the accrual method are two basic accounting procedures. Under the cash method, income is taken into account only when cash is actually received, and expense is taken into account only when cash is actually expended.

The cash method is simple and straight forward form of income recognition and no attempt is made to match revenues with the accompanying expenses.

The accrual method is the second basic accounting procedure. Under these method, income is taken into account in the fiscal period during which it is earned, regardless of whether payment is actually received.

Accounting for long term contracts:

The tax reform act of 1986 mandates that one of three methods of accounting must be applied by contractors to their long term construction contractors. These are called the percentage of completion method, the percentage of completion- capitalized cost method, and the completed contract method.

Percentage of completion method:

The percentage of completion method recognizes job income from long term contracts as the work advances. Thus, the profit is distributed and the taxes are paid over the fiscal year during which the construction is under way. This method has a advantage of recognizing project income periodically on a current basis rather than regularly as contractors are completed.

Completed contract Method:

The completed contract method of accounting recognizes project income only when the contract is completed. What actually constitutes completion of a contract for income- reporting purposes has been subject to varying interpretation by the courts. Under the completed contract method, project costs are accumulated during construction using extended period cost capitalization. The scope of contract costs that must be capitalized includes not only the costs directly related to the contracts but also indirect costs attributable to the project. Costs such as general and administrative expenses and interest expense relate to the performance of the contract are included.

These financial statements serve many important functions with respect to external agencies. Bankers, surety and insurance companies, equipment dealers, credit –reporting agencies, and clients are concerned with the contractor's financial status and profit experience. Stock holders, Partners, and others with a proprietary interest use the statements to obtain information concerning the company's financial condition and the status of their investment. Two financial statements of particular importance are the income statements and the balance sheet.

Financial Reports:

Budget: It helps management to plan and control the effective and efficient application of all the resources of the company and it usually covers monetary units such as rupees, estimates the performance potential of the responsibility center.

Cost Reports: Cost reports focus on cost data that aids management in controlling cost and taking other related decisions and they also cover products, services, jobs, programmes, divisions, departments, projects.

Profit and loss account: It is an activity statement that shows details and result of the company's profit related activities for a period of time.

Cash flow statement: It is an activity statement that shows the details of company's activities involving cash during a period of time.

The income statement

The income statement is an abstract of the nature and the amounts of the company's income and expense for a given period of time, usually a quarter or full fiscal year.

The balance sheet:

A balance sheet presents a summary of the assets, liabilities, and net worth of the company at a particular time. The basic balance sheet equation may be stated as follows:

Assets = Liabilities + Net worth

The balance sheet presents in analytical form all company-owned property, or interests in property, and the balancing claims of stockholder or others against this property.

Financial Ratios:

Liquidity ratios: these measures reveal a company's ability meet its financial obligations.

Activity ratios: these ratios indicate the level of investment turnover or how well the company is using its working capital and other assets.

Profitability Ratios: These values relate company profits to various parameters such as contract volume or total assets.
Leverage Ratios: These ratios compare company debt with other financial measures such as total assets or net worth.

Equipment Management:

Management involves making informed judgments about equipments acquisition and financing, establishing a comprehensive preventive maintenance programme, managing accurate and current records of equipment income, expenses, and usage, and establishing an appropriate company policy concerning equipment replacement.

Equipment Depreciation:

Business property steadily declines in value because of age, wear and obsolescence. This reduction in value is called depreciation. Depreciation charges for equipment-oriented contractors account for an appreciable portion of their annual operation expense. Basically depreciation systematically reduces the value of a piece of equipment on an annual basis. The sum of these reductions at any time is depreciation reserve which, when subtracted from the initial cost of equipment, gives its current book value.

Procurement:

Procurement involves the preparation and use of a number of standard documents forms such as requisitions, purchase orders, and subcontractors.

The principle procurements are

1. Purchasing
2. Expediting and receiving
3. Inspections
4. Shipping
5. Subcontractors

Cash discounts:

Cash discounts are in the nature of a premium given in exchange for payment of an invoice before it becomes due, and

the buyer is entitled to the discount only when payment is made with in the time specified.

Title of purchasers:

1. Cash sale 2. On-approval sale
3. Sale or return 4. Delivery by vendor
5. Shipment by common carrier

Periodic Payments

Construction contracts typically provide that partial payments of the contract amount shall be made to the prime contractor as the work progresses. Payments to the contractor at monthly intervals is the more usual contract provision. The pay request may be prepared by the contractor, the architect-engineer, or the owner. The general conditions or supplementary conditions of the contract normally stipulate which party is to have the responsibility and authority for compiling these requests. Such periodic payments made by the owner to the prime contractor or subject to the retainage provisions contained in the construction contract.

Project cost breakdowns:

The break down, which is actually a schedule of costs of the various components of the structure, including all work done by sub contractors, is prepared in sufficient detail so that the architect-engineer or owner can readily check the contractor's pay requests.

Payment requests for lump-sum contracts:

Usually prepared by the contractor, it includes all sub contracted work as well as that done by the contractor's own forces. For each work classification that it does itself, the contractor estimate the percentage completed and in place. From invoices submitted by the subcontractors, suitable percentage figures are entered for all subcontracted work.

Payment requests for unit-price contracts:

Payment requests under unit-price contracts are actual quantities of each bid item completed to date. The determination of quantities accomplished in the field is done in several different

ways, depending on the nature of the particular bid item. On unit-price contracts, the owner or architect-engineer often pay request and sends it to the contractor for checking and approval before payment is made.

Final payment:

In building construction, the process typically commences when the contractor having achieved substantial completion, requests the preliminary inspection. The owner or its authorized representative, in company with general contractor and sub contractor personal, inspect the work, list of deficiencies to be completed are corrected is prepared and the engineer issues a certificate of substantial completion. After the deficiencies have been remedied, a final inspection is held and the contractor presents its application for final payment.

Payment to subcontractor

The general contractor must check each monthly pay request from a sub contractor to ensure that it is a fair measure of work actually performed. The prime contractor does not wish to allow its subcontractors to be overpaid any more than the owner wants to over pay the general contractor.

Payments to material suppliers:

Payments by the contractor to its material suppliers are made in accordance with the terms applicable purchase order or usual commercial terms. For materials is not normally dependent on any disbursement made by the owner to the general contractor, but it is due and payable in full 30days after invoice date, receipt of materials, end of the month in which delivery was made.

INVESTMENT ANALYSIS

Basic Steps

1. Estimating CashFlows
2. Estimating the Cost of Capital
3. Applying Appraisal criteria

Cash Flow

Cash flow refers to a contractors income and out go of cash. The net cash flow is the difference between disbursement and the income over a period of a time. A positive cash flow indicates that cash income is exceeding disbursement and a negative cash flow signifies just the opposite. And the contractor must maintain a cash balance sufficient to meet pay rolls, pay for materials, make equipment payments, and satisfy other financial obligations as they become due.

PROJECT CASH FLOWS

Cash Flow Stream – Basic Components

Initial Investment
Operating Cash Flows
Terminal Cash Flow

Cash forecast:

A Cash forecast is a schedule that summarizes the estimated cash receipts, estimated disbursement, and available cash balances for some period into the future. The preparation of the cash forecast begins with the collection of detailed information regarding future cash income and expenditures.

APPRAISAL [DECISION MAKING] CRITERIA

Evaluating Project's Financial Feasibility

Two broad categories
1. Non discounting criteria
   Pay Back Period
   Average Rate of Return

2. Discounting criteria
   Net Present Value --NPV
   Internal Rate of Return--- IRR

PRESENT VALUE [PV]

- Present Value of a Single amount:

$$PV = F_n \quad [1/(1+r)]^n$$

Where,

P = Present Value
F = Future Value
r = Discount rate per period
n = Number of periods

- Present Value of a Cash Flow Stream

$$PVn = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

PVn = Present Value of a Cash Flow stream
C_t = Cash Flow occurring at time t
r = Discount rate
n = Duration of Cash Flow stream

NET PRESENT VALUE - NPV

Sum of the Present Value of all expected Cash flows [inflows as well as outflows] associated with an investment / project, taken one year at a time and discounted by a factor which represents the opportunity cost of capital.

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

Where,
Ct = Cash Flow occurring at the end of year t, t = 0....n)
[A cash inflow will have a positive sign, whereas a cash outflow has a negative sign]
n = Life of the project
r = Rate of Discount

INTERNAL RATE OF RETURN [IRR]

The discount rate which results in NPV = O
It is the discount rate in the equation

$$\sum_{t=1}^{n} \frac{C_t}{(1+r)^t} = 0 \text{ (NPV)}$$

Where

C_t = Cash flow at the end of year t

r = Internal Rate of Return [Discount rate]

n = Life of the project

- ACCEPT, IF NPV IS POSITIVE
- REJECT, IF NPV IS NEGATIVE
- INDIFFEENT , IF NPV IS ZERO

Computer Usage:

The computer is invaluable and indispensable element in the conduct of a successful construction business.

Areas of computer usage:

1. Financial accounting: The computer performs basic accounting functions such as accounts receivable, accounts payable, general ledger, inventory, cash forecast, financial statements, subcontractor control.

2. Equipment accounting: Computer maintains records of equipment depreciation, ownership and operating costs, hours of operation, maintenance, spare parts, production rates and units costs.

3. Payroll: Using time card input, the computer prepares payroll checks, periodic and special payroll and tax reports, the payroll register, and updates the employee master files.

4. Purchasing: The computer participates in the tabulation and handing of bits, purchase order preparation, expediting and shop drawings.

PROFESSIONAL ASPECTS

Role of a Quantity Surveyor

Description
The elements of Civil Engineering, Economics, Finance, Statistics, Valuation, Management and Law together define the role of Quantity Surveyor.

Tasks and Duties

- Consult with the clients about the cost of building projects
- Study Architects and the engineers building plans
- Measure and estimate building and material costs for projects
- Prepare reports about projected building costs for clients
- Administer the tendering process for contractors and subcontractors
- Visit building sites to monitor to progress and to check that the work is to budget
- Recalculate costs if the design or material changes
- Certify progress claims from contractors
- Manage the payments for contractors and suppliers
- Prepare a statement of final account recording the actual costs of the project
- Offer services in value management, comparing building costs to similar buildings.
- Prepare building feasibility studies
- Prepare bank reports and offer financial advice to clients
- Consult with other construction industry professionals

Quantity surveyors can specialize in different areas, contractor quantity surveyors mostrly work on estimating building costs, managing building contracts and monitoring construction progress. Quantity surveying practices often focus on offering clients financial advice and estimation services for setting up building contracts. They may also be involved in mediation and arbitrations between parties about building contracts.

Quantity surveyors need to have

- Skills in reading building plans and estimating building and material costs.
- Good oral and written communication skills.

Problem solving and negotiation skills

- Maths and basic accounting skills
- Good organizational and time management skills

Brief on Building Economics

■ Economics in general is about the choice in the way that scarce or limited resources and ought to be allocated between their possible uses.
■ Building Economics serves in cost planning technique and this profession well in offering value added services to clients and the concept of elements has been incorporated in to the development of life cycle costing and value management.
■On private finance initiative schemes, the provider's ability to control costs through the life of the building is central to the profitability of the contract.
■ Cost planning, value management and life cycle costing are essential tools in the development of optimum solutions.
■ To meet construction industry requirements, schematic study of various factors affecting the cost of buildings and their economic consideration in various stages has been made.

Necessity For Economy In Construction :

■ To limit the client's expenditure
■ To achieve a balanced design expenditure
■ To provide the client with a value for money project.
■ The clients requirements today are more complex than those of past
■ The introduction of new constructional techniques, materials and components creates greater problems in assessing the capital and maintenance costs of buildings.

Factors to consider

■ Site Considerations
■ Building Size

- Planning Efficiency
- Plan Shape
- Height
- Storey heights
- Grouping of Buildings

Design Cost Management

- *Design* : The process of producing the required model of a building
- *Cost* :The total price that the builder wants to complete his work
- *Management*: The responsibility for ensuring that the functions of planning, control and feed back are successfully brought in terms of design, cost, time and quality.

Value for money in construction

- May be increased by improving utility with no change in cost,
- Retaining the same utility for less cost or combining an improved utility with a decrease in cost.

FIRST AID FACILITIES

First aid facilities as per Contract Labour (R&A) Act 1970.One box for every 150 Contract labours to contain;

a. 12 Small sterilized dressings.
b. 6 medium Size sterilized dressings.
c. 6 Large size sterilized dressings.
d. 6 Large size sterilized burn dressings.
e. 6 (15 gms.) packers sterilized burn wool.
f. 1 (60 ml.) bottle containing Tincture of Iodine.
g. 1 (60ml.) bottle containing Salvolatile having the dose and mode of administration indicated on the label for faintness cure.
h. 1 (30 gms.) bottle of potassium permanganate crystals.
i. 1 Roll of a adhesive plaster.
j. A snake bite lancet.
k. 1 pair Scissors.
l. 1 copy of the first aid leaflets issued by the Director General, Factory Advice Service and Labour.
m. A bottle containing 100 tablets (each of 5 grains) of aspirin.

n. Ointment for burns.
o. A bottle of Suitable Surgical Anti septic Solution.

In addition the following items are also advisable.

1. A Clinical Thermometer.
2. A hot water bag.
3. Tincture of Benzoin.
4. Liquor Ammonia for Scorpion bite.
5. Vaseline.
6. Boric Acid powder.
7. Bicarbonate of soda.

Nothing except the prescribed Contents shall be kept in the First Aid Box.

SOFTWARE AVAILABLE FOR ESTIMATION

Super rate analysis 2000,
Super civil cd.com Build Quant,
www.ensoftindia.com.

QE Pro www.softtech_engr.com

Geo synthetics for reinforced soil structure www.polyfelt.com

www.intecc.com

Email: bgdtech@vsn.com

Email: dirmar@vsn.com www.Beml.co.in

M25	:	340 Kg
M30	:	380 Kg
M35	:	410 Kg
M40	:	430 Kg
M45	:	450 Kg
M50	:	450 + M.S 7.5%

General Notes for civil Engineering

- Electrical conduits shall not run in column
- Earth work excavation for basement above 3 m Should be stepped form
- Any Back filling shall be compacted 95% of dry density at the optimum moisture content and in layers not more than 200mm for filling above structure and 300 mm for no structure
- F SOLING IS SPECIFIED THE SOLING STONES SHALL BE LAID AT45° TO 60° INCLINATION (AND NOT VERTICAL) WITH INTERSTICES FILLED WITH SAND OR MOORUM.
- Y REPRESENTS TOR STEEL GRADE - Fe-415 OF IS:1786. WITH CHARECTERISTIC YIELD STRENGTH OF 415 N/MM MINIMUM.
- Ø REPRESENTS MILD STEEL GRADE - 1 OF IS:432 (PART-1)
- ALL REINFORCEMENT SHALL BE FREE FROM MILL SCALES, LOOSE RUST & COATS OF PAINTS, OIL OR ANY OTHER SUBSTANCES.
- BY PROVIDING PROPER COVER BLOCKS, SPACERS, CHAIRS ETC.. ALL REINFORCEMENT SHALL BE PLACED AND MAINTAINED IN POSITION AS SHOWN IN STRUCTURAL DRAWING
- CEMENT SHALL BE 43 GRADE ORDINARY PORTLAND CEMENT CONFORMING TO IS:8112 OR53 GRADE ORDINARY PORTLAND CEMENT CONFORMING TO IS:12269-1987.

- CEMENT SHALL BE STORED IN DRY PLACES ON A RAISED PLATFORM ABOUT 200mm ABOVE FLOOR LEVEL AND 300mm AWAY FROM WALLS. BAGS TO BE STACKED NOT MORE THAN 10 BAGS HIGH IN SUCH A MANNER THAT IT IS ADEQUATELY PROTECTED FROM MOISTURE AND CONTAMINATION.

- WATER USED FOR BOTH MIXING AND CURING SHALL BE CLEAN AND FREE FROM INJURIOUS AMOUNTS OF OILS, ACIDS, ALKALIS, SALTS, SUGAR AND ORGANIC MATERIALS OR OTHER SUBSTANCES THAT MAY BE DELETERIOUS TO CONCRETE OR STEEL. THE pH SHALL BE GENERALLYBETWEEN 6 AND 8.

- CEMENT SHALL BE TESTED FOR ITS SETTING.

1. THE INITIAL SETTING TIME SHALL NOT BE LESS THAN 30 MINUTES.

THUMB RULE FOR STEEL IN RCC

Type of structure	Steel kg/ft
Residential building	2.5 to 4.5
Commercial Building	4.5 to 5.5
Havy structure projects	8 t0 9

The steel percentage against concrete volume will vary based on the structual element and the minimum and maximum percentage of steel utilization have listed below as per IS standard

Structural element	% of steel in concrete
Slab	1%
Beam	1% to 2%
Column	2.50%
Footings	0.85%

THUMB RULE

Types	Minimum
RCC Beam Size	9"x 9"
RCC Slab	4.5"thick
Foundation	1m x 1m (load <30T)
Columns	4 Bars of 12mm steel rods FE 415
Beams	2 Bars of 12 mm in bottom and 2 Bars of 100 mm on Top
One Way Slab	Main Steel 8 mm bars @ 6" C/C and Distribution Steel of 6 mm bars @ 6" C/C
Two way Slab	Main Steel 8 mm bars @ 6" C/C and Distribution Steel of 9 mm bars @9" C/C
Foundation	6" of PCC layers comes first. Over than a tapered or rectangular footing is minimum. Steel mesh of 8mm bars @6" C/C should be laid.

2. THE FINAL SETTING TIME SHALL NOT BE MORE THAN 10 HOURS.

- SAMPLES FROM FRESH CONCRETE SHALL BE TAKEN AND AT LEAST A SET OF 6 CUBES OF 150mm SHALL BE PREPARED AND CURED. 3 CUBES EACH AT 7 DAYS AND 28 DAYS SHALL BE TESTED FOR COMPRESSIVE STRENGTH. THE TEST RESULTS SHOULD BE SUBMITTED TO ENGINEER FORAPPROVAL. IF RESULTS ARE UNSATISFACTORY NECESSARY ACTION/RECTIFICATION/REMEDIAL MEASURES HAS TO BE EXERCISED.
- A SET OF CUBE TESTS SHALL BE CARRIED OUT FOR EACH 30 Cum OF CONCRETE / EACH LEVELS OF CASTING / EACH BATCH OF CEMENT.
- WATER CEMENT RATIO FOR DIFFERENT GRADES OF CONCRETE SHALL NOT EXCEED 0.45 FOR M20 AND ABOVE AND 0.50 FOR M10 / M15 CONTRACTOR / MIX DESIGNER TO CARRY OUT THE NECESSARY INITIAL (PRELIMINARY) TESTS. FOR CONCRETE GRADES M20 AND ABOVE APPROVED ADMIXTURE SHALL BE USED AS PER MIX DESIGN REQUIREMENTS.

CONCRETE COVER

- CLEAR COVER TO MAIN REINFORCEMENT IN

1.	FOOTINGS	: 50 mm
2.	RAFT FOUNDATION.TOP	: 50 mm
3.	RAFT FOUNDATION.BOTTOM/SIDES	: 75 mm
4.	STRAP BEAM	: 50 mm
5.	GRADE SLAB	: 20 mm
6.	COLUMN	: 40 mm
7.	SHEAR WALL	: 25 mm
8.	BEAMS	: 25 mm
9.	SLABS	: 15 mm
10.	FLAT SLAB	: 20 mm
11.	STAIRCASE	: 15 mm
12.	RET. WALL on earth	: 20/ 25 mm
13.	WATER RETAINING STRUCTURES	: 20 / 30 mm

- CONTRACTOR SHALL ALLOW FOR INDEPENDENT TESTING OF REINFORCEMENT STEEL FOR EACH DIA OF BAR FOR EVERY 50T AND AT CHANGE OF SOURCE.
- ALL BEAM REINF. TO BE ANCHORED FOR A MINIMUM LENGTH OF 46 x DIA OF BAR INTO COL / SUPPORTING BEAM U.N.
- BINDING WIRES SHALL BE 16 GUAGE 1.6mm SOFT ANNEALED STEEL WIRES FREE FROM RUST AND OTHER CONTAMINANTS.
- CONCRETE DESIGN MIX REPORT.
    1. CONCRETE DESIGN MIX REPORT ALONG WITH THE TEST RESULTS FOR CONCRETE CUBES SHALL BE

- If the solution is lighter or just straw yellow colour the sand can be used for concreting without any further test.

QUANTITIES REQUIRED:-

Plastering (CM 1:3)	= 1.50 bags / 10 m^2
Plastering (CM 1:5)	= 1.05 bags / 10 m^2
Ceiling Plastering (CM 1:3)	= 48 kg / 10 m^2
Brick work (CM 1:5)	= 86 Kg / 10 m^3
Brick work (CM 1:6) 9" thick	= 80.64 Kg / 10 m^3
Brick work (CM 1:3) 4½" thick	= 15.46 Kg / 10 m^3
Lime for white washing	= 10 Kg/100 m^2
Painting	= 10 ltr/ 100 m^2
Distemper 1st coat	= 6.5 Kg / 100 m^2
Distemper 2nd coat	= 5.0 kg / 100 m^2
Snowcem 1st coat	= 30 Kg / 100 m^2
Snowcem 2nd coat	= 20 Kg / 100 m^2
Paint ready mixed one coat	= 10 ltr / 100 m^2
Weathering Course	= 7.68 Kg / m^2
Flooring	= 8.10 kg / m^2
Pressed tiles for weathering course (CM 1:3)	= 7.68 Kg / 10 m^2
Granolithic floor finish	= 8.10 Kg / 10 m^2

WATER CEMENT RATIO:-

M20	=	0.55
M25	=	0.50
M30	=	0.45
M35	=	0.45
M40	=	0.40

SPACING OF BARS:-

- Provide the dia of the bar, if the dia of the bar are equal.
- Provide the dia of the larger bar, if the dia are unequal.
- 5mm more than the nominal maximum size of the coarse aggregate.

CONVERSION:-

Design Mix:

M10 (1 : 3.92 : 5.62)

Cement	:	210 Kg/ M^3
20 mm Jelly	:	708 Kg/ M^3
12.5 mm Jelly	:	472 Kg/ M^3
River sand	:	823 Kg/ M^3
Total water	:	185 Kg/ M^3
Fresh concrete density:		2398 Kg/M^3

M20 (1 : 2.48 : 3.55)

Cement	:	320 Kg/ M^3
20 mm Jelly	:	683 Kg/ M^3
12.5 mm Jelly	:	455 Kg/ M^3
River sand	:	794 Kg/ M^3
Total water	:	176 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2430 Kg/ M^3

M25 (1 : 2.28 : 3.27)

Cement	:	340 Kg/ M^3
20 mm Jelly	:	667 Kg/ M^3
12.5 mm Jelly	:	445 Kg/ M^3
River sand	:	775 Kg/ M^3
Total water	:	185 Kg/ M^3
Admixture	:	0.6%
Fresh concrete density:		2414 Kg/ M^3

Note: sand 775 + 2% moisture, Water 185 -20.5 = 164 Liters, Admixture = 0.5% is 100ml

M30 (1 : 2 : 2.87)

Cement	:	380 Kg/ M^3
20 mm Jelly	:	654 Kg/ M^3
12.5 mm Jelly	:	436 Kg/ M^3
River sand	:	760 Kg/ M^3
Total water	:	187 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2420 Kg/ M^3

Note: Sand = 760 Kg with 2% moisture (170.80+15.20)

M35 (1 : 1.79 : 2.57)

Cement	:	410 Kg/ M^3
20 mm Jelly	:	632 Kg/ M^3
12.5 mm Jelly	:	421 Kg/ M^3
River sand	:	735 Kg/ M^3
Total water	:	200 Kg/ M^3
Admixture	:	0.7%
Fresh concrete density:		2400 Kg/ M^3

Note: sand = 735 + 2%, Water = 200- 14.7 = 185.30, Admixture = 0.7%

M40 (1 : 1.67 : 2.39)

How To Calculate Cutting Length Of Stirrups

Rectangular Column:

Size Of Column = 300mm × 400mm

Length Of Column (A) = 300 - (2 × 44) = 212mm

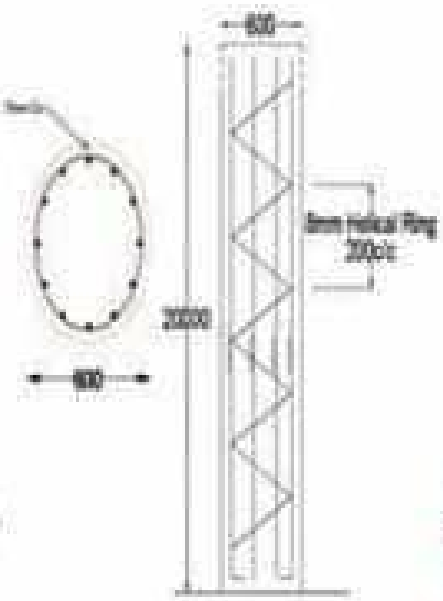
Breadth Of Column (B) = 400 - (2 × 44) = 312mm

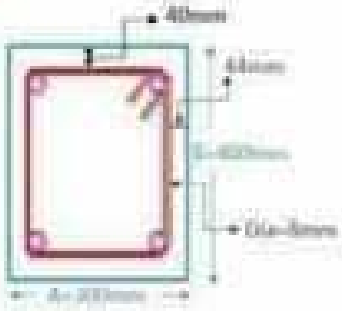
Hook Length = 10 D = 10 × 8 = 80 × 2 = 160mm

Cutting Length Of Stirrup = (A ×2) + (B ×2) + Hook Length

= (212 ×2) + (312 ×2) + 160

= 1208 mm / 1000 = 1.208m





Circular Column:

Dia Of Column = 600mm

Dia Of Stirrup c/c = 600 – (2× 40) – (4 + 4) = 512mm

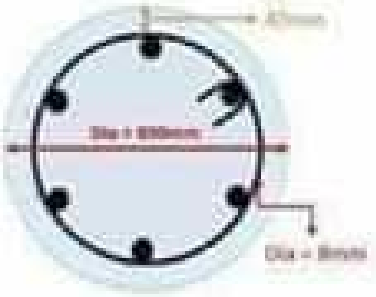
Parameter Of Stirrup = πd = 3.142 × 512 = 1608.704mm

Hook Length = 10 D = 10 × 8 = 80 × 2 = 160mm

Cutting Length Of Stirrup = Parameter Of Stirrup + Hook L

= 1608.704 + 160

= 1768.704 mm / 1000 = 1.768m

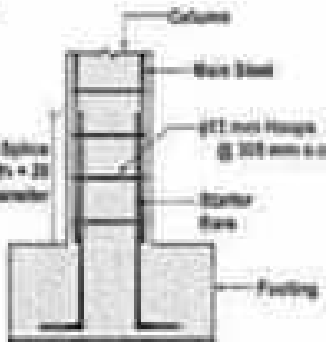


Over Lapping Length of Steel in Slab, Beam and Column

- Slab Over Lap = 60D
  = 60(12) = 720mm

- Beam Over Lap,
  In Compression Zone = 24D = 24(12) = 288mm
  In Tensile Zone = 50D = 50(12) = 600mm

- Column Over Lap = 45D
  = 45(12) = 540mm



RCC Road quantity

Example # 1

Calculate concrete, steel and sub base material for given road section, take 60' as road length. Ignore joints in calculation.

Solution:-

① Quantity of sub base materials =

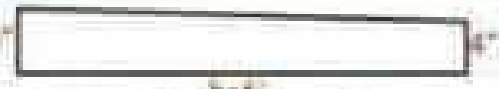
=Length x breath x thickness

$= L \times B \times (d + \frac{d}{2})$

$= 60 \times 14 \times (0.75 + \frac{0.75}{2})$

Sub base = 945 cft

② RCC work



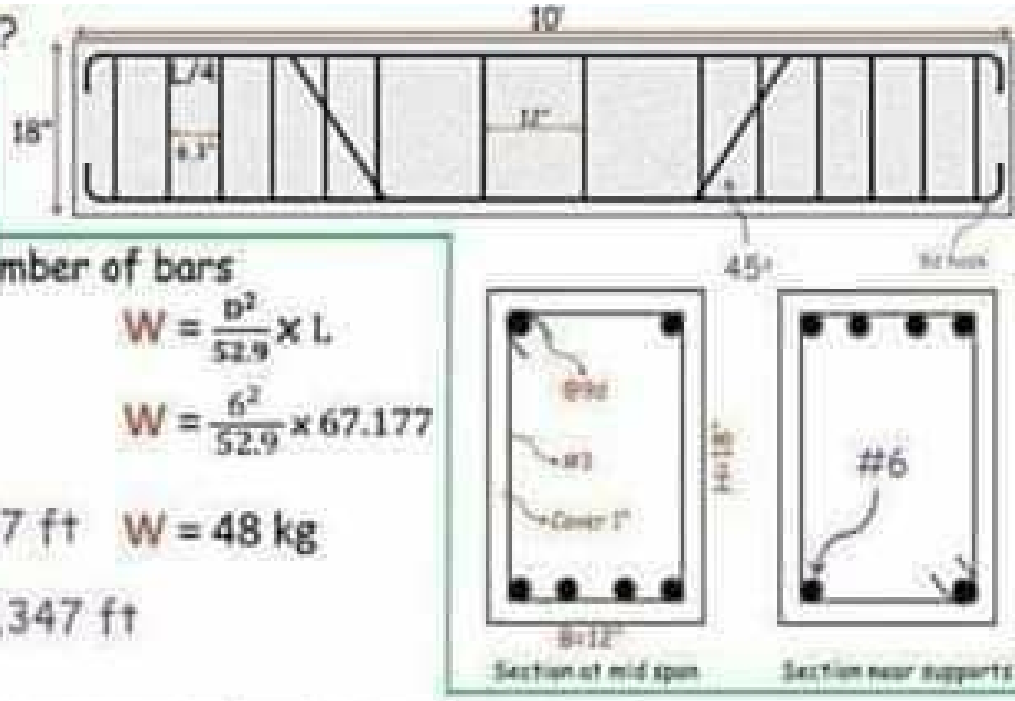
RCC work = X-section area x road length

$RCC\ work = 2 \times (\frac{0.334+0.5}{2}) b \times L$

$RCC\ work = 2 \times (\frac{0.334+0.5}{2}) 6 \times 60$

RCC work = 300.25 cft

Steel quantity in given beam ?



Steel for straight main bars:

Total cut Length of bars:

= [10' -2(c.c) +2(hooks)] x Number of bars

= [10' -2(1") +2(9(6/8"))] x 4

= 43.83 ft.

$$W = \frac{D^2}{52.9} \times L$$

$$W = \frac{6^2}{52.9} \times 67.177$$

Steel for bent up bars: =23.347 ft $W = 48$ kg

Total cut length= 43.83 ft +23.347 ft

Total cut length= 67.177 ft.

Total length for all stirrups = 64.6 ft

$$W = \frac{D^2}{52.9} \times L$$

WE WILL CHECK IF THE COLUMN CAN SUPPORT THE APPLIED LOAD

Question:-

Can the given mild steel column carry 1500 kips load?

Solution:- 2) Check for buckling

$$\text{Euler's}_{\text{buckling}} = \frac{\pi^2 EI}{l^2}$$

$$\text{Euler's}_{\text{buckling}} = \frac{\pi^2 \times 29000 \times 833.34}{96^2}$$

Buckling load= 25880.8 kips

25880.8 kips > 1500 kips

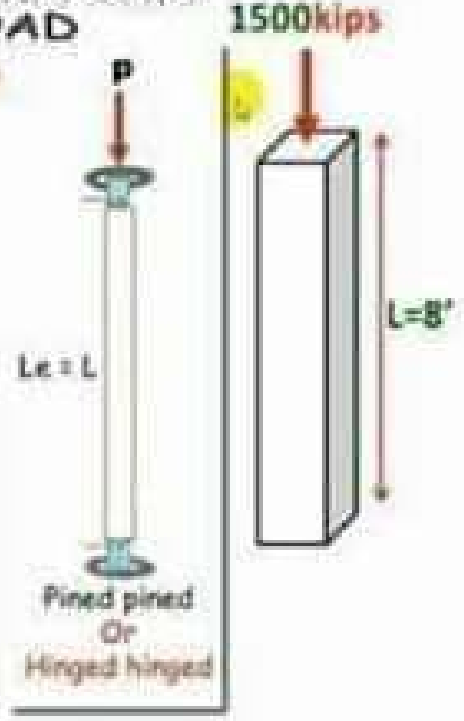
So the column is ok in buckling

10" x 10"

$$I = \frac{side^4}{12}$$

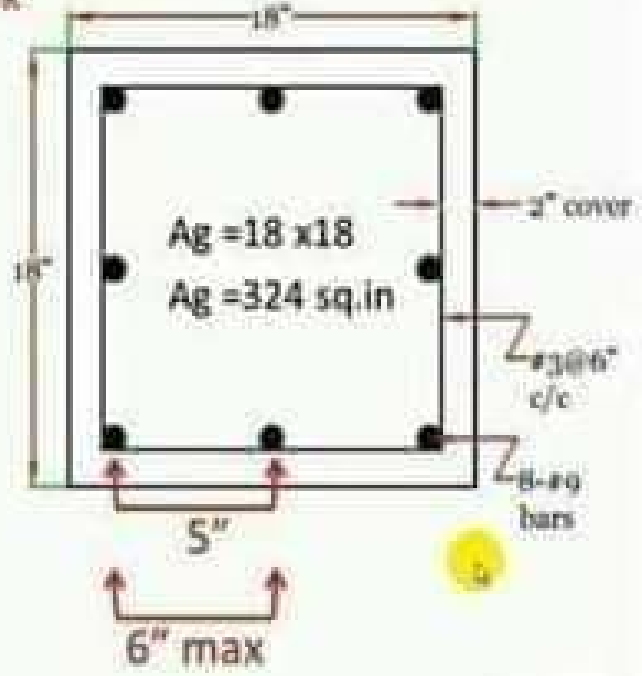
$$I = \frac{10^4}{12}$$

$$I = 833.34 in^4$$



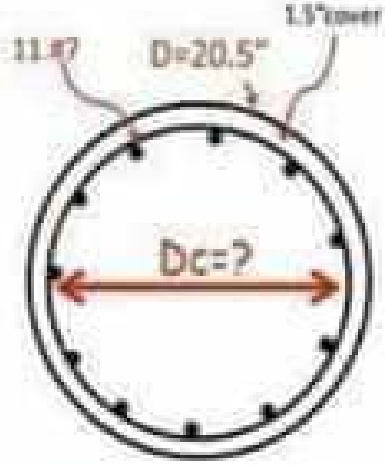
Detailing check:-

- Steel percentage= $\frac{Ast}{Ag} = \frac{8}{324} = 0.024 = 2.4\%$ ok
- Number of bars= 8 no's ok
- Minimum tie size= #3 ok
- Minimum tie spacing= 1" ok
- maximum tie spacing=
  - = 48d= 48 $(\frac{3}{8})$ = 18"
  - = 16D= 16 $(\frac{9}{8})$ = 18"
  - = least column dimension=18" ok
- Main bars spacing = $\frac{18" - 2(2) - 2(3/8) - 3(1.125")}{2}$
- Main bars spacing = 5" ok



RCD:- design of a spiral column based on ACI codes

Example#1 Design spiral for given column . If
$f_c' = 4$ ksi and $f_y = 60$ksi $\alpha = 0.85$, $\phi = 0.75$



Design solution

Gross area of the column = $A_g = \frac{\pi D^2}{4} = \frac{\pi(20.5)^2}{4} = 330 in^2$

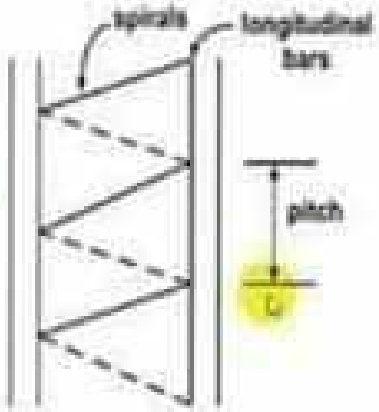
Cover diameter = $D_c = 20.5" - 2(1.5") = 17.5$ in

Area of the cover = $A_c = \frac{\pi(Dc)^2}{4} = \frac{\pi(17.5)^2}{4} = 240.53 in^2$

Spiral ratio = $\rho_s = 0.45\left(\frac{Ag}{Ac} - 1\right)\frac{f'c}{fy}$

Spiral ratio = $\rho_s = 0.45\left(\frac{330}{240.53} - 1\right)\frac{4}{60}$

Spiral ratio = $\rho_s = 0.0111591$



$$\rho_{s(min)} = \frac{4a_s(D_c - d_b)}{sD^2}$$

$$s = \frac{4a_s(D_c - d_b)}{\rho D^2}$$

$$s = \frac{4 \times 0.11(17.5 - 3/8")}{0.0111591 \times 20.5^2}$$

$$s = 1.606"$$

Example#1:

If plaster Area = 10000 Sft

Cement mortar ratio = 1 : 3

Plaster thickness = ½" or (0.5")

Calculate Cement and Sand for Given cement plaster ?

Wet volume = $10000 \times \frac{0.5"}{12}$

Wet volume = 416.67 Cft

Dry volume = Wet volume x 1.27

Dry volume = 416.67 x 1.27

Dry Volume = 529.16 Cft

Solution:

$$Material = \frac{ratio\ of\ material}{sum\ of\ ratio} \times Dry\ volume$$

Cement = $\frac{1}{4} \times 529.16 = \frac{132.29\ cft}{1.25}$ = 106 cement bags

Sand = 132.29 x 3 = 397 cft

Calculate water quantity in litters for 1:2:4 concreter

Solution : - We know

volume of 1 cement bag is 1.25 cft or 0.035 Cu.m

volume of sand (fine aggregate) = $0.035 \times 2 = 0.07\ m^3$

volume of bajri (coarse aggregate) = $0.035 \times 4 = 0.14\ m^3$

total volume of aggregates = $0.07 + 0.14 = 0.21\ m^3$

volume of water for cement = 11.667 lits

volume of water for aggregates = $\frac{5}{100} \times 0.21 = 0.0105\ m^3$

Or $= 0.0105 \times 1000 =$ 10.50 lits

So total quantity of water = Water for cement + water for aggregates

$= 11.667 + 10.50 =$ 22.16 lits

Note

Water quantity is calculated in litters or in gallons. Commonly water for 1 bag of cement is 11.667 litters (3 gallons) which is 1/3 of cement bag and 5% for aggregates.

(1 Cu.m = 1000 lits)

Example#1 Workout the quantity of earth work f0r an embankment 150m long and 10m wide at the top. Side slope is 2:1 and depths at each 30m interval are 0.60, 1.2, 1.4, 1.6, 1.4, and 1.6m.

solution:- Mean area method

Station	depth	Center area =B.d	Area of sides=sd^2	total area B.D +sd^2	Mean area A1+A2/2	Interval	quantity Cut	quantity Fill
0	0.6	6	0.72	6.72				
30	1.2	12	2.88	14.88	10.8	30		324
60	1.4	14	3.92	17.92	16.4	30		492
90	1.6	16	5.12	21.12	19.52	30		585.6
120	1.4	14	3.92	17.92	19.52	30		585.6
150	1.6	16	5.12	21.12	19.52	30		585.6
Total filling or embankment quantity =								**2572.8**m^3

$\frac{6.72 + 14.88}{2}$ =10.8 sq.m

$\frac{14.88 + 17.92}{2}$ =16.4 sq.m

Steel calculation for square column

For example:- Calculate weight of main bars and ties. Take 6" as pitch for ties and 1" C.C ?

Solution:- Calculation for ties:-

$= 4\{14 - 2(c.c) + 5d\}$

$L = 4(14 - 2(1) + 5(3/8))$

Length of tie bar $= \frac{55.5"}{12}$

Length of tie bar = 4.625 ft

Total length for all ties=

$= 4.625 \times$ No's of ties

$= 4.625 \times \frac{13}{c/c} - 1$

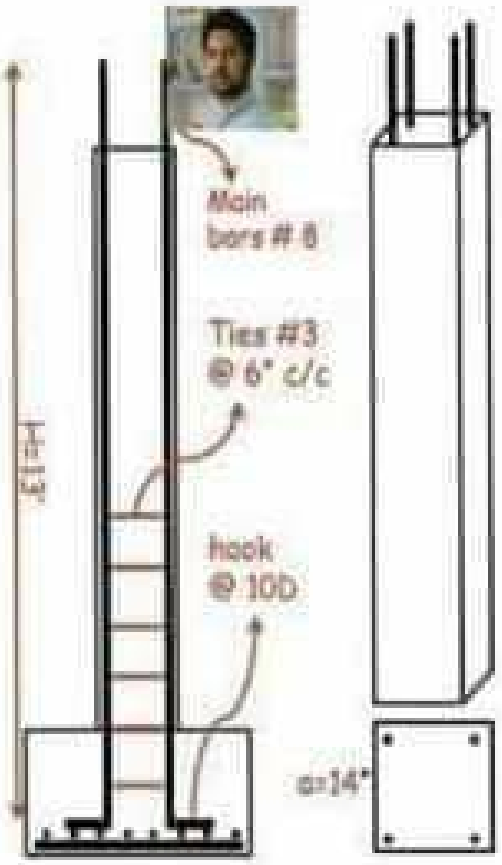
= 115.625 ft

W of bar $= \frac{D^2}{52.9} \times L$

W of bar $= \frac{3^2}{52.9} \times 115.62$

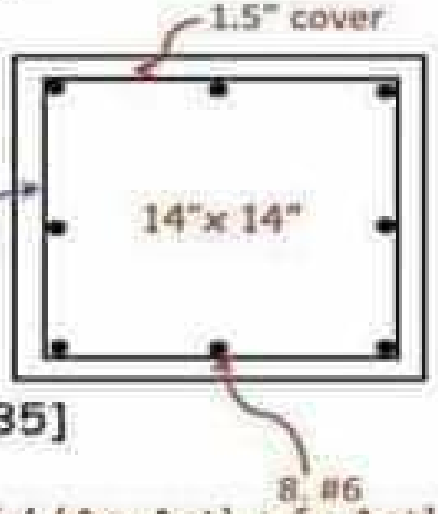
$W = 0.17 \times 115.62$

$W = 19$ kg



Example#1: Find the design axial load strength for the square tie column shown. take fc' = 4ksi and fy = 60 ksi.

Solution:



$$\emptyset Pn = \emptyset\alpha[0.85\, fc' (Ag - Ast) + fy\, Ast] \text{----(1)}$$

Design capacity (α=0.80 , $\emptyset$=0.65)

$Ag = 14 \times 14" = 196 in^2$

$Ast = \frac{\pi D^2}{4} \times 8 = \frac{\pi(6/8)^2}{4} \times 8 = 3.535 in^2$

$$\emptyset Pn = 0.65(0.80)[0.85 \times 4(196 - 3.535) + 60 \times 3.535]$$

$\emptyset Pn = 450.57$ kips *answer*

$$\emptyset Pn = \emptyset\alpha[0.85\, fc' (Ag - Ast) + fy\, Ast]$$

$\emptyset Pn$ = design axial load strength of the column

$\emptyset\alpha$ = design capacity (for tie column α=0.80 , $\emptyset$=0.65)
(for spiral column α=0.85 , $\emptyset$=0.75)

fc' = grade of concrete (strength of concrete)

fy = grade of steel (strength of steel)

Ag = gross sectional area of the column.

Ast = area of steel in section.

DESIGN OF WATER TANK

Volume of water Requirement For one person Per day:-

Per day **135 litres** of water are required for One Person.

Details

1. Drinking = 5 litres
2. Cooking = 5 litres
3. Bathing & Toilet = 85 litres
4. House cleaning = 10 litres
5. Cloth washing = 30 litres

Total water 135 litres

So-

$162 \times 0.001\ m^3$

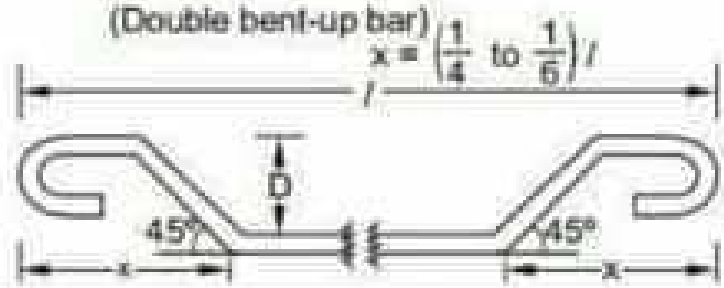
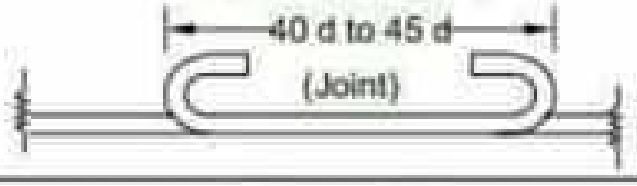
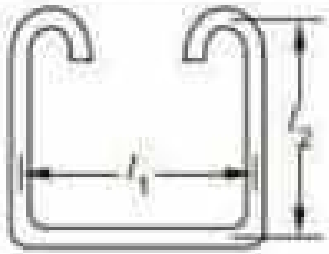
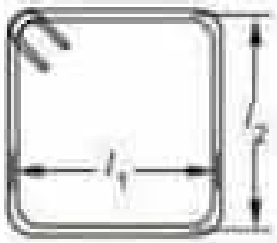
Volume of water = **1.62 m³**

Assume Hight of water Tank:- Say **1.5 m**

Find Area of Tank = $\frac{1.62}{1.5}$ = **1.08 m²**

To find length and Breadth of water Tank:-

Take :- $\sqrt{1.08} = 1.03923$ **H = 1.5 m**

Sl. No.	Details of Bar Shape	Length of Hooks	Total Length of Bar
1.		2[9d] = 18 d (both hooks together)	[l + 18 d]
2.	[Bent-up at one end only]]  D = Vertical distance (C/C) between bars	2[9d] = 18d (both hooks together)	[l + 18 d + 0.42 D]
3.	(Double bent-up bar) 	2[9d] = 18d (as for above cases)	[l + 18 d + 2 × 0.42 D]
4.	(Overlap of bars) 	2[9d] = 18d	Overlap length at joint = [(40 d to 45 d) + 18 d]
5.		[Here, one hooks height = 14d] 2 × (14d) = 28 d	[$l_1 + 2l_2 + 28$ d]
6.		2(12d) = 24 d	[$2(l_1 + l_2) + 24$ d]

Cutting length determination of a spiral or helix bar

Lets consider:-

Height= 15'

Top dia= 4'

bottom dia= 4'

Pitch= 3'

Length of helix/spiral bar = ?

$n = \frac{H}{P}$

$n = \frac{15}{3}$

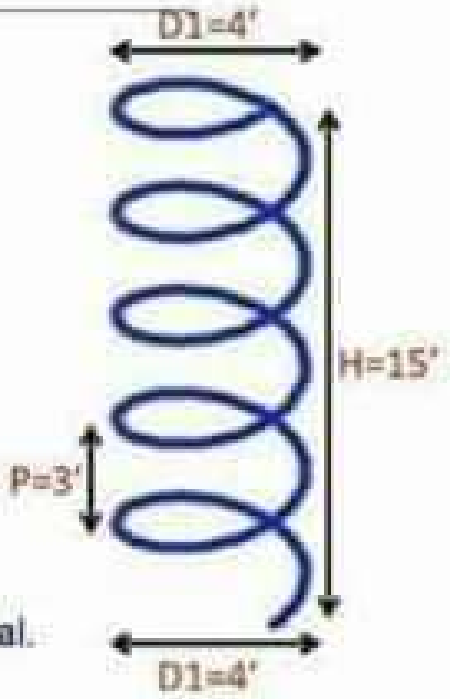
$n = 5$

Circumference = π D

C = π (4)

C = 12.566'

Round Column - Spiral



Length of helix = $n\sqrt{C^2 + p^2}$

Length of helix = $5 \times \sqrt{12.566^2 + 3^2}$

Length of helix = 64.59 ft.

n = Number of turns.

C = Circumference of spiral.

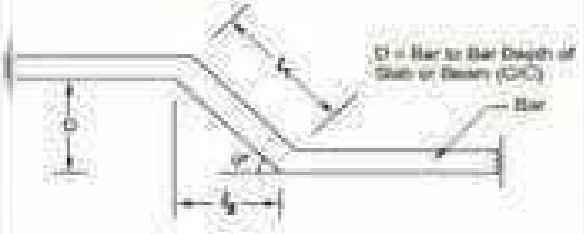
P = Pitch

Sl. No.	Details of Bar Shape	Length of Hooks	Total Length of Bar
1.	Diameter [Straight bar] 4d 4d l	2[9d] = 18 d (both hooks together)	[l + 18 d]
2.	[Bent-up at one end only]] $x = \frac{l}{4}$ to $\frac{l}{6}$ D 45° x l D = Vertical distance (C/C) between bars	2[9d] = 18d (both hooks together)	[l + 18 d + 0.42 D]
3.	(Double bent-up bar) $x = \left(\frac{1}{4}\text{ to }\frac{1}{6}\right)l$ l D 45° 45° x x	2[9d] = 18d (as for above cases)	[l + 18 d + 2 × 0.42 D]
4.	(Overlap of bars) 40 d to 45 d (Joint)	2[9d] = 18d	Overlap length at joint = [(40 d to 45 d) + 18 d]
5.	l_1 l_2	[Here, one hooks height = 14d] 2 × (14d) = 28 d	[l_1 + 2l_2 + 28 d]
6.	l_1 l_2	2(12d) = 24 d	[2(l_1 + l_2) + 24 d]

Sl. No.	θ°	$\frac{D}{\sin\theta}$	$\frac{D}{\tan\theta}$	Additional Length of Bent-up Bar, l_a
1	30°	$\frac{D}{0.5}$	$\frac{D}{0.5733}$	**0.27 *D***
2	45°	$\frac{D}{0.707}$	$\frac{D}{1.0}$	0.414 *D* ≈ **0.42 *D*** (0.42 *D* is generally the value that is adopted)
3	60°	$\frac{D}{0.866}$	$\frac{D}{1.732}$	0.577 *D* ≈ **0.58 *D*** (0.58 *D* is usually adopted)

∴ The additional length = $\frac{D}{\sin\theta} - \frac{D}{\tan\theta}$

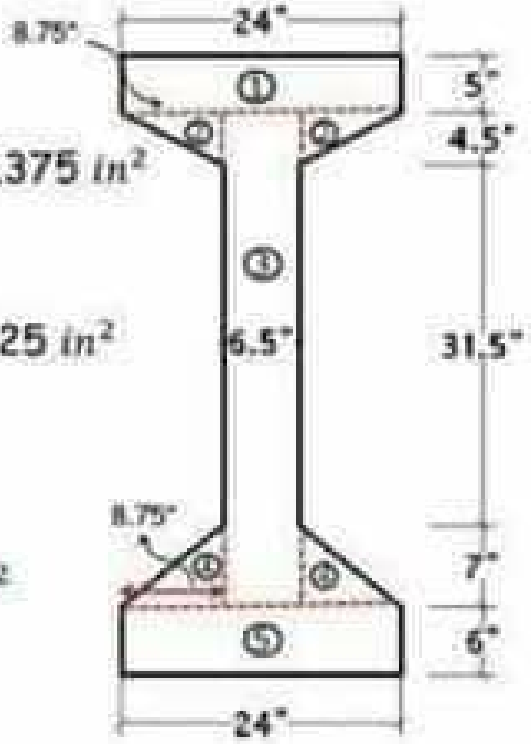
(a) Standard Hook



(b) Bent-up Bar

Example #2 Work out concrete for the given bridge girder. Take length = 30 ft

Solution:



Area of figure 1 = 24" x 5" = 120 in^2

Area of figure 2 = $\frac{base \times height}{2} \times 2 = \frac{8.75" \times 4.5"}{2} \times 2 = 39.375\ in^2$

Area of figure 3 = 43" x 6.5" = 279.5in^2

Area of figure 4 = $\frac{base \times height}{2} \times 2 = \frac{8.75" \times 7"}{2} \times 2 = 61.25\ in^2$

Area of figure 5 = 24" x 6" = 144 in^2

Total sectional area= 120 in^2 +39.375 in^2 +279.5 in^2

+61.25 in^2 + 144 in^2 = 644.125in^2

Total sectional area= $\frac{644.125\ in^2}{12 \times 12}$

Engineer Boy

SUMMARY OF SHAPE CODES
(Reference: SANS 282:2004, Edition 5.1 – Bending dimensions and scheduling of steel reinforcement for concrete)

20

32

33

34

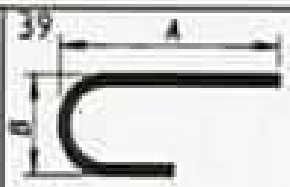
35

36

37

38

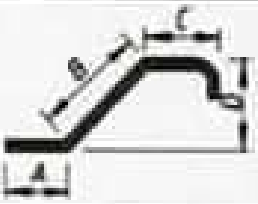
39



41

D shall be at least 2a

42



43

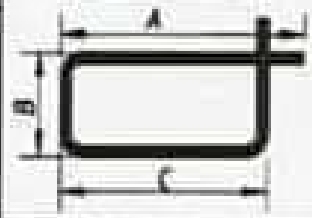
45

48

49

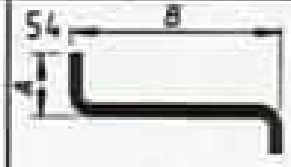
51

52

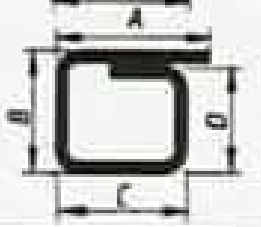


53

54



55

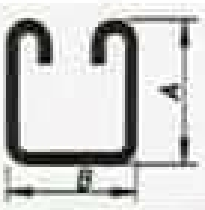


60

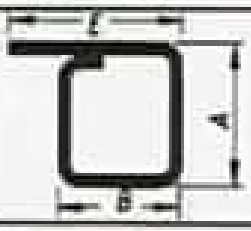
62

65

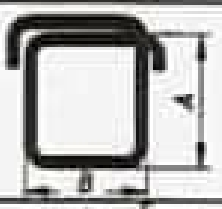
72



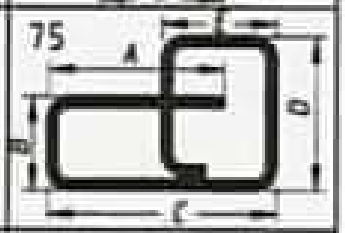
73



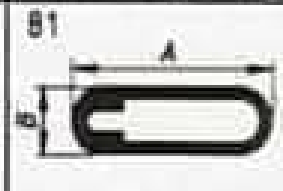
74



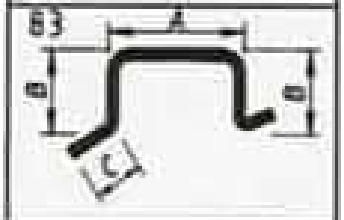
75



81



83



85

86

HOW TO DETERMINE THE WEIGHT OF AN IRON PIPE

Suppose Find the weight of the given cast iron pipe

Solution: Weight = volume x unit weight

Volume = X-Area x length

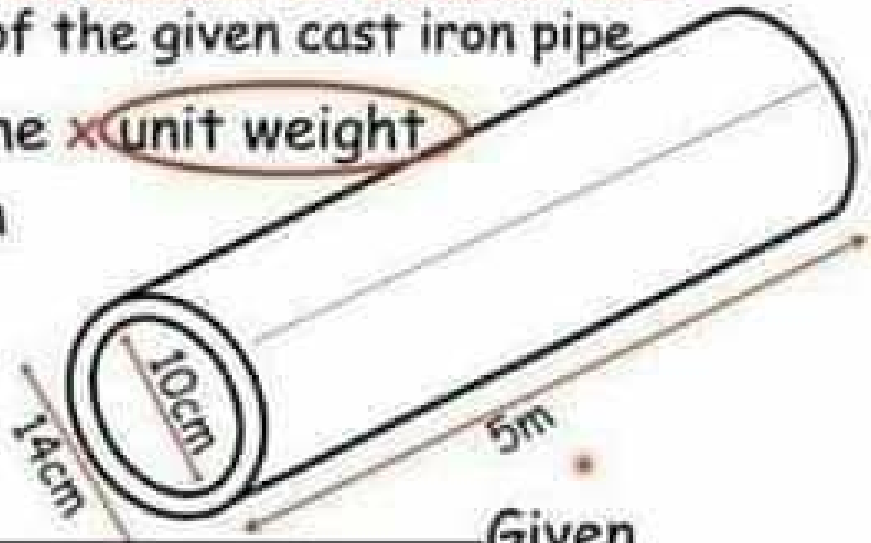
$$\text{Volume} = \frac{\pi(D^2 - d^2)}{4} \times L$$

$$V = \frac{\pi(0.14^2 - 0.10^2)}{4} \times 5$$

V = 0.0376991 cu.m

Weight = 0.0376991

Weight of pipe = 271.433 kg



Material	Unit weight	Unit weight
Cast iron	450 lbs/ft^3	7200 kg /m^3
Wrought iron	480 lbs/ft^3	7680kg /m^3
Steel	490 lbs/ft^3	7850kg /m^3

Given

L = 5 meters

D = 14 cm

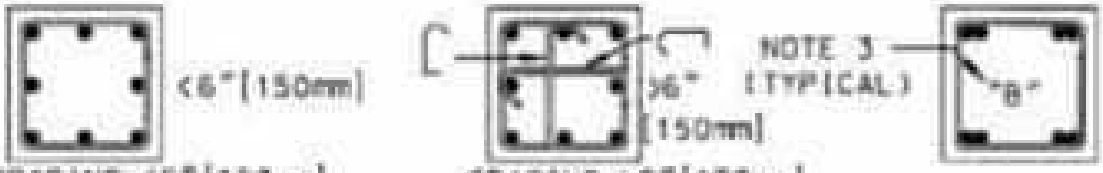
d = 10 cm

SL KHAN

4 BAR

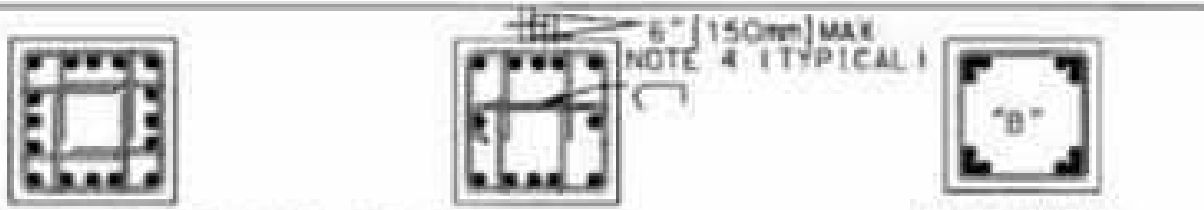
6 BAR

6 BAR



10 BAR

12 BAR



14 BAR

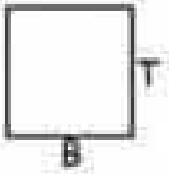
14 BAR

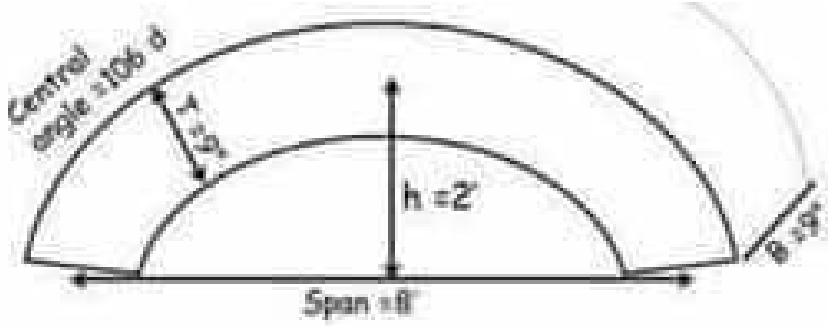
TIED COLUMNS WITH 2-BAR BUNDLES

A different pattern of ties may be substituted provided that details of the requirements are shown on the contract drawings. Single-leg tie arrangements instead of the one piece diamond tie shown are an acceptable alternate.

Quantity calculation for arches?

Workout the quantity of given arch.



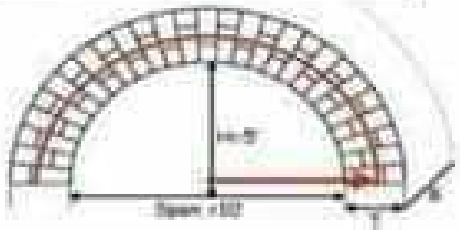


Quantity = X-section area X Arch length

Quantity = B×T X L

Quantity = 0.75×0.75 X 9.273

Quantity = 5.216 cft



$$\text{Arch length} = \frac{\emptyset \pi R}{180}$$

$$\text{Arch length} = \frac{106(\pi)(5)}{180}$$

Arch length= =9.273 ft

$$R = \frac{a^2 + h^2}{2h}$$

$$R = \frac{4^2 + 2^2}{2(2)}$$

R = 5 ft.

BEAM ON ELASTIC FOUNDATION ANALYSIS

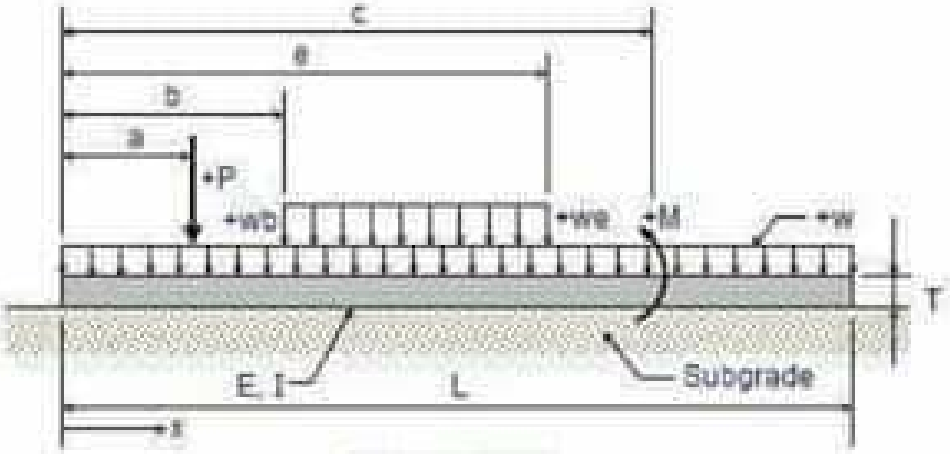
For Soil Supported Beam, Combined Footing, Slab Strip or Mat Strip of Assumed Finite Length with Both Ends Free

Job Name:		Subject:			
Job Number:		Originator:		Checker:	

Input Data:

Beam Data:

Length, L =	25.0000	ft.
Width, B =	4.0000	ft.
Thickness, T =	0.7500	ft.
Modulus, E =	3600	ksi
Subgrade, K =	100	pci



Beam Loadings:

Full Uniform?

w = 0.4500 kips/ft.

Distributed:	Start b (ft.)	Start wb (kips/ft.)	End e (ft.)	End we (kips/ft.)
#1:				
#2:				
#3:				
#4:				
#5:				
#6:				

Point Loads:	a (ft.)	P (kips)
#1:	5.0000	8.00
#2:	20.0000	12.00
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Nomenclature

Results:

Beam Flexibility Criteria:

for β*L <= π/4	beam is rigid
for π/4 < β*L < π	beam is semi-rigid
for β*L >= π	beam is flexible
for β*L >= 6	beam is semi-infinite long

Inertia, I =	0.1406	ft^4	I = B*T^3/12
β =	0.221		β = ((K*B)/(4*E*I))^(1/4)
β*L =	5.516		β*L = Flexibility Factor

Beam is flexible

Max. Shears and Locations:

+V(max) =	6.27	k	@ x =	20.00	ft.
-V(max) =	-5.73	k	@ x =	20.00	ft.

Max. Moments and Locations:

+M(max) =	13.00	ft-k	@ x =	20.00	ft.
-M(max) =	-4.95	ft-k	@ x =	12.75	ft.

Max. Deflection and Location:

Δ(max) = -0.032 in. @ x = 20.25 ft.

Max. Soil Pressure and Location:

Q(max) = 0.456 ksf @ x = 20.25 ft.

Comments:

Example: Workout cement , sand , crushed stone and steel for given water tank.

solution:- PCC work $= \frac{\pi D^2}{4} \times T = \frac{\pi(4.5)^2}{4} \times 0.1 = 1.59\ m^3$

RCC work in wall (1/1) $= \frac{\pi D^2}{4} \times T = \frac{\pi(4.3)^2}{4} \times 0.15 = 2.178\ m^3$

RCC work in wall (1/2) $= \frac{\pi(D1^2 - D^2)}{4} \times d$

RCC work in wall (1/3) $= \frac{\pi(4.3^2 - 4^2)}{4} \times 3 = 5.867\ m^3$

RCC work in slab $= \frac{\pi D^2}{4} \times T = \frac{\pi(4.3)^2}{4} \times 0.1 = 1.452\ m^3$

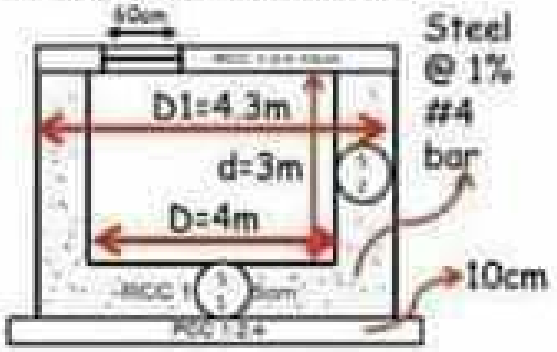
Deduction for hole $= \frac{\pi D^2}{4} \times T \quad \frac{\pi(0.6)^2}{4} \times 0.1 = 0.0282\ m^3$

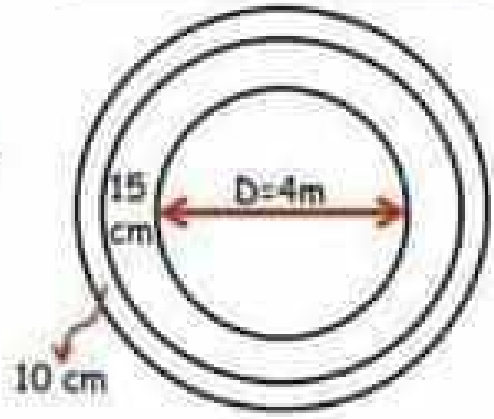
$= 1.423\ m^3$

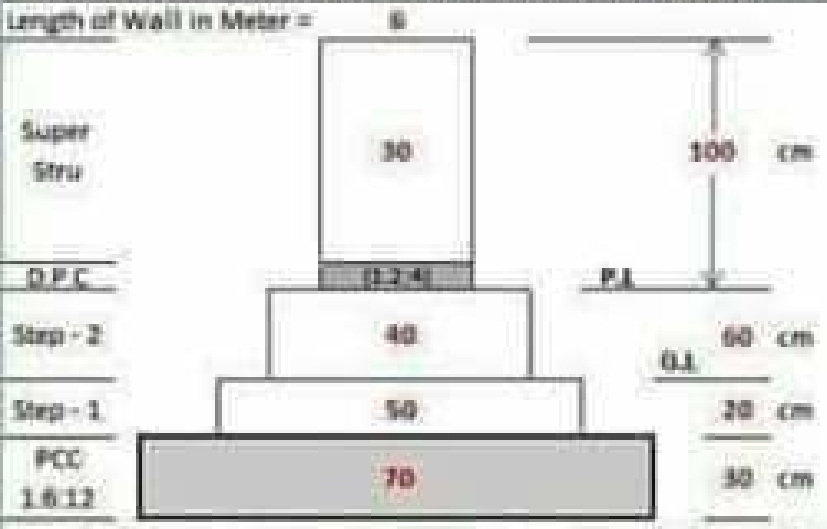
Total RCC $= 2.178\ m^3 + 5.867\ m^3 + 1.423\ m^3 = 9.468\ m^3$

steel $= \frac{1\%}{100} \times 9.468 = 0.09468\ m^3 \times 7850 = 744$ kg

Total net RCC $= 9.468\ m^3 - 0.09468\ m^3 = 9.373\ m^3$







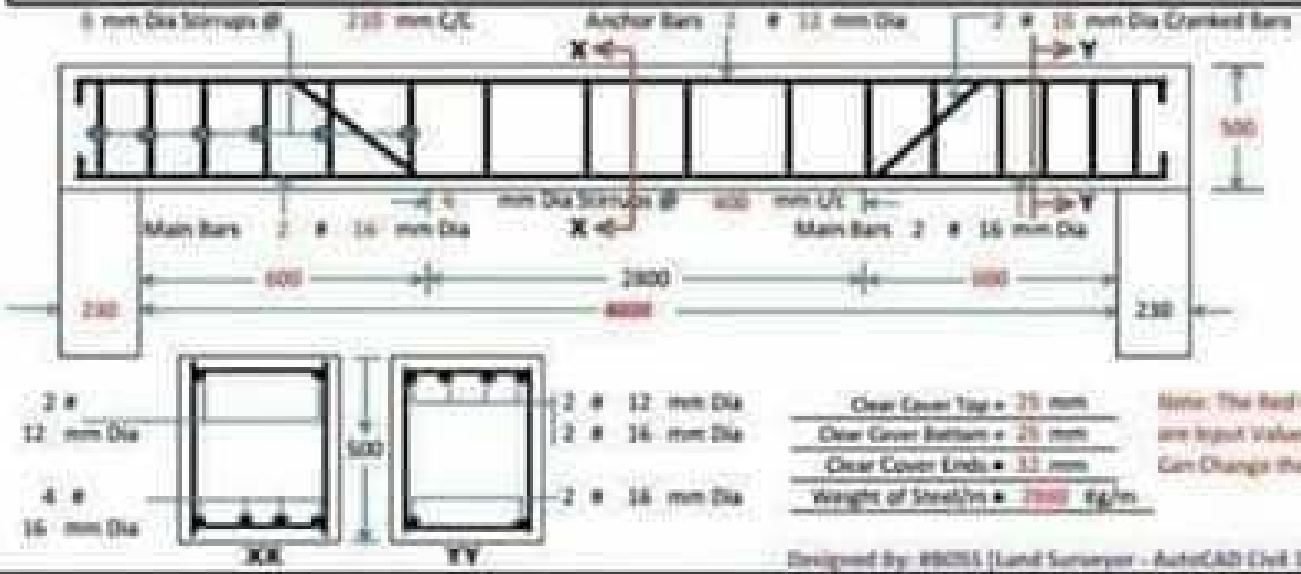
Estimate of I-WALL

a) Excavation or Earth Work
b) Concrete Work (1:6:12)
c) Brick Work in Foundation and Plinth
d) Damp Proof Course (1:2:4)
e) Brick Work in Super Structure
f) Cement Plaster
g) White Washing

Note: The Input Data are in Red color (in cm), you can change the values as per your requirement

S#	Description	No	Length (L) (m)	Breadth (B) (m)	Height (H) (m)	Quantity (Cu.m)	Remarks
1	Excavation (Length * Breadth of PCC - Breadth of Wall * Length of Wall)	1	6.40	0.70	0.50	2.24	0.70 - 0.30 * 6 = L 0.30 * 0.30 * H
2	Concrete (1:3:6) (Length * Same As Per Excavation)	1	6.40	0.70	0.30	1.34	
3	Brick Work (Foundation upto Plinth) (Length * Breadth of BW - Breadth of Wall * Length of Wall)						
	First Step (Step - 1)	1	6.20	0.50	0.20	0.62	0.50 - 0.30 * 6 = L
	Second Step (Step - 2)	1	6.10	0.40	0.60	1.46	0.40 - 0.30 * 6 = L
			Total Brick Work =			2.08	
4	D.P.C (1:2:4) 1.5" thick (Length * Breadth of DPC - Breadth of Wall * Length of Wall)	1	6.00	0.30	—	1.80	0.30 - 0.30 * 6 = L
5	Brick Work (in Cement Mortar (1:4) in Sill) (Length * Diglonal Length of Wall)	1	6.00	0.30	0.30	0.54	0.30 - 0.30 * 6 = L
6	Cement Plaster (1" Thick with mortar 1:3)						
	Front and Back (L x H)	2	6.00	—	1.00	12.00	
	Sides (B X H)	2	—	0.30	1.00	0.60	
	Top (L X B)	1	6.00	0.30	—	1.80	
			Total Plaster =			14.40	
7	White Wash 3 Coats		As Per Item No. 6			14.40	

BAR BENDING SCHEDULE OF RCC BEAM



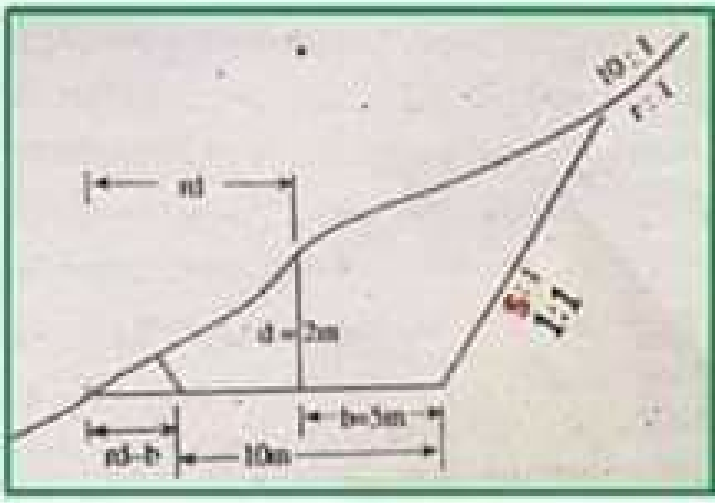
Clear Cover Top =	25 mm
Clear Cover Bottom =	25 mm
Clear Cover Ends =	32 mm
Weight of Steel/m =	7860 Kg/m

Note: The Red Color Cells are Input Values Cells, You Can Change these values.

Designed by: #BOSS [Land Surveyor - AutoCAD Civil 3D]

	CUT LENGTH OF BARS (mm)	Dia mm	Nos	LENGTH INCLUDE BENDS (m)	TOT LENGTH (m)	WT OF STEEL (Kg/m) VOL = Pi/4xD²x Wt of Steel/m	TOTAL WEIGHT (Kg)
B	Main Bars 4000 + 2 x 230 - 2 x 32 C.Span + Int. Thickness - Ends Cover	16	2	4396 + 18 x 16 Clength + 18 x Dia of Bar = 4684 = 4.684 m	4.684 x 2 9.368 m	Pi/4 x [16/1000]² x 7860 1.580 Kg/m	1.580 x 4.684 7.399 Kg
B	Anchor Bars 4000 + 2 x 230 - 2 x 32 C.Span + Int. Thickness - Ends Cover	12	2	4396 + 18 x 12 Clength + 18 x Dia of Bar = 4612 = 4.612 m	4.612 x 2 9.224 m	Pi/4 x [12/1000]² x 7860 0.888 Kg/m	9.224 x 4.612 42.543 Kg
C	500 - 2 x 25 - 16 = 434 Cranked Bars 798 2600 798	16	2	4396 + 18 x 16 + 2 x 0.414 x 434 = 5043.552 Clength + 18d + 2 x 0.41m	5.043 x 2 10.087 m	Pi/4 x [16/1000]² x 7860 1.580 Kg/m	10.087 x 1.580 15.932 Kg
A	Ct Length + 41.6xdC	Gt Length + 41.6xdC		5.043 m	m		
M	450 Stirrups 180 We 500 - 2 x 25 We 230 - 2 x 25	6	17	2 x (450 + 180) + 24 x 6 = 1404 2 x (L+B) + 24 Dia of Bar 1.404 m (798 / 210) + 1 x 2 + (2800 / 400) 17 Nos	1.404 x 17 23.868 m	Pi/4 x [6/1000]² x 7860 0.222 Kg/m	0.222 x 23.868 5.302 Kg
						TOTAL WEIGHT OF STEEL IN KG =	71.174 Kg
						TOTAL WEIGHT OF STEEL IN TON =	0.071 T

Example1 : Work out the quantity of earth work for 50 meter long road in hilly area. Formation width of the road is 10 meter, average depth for cutting at center line of the road is 2 meter, cross slope of hill side is 10:1 and side slope are 1:1 in cutting and 1.5:1 in filling



Solution :

Volume of earth work

= Area in cutting x length ------(1)

$$\text{Area in cutting} = \frac{sb^2+2r^2bd+sr^2d^2}{r^2-s^2}$$

$$A = \frac{1(5)^2+2(10)^2(5)(2)+1(10)^2(2)^2}{10^2-1^2}$$

$$A = 24.50\ m^2$$

Earth work = $24.50\ m^2$ x 50 m = $1225\ m^3$

SL KHAN

Example#1 Workout the quantity of earth work for an embankment 150m long and 10m wide at the top. Side slope is 2:1 and depths at each 30m interval are 0.60, 1.2, 1.4, 1.6, 1.4, and 1.6m.

solution:- Mean area method

Station	depth	Center area =B.d	Area of sides=sd^2	total area B.D +sd^2	Mean area A1+A2/2	Interval	quantity Cut	quantity Fill
0	0.6	6	0.72	6.72				
30	1.2	12	2.88	14.88	10.8	30		324
60	1.4	14	3.92	17.92	16.4	30		492
90	1.6	16	5.12	21.12	19.52	30		585.6
120	1.4	14	3.92	17.92	19.52	30		585.6
150	1.6	16	5.12	21.12	19.52	30		585.6
Total filling or embankment quantity =								**2572.8m^3**

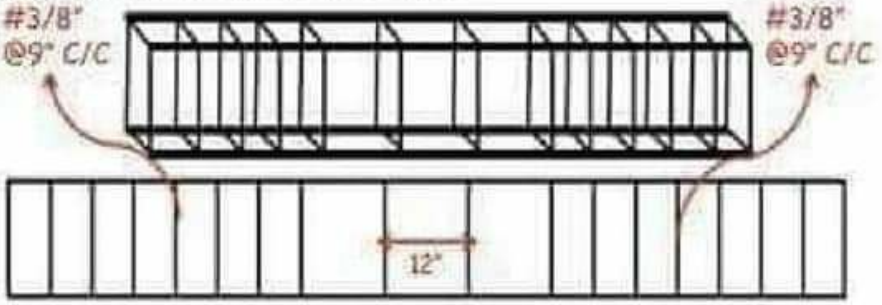
$\frac{6.72 + 14.88}{2}$ =10.8 sq.m

$\frac{14.88 + 17.92}{2}$ =16.4 sq.m

Quantity survey: Steel calculation for beams

For example:-

Calculate steel in kg for given beam.? Take 1" C.C to all sides. Length=15'



Solution:- Calculation for stirrups

Length of all stirrups bar=

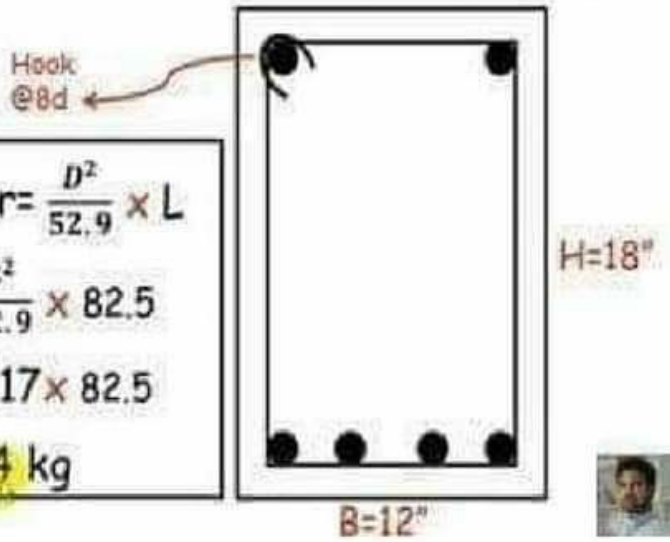
Length of one stirrup x number of stirrups

$= 2\{12 - 2(c.c)\} + 2\{(18 - 2(c.c))\} + 8d \times 18$

$= 2\{12 - 2(1)\} + 2\{(18 - 2(1)\} + 8\frac{3}{8} \times 18$

Length of all stirrups bar= $\frac{990"}{12}$

Length of all stirrups bar= 82.5'



W of bar= $\frac{D^2}{52.9} \times L$

$W = \frac{3^2}{52.9} \times 82.5$

$W = 0.17 \times 82.5$

W= 14 kg

How To Calculate Cutting Length Of Stirrups

Rectangular Column:

Size Of Column = 300mm × 400mm

Length Of Column (A) = 300 - (2 × 44) = 212mm

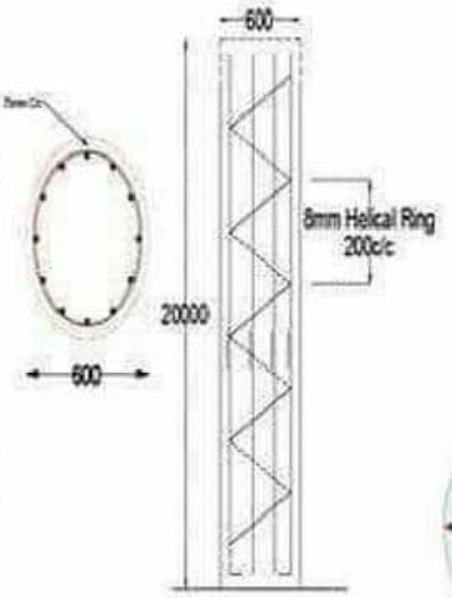
Breadth Of Column (B) = 400 - (2 × 44) = 312mm

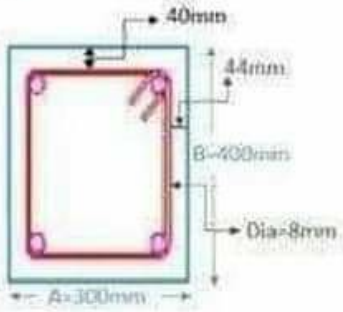
Hook Length = 10 D = 10 × 8 = 80 × 2 = 160mm

Cutting Length Of Stirrup = (A ×2) + (B ×2) + Hook Length

= (212 ×2) + (312 ×2) + 160

= 1208 mm / 1000 = 1.208m





Circular Column:

Dia Of Column = 600mm

Dia Of Stirrup c/c = 600 – (2× 40) – (4 + 4) = 512mm

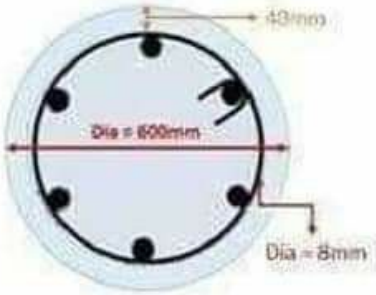
Parameter Of Stirrup = πd = 3.142 × 512 = 1608.704mm

Hook Length = 10 D = 10 × 8 = 80 × 2 = 160mm

Cutting Length Of Stirrup = Parameter Of Stirrup + Hook L

= 1608.704 × 160

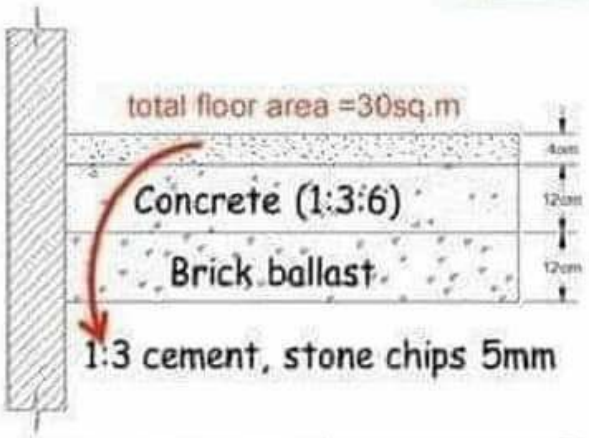
= 1768.704 mm / 1000 = 1.768m



Materials calculation for floors?

1)Brick ballast in sub base= 3.6

Example: Calculate materials in given floor section ?



Solution:-

3) Topping stone chips and cement(1:3)

Total wet volume = $30 \times 0.04 = 1.2\ m^3$

$$Material = \frac{ratio\ of\ material}{sum\ of\ ratio} \times Dry\ volume$$

$$Cement = \frac{1}{4} \times 1.524 = 0.381\ cu.m$$

$$Cement = \frac{0.381}{0.035} = 10.88 bags$$

$$Stone\ chips = 0.381 \times 3 = 1.143\ m^3$$

Dry volume = wet volume x 1.27

Dry volume = 1.2 x 1.27

Dry volume = 1.524 m^3

Ratio

1 : 3

Sum of ratio

1 + 3 = 4

cement= 10.88 *bags*

Stone chips = **1.66** m^3

How to find Slope of the Stair?

$$\text{Tan}\alpha = \frac{Rise}{Run} \qquad \text{Tan}\alpha = \frac{Rise}{R}$$

$$\text{Tan}\alpha = \frac{6}{12} \qquad \text{Tan}\alpha = \frac{6}{12}$$

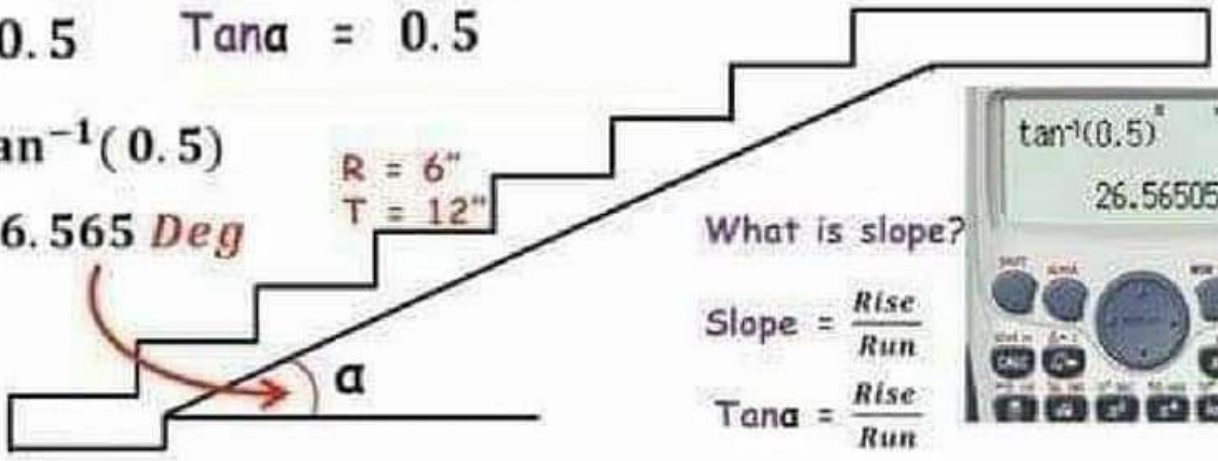
$$\text{Tan}\alpha = 0.5 \qquad \text{Tan}\alpha = 0.5$$

0.5 = 6/12

now what? if the rise and run of the stair are unknown...?

$$\alpha = \tan^{-1}(0.5)$$

$$\alpha = 26.565\ Deg$$



What is slope?

$$\text{Slope} = \frac{Rise}{Run}$$

$$\text{Tan}\alpha = \frac{Rise}{Run}$$

Example:- Calculate steel in kg for given slab if both directional steel are #4@12" c/c? Ignore concrete cover

Solution:-

L1= 20 ft.

L2=L1 - 2

L2=20 - 2 =18'

L3=L2 - 2

L3=18 - 2 =16'

L4=L3 - 2

L4=16 - 2 =14'

L5=L4 - 2

L5=14 - 2 =12'

L6=L5 - 2

L6=12 - 2 =10'

L7=L6 - 2

L7=10 - 2 =8'

L8=8 - 2 =6'

L9=6 - 2 =4'

L10=4 - 2 =2'

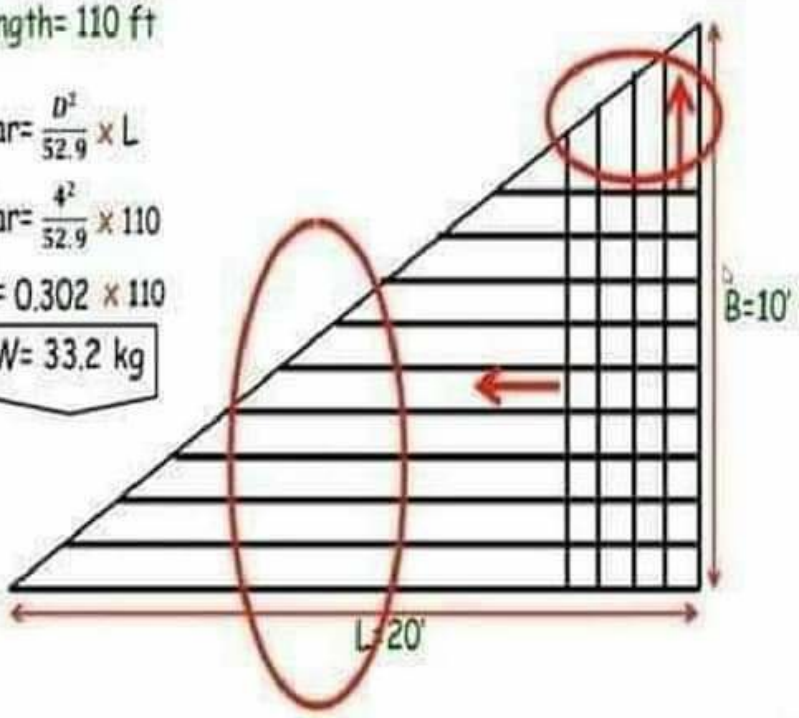
Total length= 110 ft

W of bar= $\frac{D^2}{52.9} \times L$

W of bar= $\frac{4^2}{52.9} \times 110$

W= 0.302 x 110

W= 33.2 kg



How to create the design of a single flat stair

Procedure Way#1

1) Suppose suitable Rise for one step.

2) Find No. of Rise

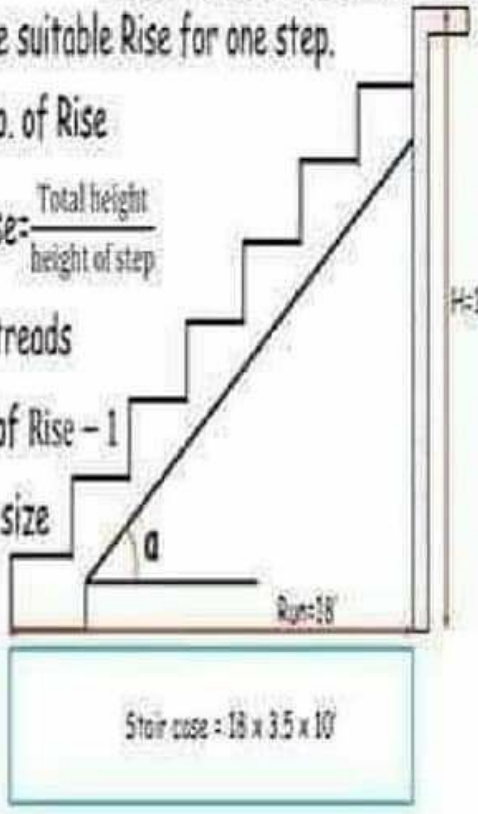
$$\text{No. of Rise} = \frac{\text{Total height}}{\text{height of step}}$$

3) Calculate No. of treads

No. of treads = No. of Rise − 1

4) Calculate tread's size

4) Check for pitch



Stair case = 18 x 3.5 x 10'

Lets try Procedure Way#1

Suppose rise = 6"

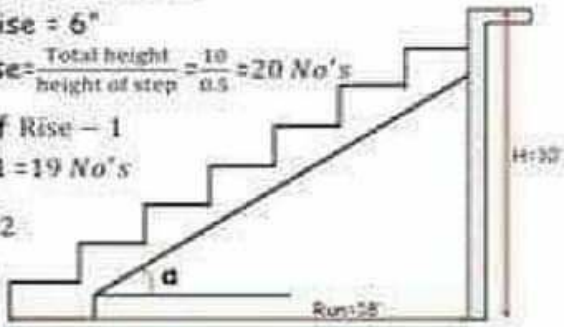
$$\text{No. of Rise} = \frac{\text{Total height}}{\text{height of step}} = \frac{10}{0.5} = 20\ No's$$

No. of treads = No. of Rise − 1

No. of treads = 20 − 1 = 19 *No's*

$$\text{Tread's size} = \frac{18'}{19} \times 12$$

Tread's size = 11.37"



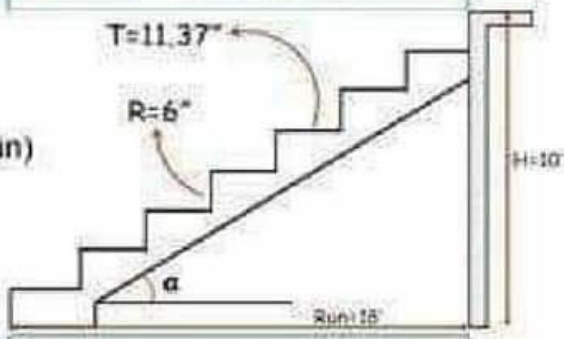
Stair case = 18 x 3.5 x 10'

Lets try Procedure Way#1

$$\alpha = \tan^{-1}(\text{Rise/Run})$$

$$\alpha = \tan^{-1}\left(\frac{6}{11.37}\right)$$

$$\alpha = 27.82\ Deg$$



Stair case = 18 x 3.5 x 10'

CONCRETE VOLUME FOR RETAINING WALL

Here we have three parts one is base Slab (A) the 2nd is stem (B)
And the 3rd one is counterfort (C).
The volume of retaining wall = Volume of base slab + Volume of stem + Volume of counterfort
= Volume of A + Volume of B + Volume of C

1) . Volume Of Base Slab (A):

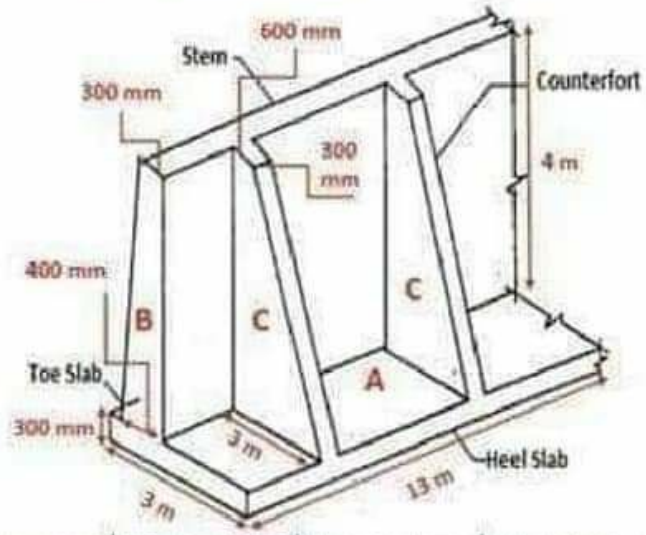
Volume of A = l x b x h = 13 x 3 x 0.3 = 11.7 m^3

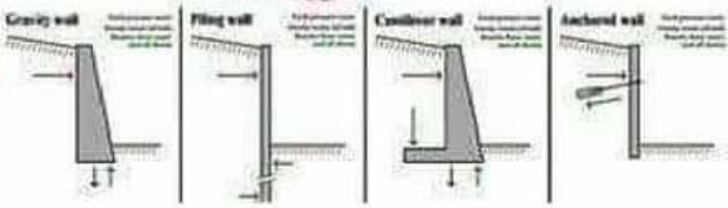
2) . Volume Of Stem (B):

Part B is a trapezoid,
So Volume of B = [{(a + b)/2} x h] x l = [{(0.3 + 0.4)/2} x 4] x 13
= 18.2 m^3

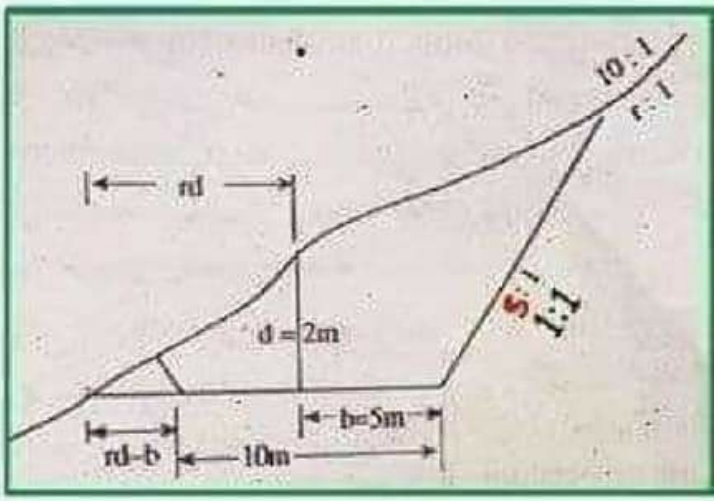
3) . Volume Of Counterfort (C):

Part C is also a trapezoid,
So Volume of C = [{(a + b)/2} x h] x l = [{(0.6 + 3)/2} x 4] x 0.3 = 2.16 m^3
The above retaining wall there is 2 counterfort so,
Volume of C = 2.16 x 2 = 4.32 m^3
Total volume of retaining wall = 11.7 + 18.2 + 4.32 = 34.22 m^3





Example1 : Work out the quantity of earth work for 50 meter long road in hilly area. Formation width of the road is 10 meter, average depth for cutting at center line of the road is 2 meter, cross slope of hill side is 10:1 and side slope are 1:1 in cutting and 1.5:1 in filling



Solution :

Volume of earth work

= Area in cutting x length ------(1)

$$\text{Area in cutting} = \frac{sb^2+2r^2bd+sr^2d^2}{r^2-s^2}$$

$$A = \frac{1(5)^2+2(10)^2(5)(2)+1(10)^2(2)^2}{10^2-1^2}$$

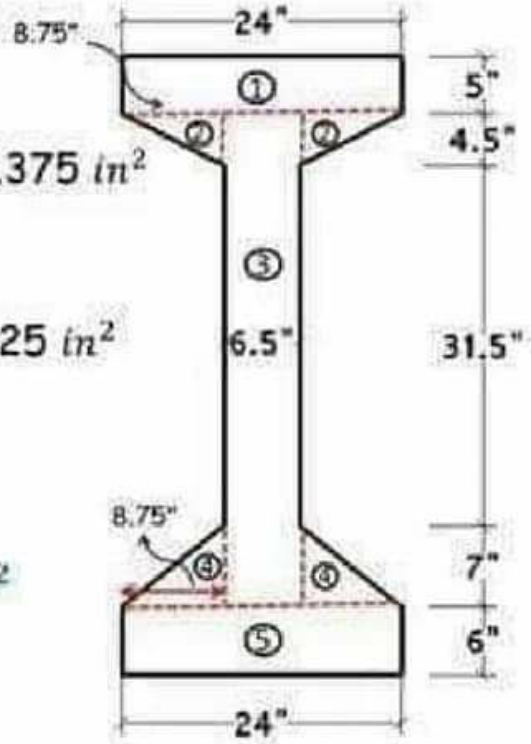
$$A = 24.50\ m^2$$

Earth work = 24.50 m^2 x 50 m = 1225 m^3

SL KHAN

Example #2 Work out concrete for the given bridge girder. Take length = 30 ft

Solution:



Area of figure 1 = 24" x 5" = 120 in^2

Area of figure 2 = $\frac{base \times height}{2} \times 2 = \frac{8.75" \times 4.5"}{2} \times 2 = 39.375\ in^2$

Area of figure 3 = 43" x 6.5" = 279.5in^2

Area of figure 4 = $\frac{base \times height}{2} \times 2 = \frac{8.75" \times 7"}{2} \times 2 = 61.25\ in^2$

Area of figure 5 = 24" x 6" = 144 in^2

Total sectional area = 120 in^2 + 39.375 in^2 + 279.5 in^2

+ 61.25 in^2 + 144 in^2 = 644.125in^2

Total sectional area = $\frac{644.125\ in^2}{12 \times 12}$

Engineer Boy

Example : calculate lime and glue of three coat for the given plastered wall...

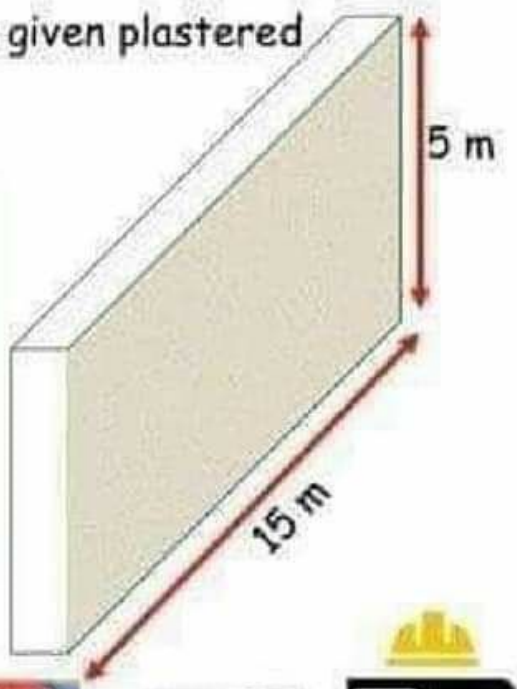
Solution :

Total white washing area= 15 m x 5 m = 75 m^2

White unslacked lime = $\frac{3.5\ kg}{10\ m^2}$ x 75 m^2 = 26.25 kg

Glue = $\frac{0.12\ kg}{10\ m^2}$ x 75 m^2 = 0.9 kg

say 1 kg



Points to Remember.. For smooth surface

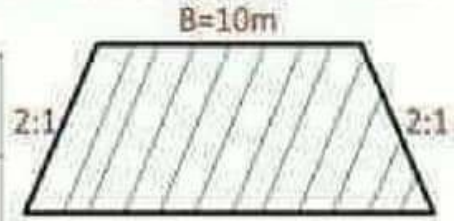
1) 2 kg per 10 m^2 of white fat lime is required for a single coat white washing with 0.06 kg Glue.
2) 2.8 kg per 10 m^2 of white fat lime is required for double coat white washing with 0.06 kg Glue.
3) 3.5 kg per 10 m^2 of white fat lime is required for a triple coat white washing with 0.12 kg Glue.
4) Color can be added lump sum. There is no specific way because it depends on choice.

Engineer Boy

Example#1 Workout the quantity of earth work f0r an embankment 150m long and 10m wide at the top. Side slope is 2:1 and depths at each 30m interval are 0.60, 1.2, 1.4, 1.6, 1.4, and 1.6m.

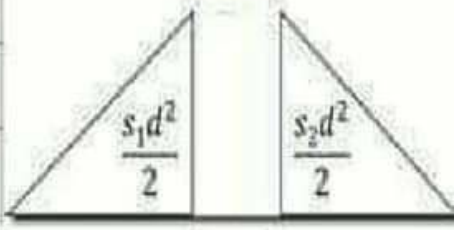
solution:- Mean area method

Station	depth	Center area =B.d	Area of sides=Sd^2	total area B.D +Sd^2	Mean area A1+A2/2	interval	quantity Cut	quantity Fill
0	0.6	6	0.72	6.72				
30	1.2	12	2.88	14.88	10.8	30		324
60	1.4	14	3.92	17.92	16.4	30		492
90	1.6	16	5.12	21.12	19.52	30		585.6
120	1.4	14	3.92	17.92	19.52	30		585.6
150	1.6	16	5.12	21.12	19.52	30		585.6
Total filling or embankment quantity =								**2572.8m^3**



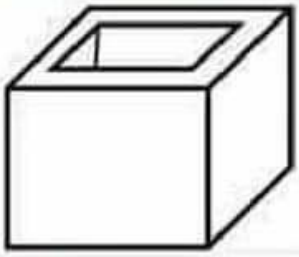
$\frac{6.72 + 14.88}{2}$ =10.8 sq.m

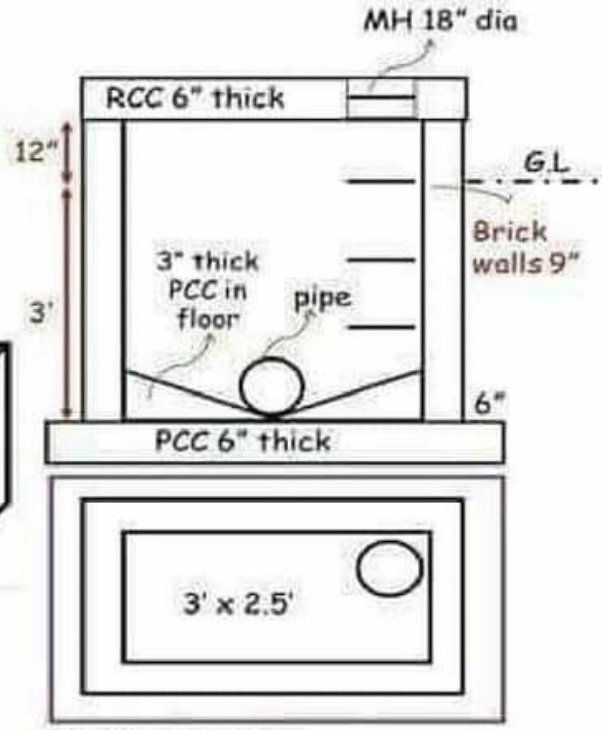
$\frac{14.88 + 17.92}{2}$ =16.4 sq.m



Manhole Quantity

1) Total excavation = 96.25 cft
2) PCC in bed layer = 13.75 cft
3) PCC (concrete) in floor = 0.9375 cft.
4) RCC in Slab = 8.12 cft
5) Brick work = 42 cft
6) Inside Plaster = 44 Sft
7) Iron steps = 3 @ 12" c/c
8) MH covers = 1 cover with 18" dia





Brick work for walls :

= Volume of external Box - volume of internal Box

$= 4.5 \times 4 \times 4 - (3 \times 2.5 \times 4)$

$72 - 30$

$= 42$ cft

Inside plaster :

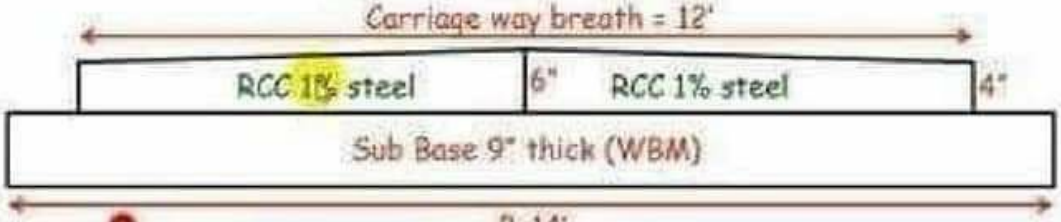
= inside parameter x Height

$= \{(3 \times 2) + (2.5 \times 2)\} \times 4$

RCC Road quantity

Example # 1

Calculate concrete, steel and sub base material for given road section, take 60' as road length. Ignore joints in calculation.



Solution:-

① Quantity of sub base materials =

=Length x breath x thickness

$= L \times B \times (d + \frac{d}{2})$

$= 60 \times 14 \times (0.75 + \frac{0.75}{2})$

Sub base= 945 cft

② RCC work

RCC work = X-section area x road length

$\text{RCC work} = 2 \times (\frac{0.334+0.5}{2}) b \times L$

$\text{RCC work} = 2 \times (\frac{0.334+0.5}{2}) 6 \times 60$

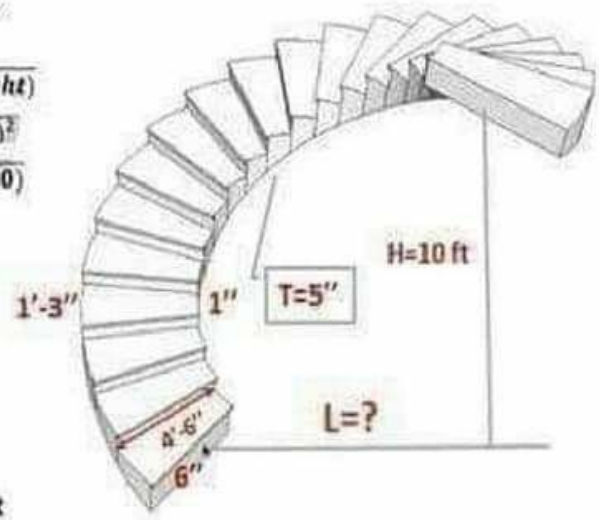
RCC work= 300.25 cft

Semi Round Stair Quantity

- Linear Length Of Stair = ?
- Inclined Length Of Stair = ?
- Waist Of Stair = 4.5 Feet
- Thickness Of S.Waist = 0.41 Feet
- Riser Of Stair = 6" = 0.5 Feet
- Tread Of Stair = 1'-3" – 1'
- No Of Steps $= \frac{Height}{One\ Riser}$

$= \frac{10}{0.5} = 20$ No's

- Linear Length = 2 (π × R) 0.50
- = 2 (3.142 × 9.5) 0.50
- = 29.84 Feet
- Inclined Length $= \sqrt{(Base) + (Height)}$
- $= \sqrt{(29.84)^2 + (10)^2}$
- $= \sqrt{(890.42) + (100)}$
- $= \sqrt{990.42}$
- = 31.47 Feet
- One Step Volume $= \frac{L \times W \times H}{2}$
- $= \frac{4.5 \times 1.125 \times 0.5}{2}$
- $= \frac{2.53}{2} = 1.26$ Cft
- Total Steps = 20 × 1.26 = 25.2 Cft
- Total Volume = 58.062 + 25.2
- = 83.26 Cft



Stair Section

Volume=?

Solution:-

How to estimate the volume of brick chimney

$$V=\frac{h}{3}\{(A_1+A_2+\sqrt{A_1 A_2})-(a_1+a_2+\sqrt{a_1 a_2})\}$$

$A_1=\frac{\pi D_1^2}{4}=\frac{\pi 5^2}{4}=19.634\ m^2$ $A_2=\frac{\pi D_2^2}{4}=\frac{\pi 1.60^2}{4}=2.01\ m^2$

$a_1=\frac{\pi d_1^2}{4}=\frac{\pi 4.4^2}{4}=15.205\ m^2$ $a_2=\frac{\pi d_2^2}{4}=\frac{\pi 1^2}{4}=0.785\ m^2$

$$V=\frac{15}{3}\{(19.634+2.01+\sqrt{19.634\times 2.01})-(15.205+0.785+\sqrt{15.205\times 0.785})\}$$

$$V=\frac{15}{3}\{(27.926)-(19.445)\}$$

V= 42.40 m³ Chimney Volume = 42.40 m³

Materials calculation for floors?

1)Materials in sub Base

Brick ballast= 3.6 m^3

2)Materials in Base

cement= 15.8 *bags*

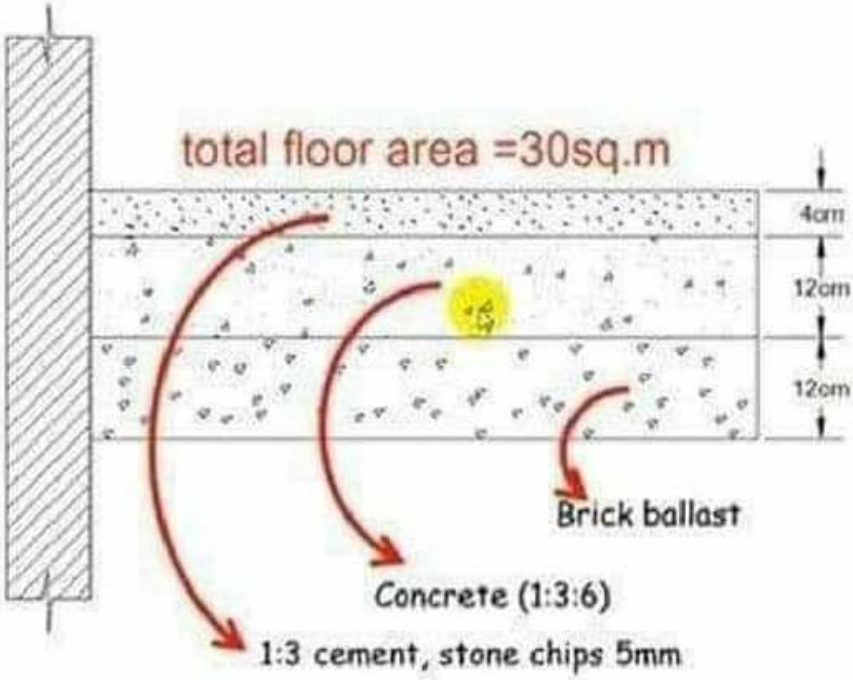
Sand **= 1.66** m^3

bajri **= 3.326** m^3

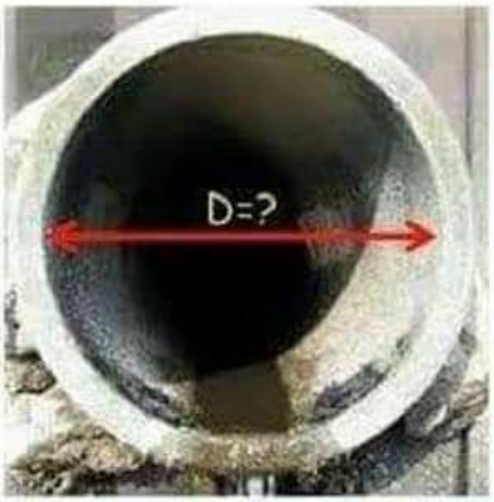
3)Materials in topping

cement= 10.88 *bags*

Stone chips **= 1.66** m^3



Example#1 Design a circular sewer pipe having average discharge equal to 40 litr/sec. Sewage velocity is 1.5 m/sec.



Design solution:

Max flow = 40 x 3 = 120 litr/sec = 0.12 m^3/sec

Max flow = **0.12** cumec

Full flow = 0.12 x 1.5 = **0.18** cumec

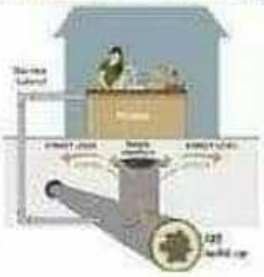
Remember! **Q = A x V** Or **A = $\frac{Q}{V}$**

$A = \frac{0.18}{1.5}$ =0.12 sq.m

$4x\frac{\pi D^2}{\pi\ 4} = \frac{0.12\ x4}{\pi}$

$\sqrt{D^2} = \sqrt{0.1527887454}$

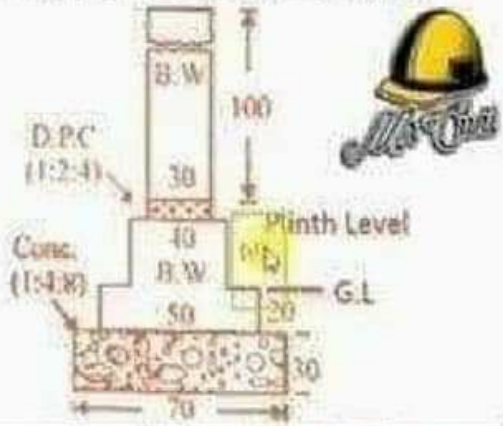
D = 0.3908820095m Or D = 39 cm Say D = 40 cm



How to Calculate Quantity of Straight Wall

Example: Workout the Following Quantities from Given data and Sketch for a Straight wall 6 Meter Long

1. Earth Work
2. Concrete Work
3. Brick Work in Foundation and Plinth
4. Damp Proof Course
5. Brick Work in Super Structure
6. Cement Plaster
7. White Wash



Solution:

S.No	Description	No	L	B	H	Quantity
1.	Excavation	1	6.40	0.70	0.50	2.24 m³
2.	Concrete (1:4:8)	1	6.40	0.70	0.30	1.34 m³
3.	Brick Work in Foundation and Plinth					
	(A) First Step	1	6.20	0.50	0.20	0.62 m³
	(B) Second Step	1	6.10	0.40	0.60	1.46 m³
	Total					2.08 m³
4.	D.P.C (1.2.4) 4 cm thick	1	6.10	0.40	--	2.44 m²
5.	Brick Work in Cement Mortar (1:4) in Super Structure	1	6.00	0.30	1.00	1.80 m³
6.	Cement Plaster 2.5 cm thick With Mortar (1:3)					
	(A) Front and Back	2	6.00	--	1.00	12.0 m²
	(B) Sides	2	0.30	--	1.00	0.60 m²
	(C) Top	1	6.00	0.30	--	1.80 m²
	Total					14.4 m²
7.	White Wash 3 Coats	As per item No. 6				14.4 m²

How To Calculate Cement Bags In 1 Cubic Meter

Consider the nominal mix is 1:2:4

Wastage of cement is considered as 2%

Output of mix is considered as 66%

To achieve 1 cum output,

We need 1/0.66 = 1.5151 say 1.52 cum dry mix.

Add the wastage of 2%, i.e (1.52 + 0.02) = 1.54 cum.

Volume of cement = $\left(\frac{Cement}{Cement+Sand+Aggregate}\right)$ × Dry Mix

= $\left(\frac{1}{1+2+4}\right)$ × 1.54

= 0.22 cum

Density of cement is 1440 kg/cum

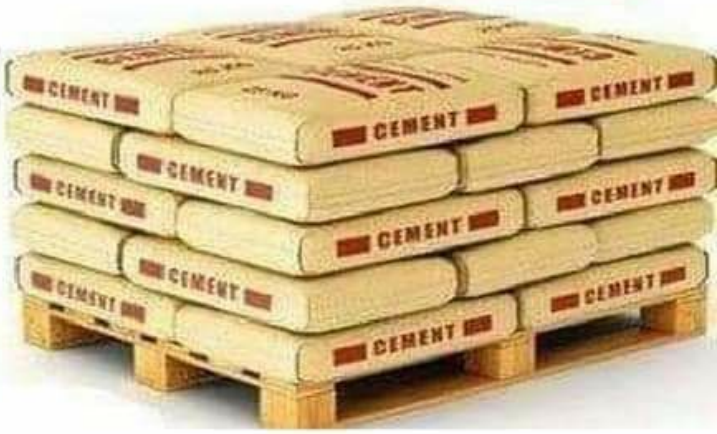
Weight of 1 bag cement = 50 kg.

So the volume of 1 bag cement = 50/1440

Volume = 0.0347 cum.

No of cement bags in 1 cum = 0.22/0.0347

So Nos Of Bags = **6.34 bags.**



Example: if we are asked to select a suitable size for a circular water tank to store 20000 liters of water for a residential building. Note that the tank depth should not be more then 2 meters.

Solution/Design:

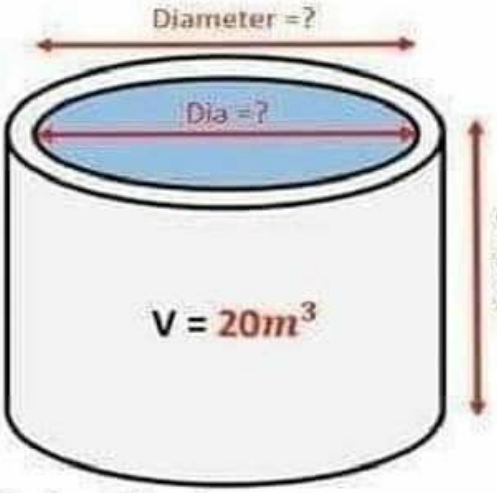
Total Capacity of Tank = $\frac{20000}{1000} = 20m^3$

Tank volume = Base area x depth

$$20m^3 = \frac{\pi D^2}{4} \times d$$

Trials:

If depth = 0.5 meter then diameter = ?
If depth = 1 meter then diameter = ?
If depth = 1.5 meter then diameter = ?
If depth = 2 meter then diameter = ?



$$20m^3 = \frac{\pi(D)^2}{4} \times 0.5$$

$$\frac{20m^3}{0.393} = \frac{0.393(D)^2}{0.393}$$

$$\sqrt{50.90} = \sqrt{(D)^2}$$

$D = 7.13$ m Say D = 7 meters

So if depth = 0.5m then Dia = 7 m

and if depth = 1m then Dia = 5 m

and if depth = 1.5m then Dia = 4.12 m

and if depth = 2m then Dia = 3.56 m

Final Design

and if depth = 1.5m then Dia = 4.12 m

Provide 1.5 meters depth and 4.12 say 4.10 meters diameter.

Example#1 cont Given:- q_a = 6 ksf 5' below the grade

fc' for footing= 3 Ksi Fy=60 Ksi Column = 14" x 14"

fc' for column= 4 Ksi sD.L= 390 K and sL.L= 260 K

Design solution:- *check for beam shear*

$$\emptyset Vc_b > Vu_b$$

$$0.75 \times 4\sqrt{fc'}\, b\, d > 7.3 \times 11 \times b$$

$$0.75 \times 4\sqrt{3000}\; b\; 30 > 80.3\, b$$

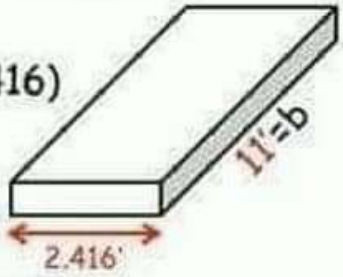
$$0.75 \times 4\sqrt{3000}\; (132)\, 30 > 80.3\; (2.416)$$

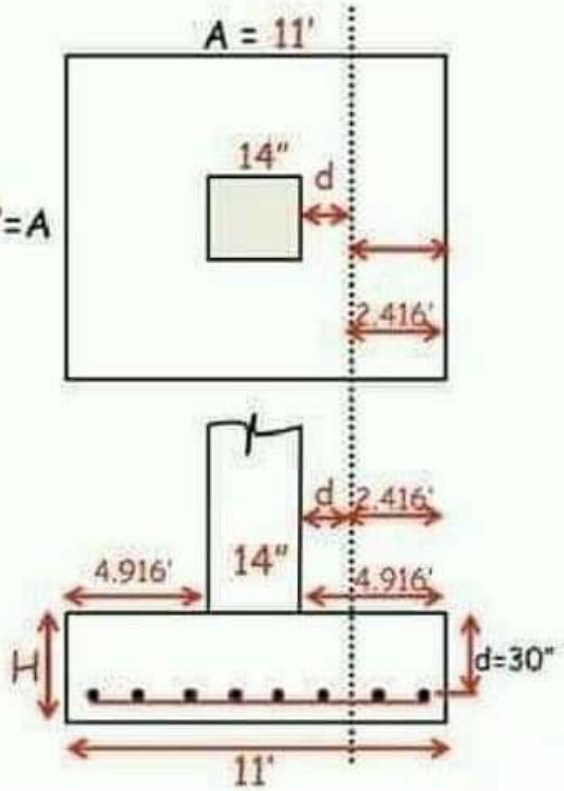
$$650k > 193\ k$$

d=30" +2" +1"

H=33"

H=36" = 3ft



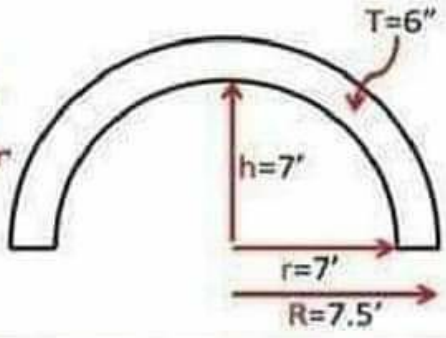


Depth "d" = 30" is okay for beam shear.....

How to Estimate Materials for RCC Dome

Example#1 Work out the cement, sand, crushed stone and steel for given half spherical dome. Concrete is 1:2:4 and steel is 1.5% as #4 bar. Also calculate external surface paint.

solution:- Dome volume?

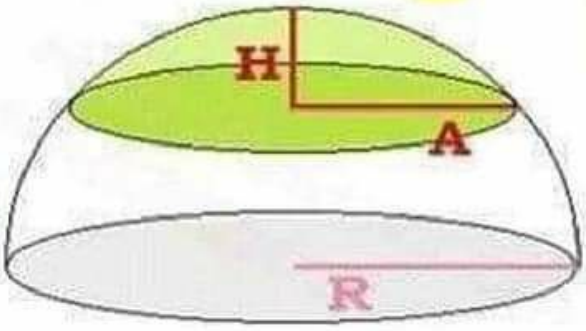


Dome concrete $= \frac{4\pi(R^3 - r^3)}{3\,(2)} = \frac{4\pi(7.5^3 - 7^3)}{6} = 165.195$ cft

steel $= \frac{1.5\%}{100} \times 165.195 = 2.478\ ft^3 \times 222.323 = 551$ kg # 4 bar

Total net RCC $= 165.195\ ft^3 - 2.478\ ft^3 = 162.717\ ft^3$

External surface Paint $= \frac{4\pi R^2}{2} = \frac{4\pi(7.5^2)}{2} = 353.43$ sft



WE WILL CHECK IF THE COLUMN CAN SUPPORT THE APPLIED LOAD

Question:-

Can the given mild steel column carry 1500 kips load?

Solution:- 2) Check for buckling

$$\text{Euler's}_{\text{buckling}} = \frac{\pi^2 EI}{l^2}$$

$$\text{Euler's}_{\text{buckling}} = \frac{\pi^2 \times 29000 \times 833.34}{96^2}$$

Buckling load= 25880.8 kips

25880.8 kips > 1500 kips

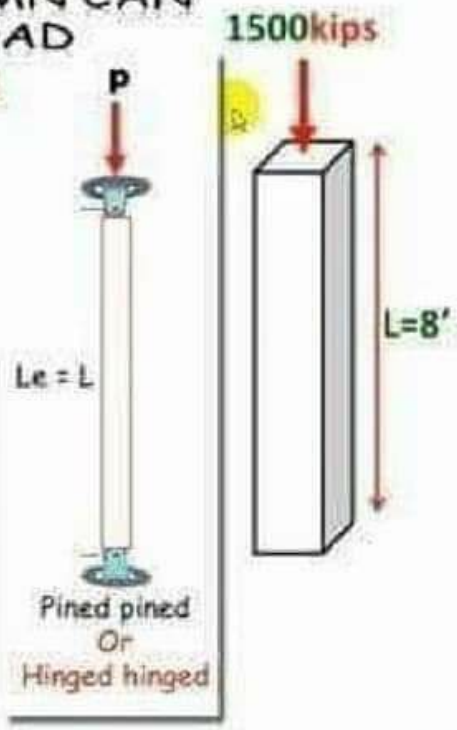
So the column is ok in buckling

10"x 10"

$$I = \frac{side^4}{12}$$

$$I = \frac{10^4}{12}$$

$$I = 833.34 in^4$$



HOW TO DESIGN SEPTIC TANK

Length of septic Tank = L = 9.75 ft

Breadth of septic Tank = B = 6.25 ft

Height of Septic Tank = D = 5.75 ft

External walls = 9" = 0.75 ft

Internal walls = 4.5" = 0.375ft

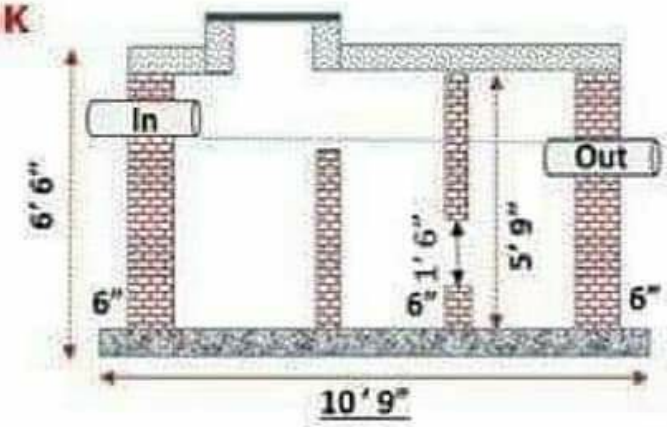
P.C.C 1:2:4 = Thick = 4 Inch

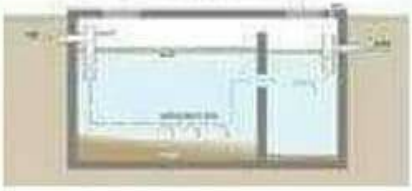
R.C.C Slab 1:2:4 = Thick = 5 Inch

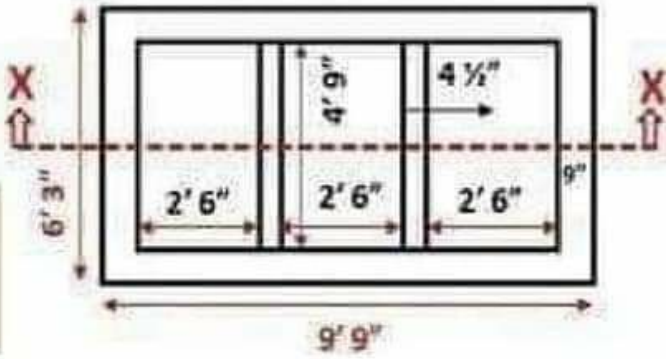
Cover Size = 2' Dia

Hole In Wall = 1.5 ft

Dia Of Pipe Min = 4 Inch







MATERIAL CALCULATION FOR PCC CONCRETE

Example#1:

Find cement, sand and crushed stone in given PCC work? Ratio of concrete is 1:2:4

$$Material = \frac{ratio\ of\ material}{sum\ of\ ratio} \times Dry\ volume$$

Dry volume = wet volume x 1.54

Wet volume=20x12x0.5

Wet volume= 120 cft

Dry volume = 120 x 1.54

Dry volume = 184.8 cft

Ratio
1 : 2 : 4
Sum of ratio
1+2+4 = 7

$$Cement = \frac{1}{7} \times 184.8 = 26.4\ cft$$

$$Cement = \frac{26.4}{1.25} = 21.12\ bags$$

$$Sand = 26.4 \times 2 = 52.8\ cft / 100 = 0.528\ sacra$$

$$bajri = 26.4 \times 4 = 105.6\ cft / 100 = 1.056\ sacra$$

Example#2:

Find only crushed stone in PCC work of volume 500 cft? Ratio of concrete is 1:3:6

$$Material = \frac{ratio\ of\ material}{sum\ of\ ratio} \times Dry\ volume$$

Dry volume = wet volume x 1.54

Wet volume= 500cft

Dry volume = 500 x 1.54

Dry volume = 770 cft

Ratio
1 : 3 : 6
Sum of ratio
1+3+6 = 10

$$Crushed\ stone = \frac{6}{10} \times 770 = 462\ cft$$

$$bajri = \frac{462}{100} = 4.62\ sacra$$

100 cft = 1 sacra

QUANTITY OF ASPHALT & NUMBERS OF DUMPERS IN A ROAD CONSTRUCTION

Suppose if length, breadth and thickness of asphalt layer are 150m, 10m and 15 cm, then calculate quantity of asphalt. Assume 2400 kg/cu.m dense asphalt.

Calculation:- Asphalt quantity = **540** Tonne

How many dumpers ?

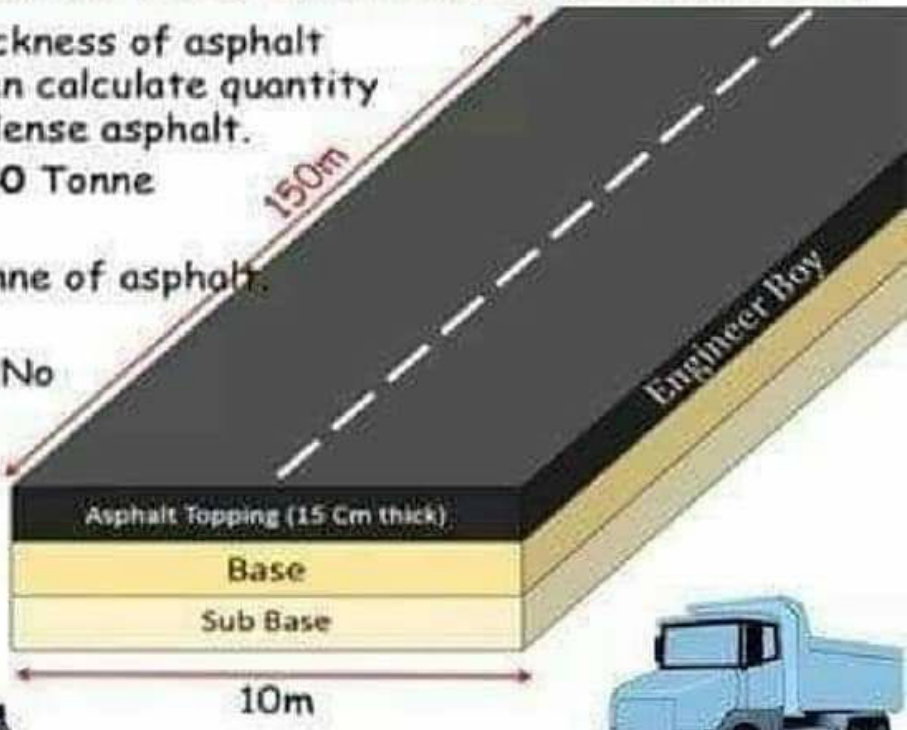
Suppose one dumper carry's 40 tonne of asphalt.

How many dumpers = $\frac{540}{40}$ = 13.5 No

Asphalt quantity = 540000 kg

Asphalt quantity = **540** Tonne

Asphalt quantity = **13.5** dumpers of 40 tonne asphalt one.



HOW TO MEASURE SAND, AGGREGATE IN TRUCK & HAIWA

Volume Of Dumper = L x B x H

Length of the dumper = L – 6 m , 5.5 m

Width of the dumper = B – 1.7 m

Height of the dumper = H – 2 m

Volume Of Dumper

$$= \frac{(6+5.5)}{2} \times 1.7 \times 2$$

$$= \frac{11.5}{2} \times 1.7 \times 2$$

$$= 5.75 \times 1.7 \times 2$$

= 19.55 Cubic Metre

HOW TO DESIGN AND CALCULATE THE VOLUME OF CONCRETE FOR U-SHAPE STAIRCASE

Wet Volume = 90.4 cuft

Dry Volume = 90.4 × 1.54

= 139.21 cuft

We will calculate for 1:2:4 Concrete mix.

Volume of cement $= \frac{1}{7} \times$ Dry Volume $= \frac{1}{7} \times 139.21$

= 19.88 cuft

Number Of Bags $= \frac{19.88}{1.25} = 15.90$, Say 16 Bags

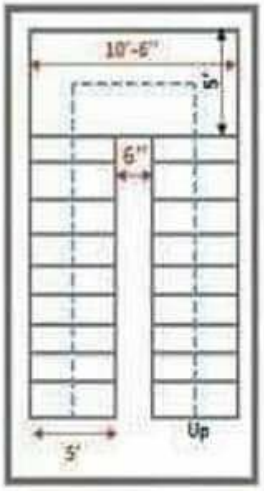
Volume Of Sand $= \frac{2}{7} \times$ Dry Volume $= \frac{2}{7} \times 139.21$

= 39.77 cuft

Volume Of Crush $= \frac{4}{7} \times$ Dry Volume $= \frac{4}{7} \times 139.21$

= 79.54 cuft

Section Of Staircase



Plan Of Staircase