DOTE TAMILNADU

Government of Tamil Nadu

# CIVIL ENGINEERING DRAWING - II

## DIPLOMA IN CIVIL ENGINEERING

## FIFTH SEMESTER / THIRD YEAR

A Publication under

Government of Tamil Nadu

Distribution of Free Text Book Programme

(NOT FOR SALE)



Untouchability is a sin

Untouchability is a crime

Untouchability is a inhuman

DIRECTORATE OF TECHNICAL EDUCATION
GOVERNMENT OF TAMIL NADU

Government of Tamil Nadu

First Edition – 2018

**CHAIR PERSON**
**Dr. R. Palaniswamy I.A.S.,**
Commissioner of Technical Education (FAC) / Chief Implementation Officer
Directorate of Technical Education, Chennai

**CONVENER**

**Thiru N. Muralikrishniah, M.E.,M.I.S.T.E.,**
Principal
Dr. Dharmambal Government Polytechnic College for Women, Chennai
Principal (addtl charge)
Institute of Printing Technology, Chennai

**AUTHORS**

**Thiru T. Arul Kumar M.Tech.**
Lecturer in Civil Engineering,
Central Polytechnic College, Chennai

**Thiru R. Ramarathnam M.Tech.**
Lecturer in Civil Engineering,
Government Polytechnic College, Uthangarai

**Tmt N. Ramya Gandhi M.E.**
Lecturer in Civil Engineering
Government Polytechnic College, Uthangarai

**REVIEWER :**

**Dr. R. Amutha, M.E., Ph.D, F.I.E**
Principal
Rajagopal Polytechnic College, Gudiyatham



| |
|---|
| This book has been prepared by the Directorate of Technical Education<br>This book has been printed on 60 G.S.M Paper |
| Through the Tamil Nadu Text book and Educational Services Corporation |

# PREFACE

We are in much happiest occasion to present CIVIL ENGINEERING DRAWING - II book for Diploma in Civil Engineering under Directorate of Technical Education, Tamil Nadu. An attempt has been made in this text learning material to meet the requirements and standards of M-Scheme curriculum of Civil Engineering Drawing -II of Fifth Semester Diploma in Civil Engineering prescribed by DOTE.

It is important to every Civil Engineer to have knowledge of public health engineering drawings, bridge drawings and structural drawings. This book deals about public health engineering drawings in first part, bridge drawings in second part and structural engineering drawings in the third part.



It is hoped that with the content exposed in this text, the readers and learners will be able to understand and pursue further in their studies. This book is written in simple and easily understandable manner.

The convener, authors and reviewer are very much grateful to the Commissioner of Technical Education Chennai for his deep involvement and encouragement in preparing this syllabus based learning material. Thanks are due to officials of DOTE, Chennai for their timely help whenever needed. Further suggestions and fair criticisms are welcome for fine tuning in future

CONVENER, AUTHORS and REVIEWER

## INDEX


| S. No. | Content | Page no. |
|---|---|---|
| **1** | List of Drawings | - |
| **2** | Public Health Engineering Drawing | 1 |
| **3** | Bridge Drawing | 14 |
| **4** | Structural Engineering Drawing with Bar Bending Schedule | 20 |
| **5** | Annexure | 59 |

## LIST OF DRAWINGS

### PUBLIC HEALTH ENGINEERING DRAWING

1. Infiltration gallery (with one infiltration well, one straight gallery pipe, one inspection well and one jack well)

2. Rapid Sand Filter

3. Septic Tank with dispersion Trench / Soak pit

4. Bio gas plant with floating type

### BRIDGE DRAWING

5. Two span Pipe Culvert

6. Two span Tee Beam Bridge with square returns.

### STRUCTURAL ENGINEERING DRAWING WITH BAR BENDING SCHEDULE

7. Simply supported one-way slab

8. Simply supported two-way slab



9. Restrained two-way slab

10. Singly reinforced Simply supported beam

11. Doubly reinforced Continuous beam with two spans

12. Tee Beams supporting continuous slab

13. Dog-legged staircase

14. Lintel cum Sunshade

15. R.C.C Column with square Isolated footing

## 1. INFILTRATION GALLERY (WITH ONE INFILTRATION WELL ONE STRAIGHT GALLERY PIPE, ONEINSPECTION WELL AND ONE JACK WELL)

If a perennial river is running nearer to the town, the infiltration gallery is one of the cheapest sources of water supply for a town. The water from Infiltration Gallery does not require any treatment except chlorination.

The infiltration gallery consists of infiltration well, inspection well and jackwell.

**Infiltration Well**

Infiltration wells are shallow wells which are constructed in series along the banks of the rivers. The water will be collected into the wells by seeping through their bottom. The wells are covered at top and open at bottom so water can be easily entered through its bottom. The sides of the wells are constructed by brick masonry with open joints. The water which received through the filtration well is very pure. Sandy beds are placed at the bottom of the tank. So that the suspended impurities and inorganic impurities get filtered.

**Inspection Well**



Inspection wells are also called man holes. For inspection purpose man holes are provided. Inspection wells are provided at an interval of 30m to 50m.

**Jack Well**

The infiltration wells are connected by porous pipes to a collecting sump known as jack well. The water thus collected through the infiltration wells flows by gravity into the jack well. Then the water from the jack well is pumped to the purification plant for further treatment.

The following particulars of an infiltration gallery are.

| | |
|---|---|
| River bed level | - + 100.000m |
| River bank level | - + 104.50m |
| Inner diameter of infiltration well | - 4m |
| Outer diameter of infiltration well | = 4.80m |
| Number of infiltration well | = 1 |
| Maximum flood level (MFL) | = 103.0m |
| Lowest summer water level (LSWL) | = + 98.20m |
| Invert level of stone water pipe | - + 94.00 |
| Diameter of stone water pipe | - 0.40m |
| Length of gallery pipe | - 50m |
| Width of gallery | - 1.80m |
| Cover Slab Thickness | - 100mm |

**Filter media**

Layer of filter media adjacent to the pipe 200mm
Next two layers are of 100mm each

| | |
|---|---|
| Inner diameter of jack well with pump house | = 6m |
| Outer diameter of jack well | = 6.90m |
| Inner diameter of inspection well | = 3.00m |
| Outer diameter of inspection well | = 3.60m |

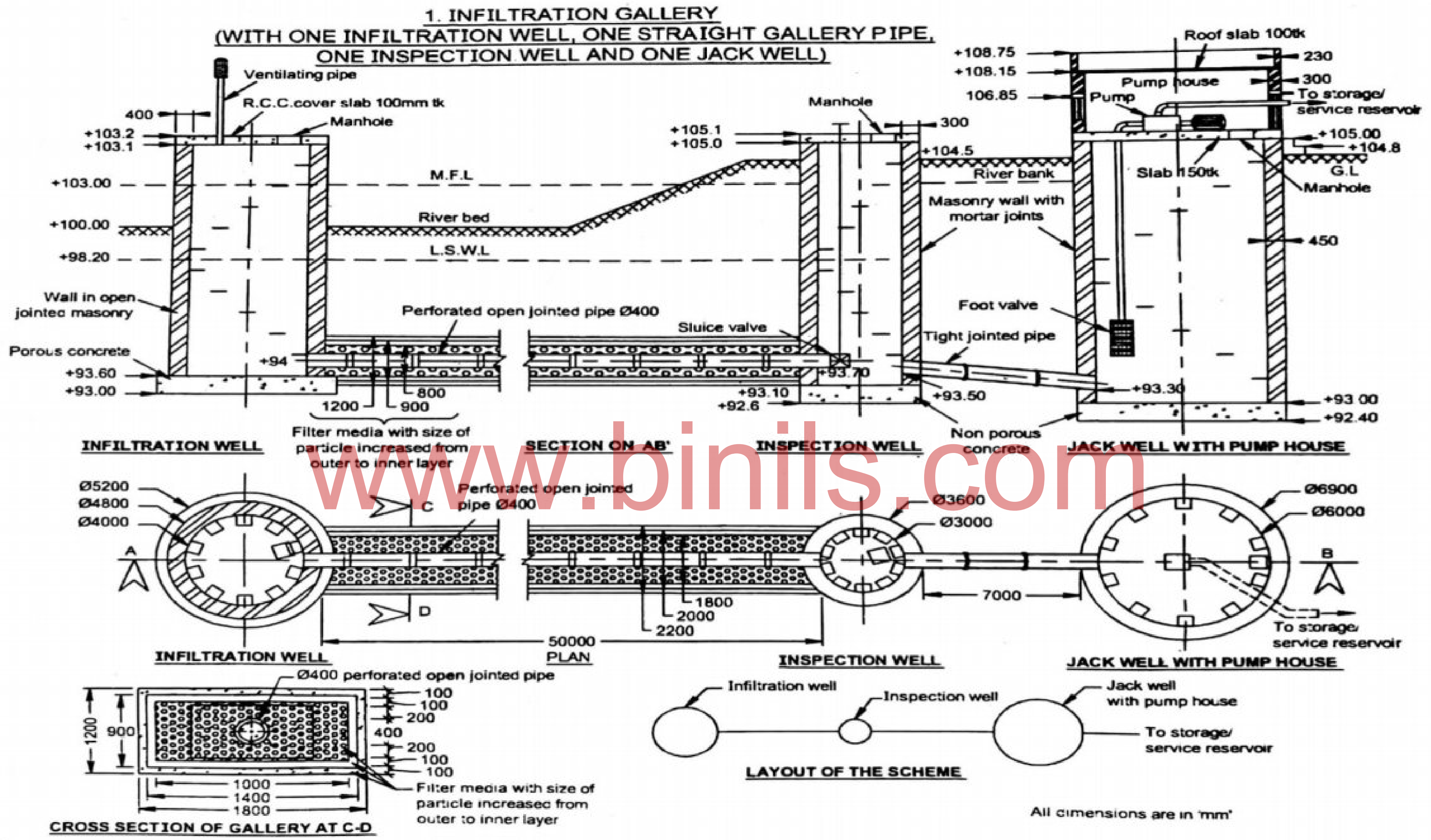
Assume any data suitably if required.

**Draw the following views to a suitable scale**

1. General layout of the scheme showing infiltration well, infiltration galleries, inspection wells, jack well and pump house. (Not to scale).
2. Longitudinal section of infiltration well, one straight gallery, one inspection well and one jack well.
3. Sectional plan of infiltration well, gallery, inspection well and jack well.
4. Cross sectional details of infiltration gallery.

**Assumptions**

1. Diameter of infiltration well - 2m to 6m
2. Diameter of inspection well 2m to 3m
3. The gallery should be laid at a minimum depth of 2m below the lowest summer water level.
4. Diameter of gallery pipe 300mm to 450mm.
5. Rate of infiltration for wells and galleries = 4500 to 6000 lit/$m^2$/day.


1. INFILTRATION GALLERY
(WITH ONE INFILTRATION WELL, ONE STRAIGHT GALLERY PIPE, ONE INSPECTION WELL AND ONE JACK WELL)
Ventilating pipe
R.C.C.cover slab 100mm tk
Manhole
M.F.L
River bed
L.S.W.L
Wall in open jointed masonry
Porous concrete
Perforated open jointed pipe Ø400
Sluice valve
Filter media with size of particle increased from outer to inner layer
INFILTRATION WELL
SECTION ON AB'
INSPECTION WELL
River bank
Masonry wall with mortar joints
Foot valve
Tight jointed pipe
Non porous concrete
Roof slab 100tk
Pump house
Pump
To storage/ service reservoir
Slab 150tk
G.L
JACK WELL WITH PUMP HOUSE
PLAN
LAYOUT OF THE SCHEME
Infiltration well
Inspection well
Jack well with pump house
CROSS SECTION OF GALLERY AT C-D
Ø400 perforated open jointed pipe
All dimensions are in 'mm'

**2. RAPID SAND FILTER**

Filtration is the process of removing bacteria, colour, taste, odour, iron, manganese from water. The efficiency of rapid sand filter is 55% more than the slow sand filter. It removes 95% of bacterial impurities. Its rate of filtration is 4000 - 5000 liters / $m^2$ / hours.

The components of rapid sand filter are

1. Enclosure tank
2. Bases materials
3. Filter media
4. Wash water trough
5. Air compressor

**Enclosure tank**

It is a rectangular water tight tank constructed either of masonry or concrete generally the length of tank is 6m to 9m.

**Filter media**

Filter mediais provided to a depth of 600mm to 900mm using a sand of effective size 0.35 to 0.6.

**Base materials**



Here gravel is used as a base material and is placed on the top of the under drainage system. This depth varies from 450mm to 600mm.

**Under drainage system**

Area of cross section of main drain or manifold should be greater than twice the area of cross section of lateral drain. The laterals are provided approximately at a rate of 150mm c/c to 300mm c/c. Diameter of perforations in the laterals should be between 6mm and 12mm and the spacing of perforations varies from 80mm to 200mm.

**Wash water trough**

The troughs are placed at a distance of 1.5m to 2m edge to edge. The bottom of the trough is about 450mm to 750mm above the sand bed. The dirty water coming from the filter bed is collected and removed.

**Air compressor**

The agitation of sand grains during washing of filter is carried by compressed air. Compressed air is passed at the rate of 60 - 80 $mm^3$/ minute / $m^2$ of filter area for 4 minutes. By this process sand gets purified and can be reused.

The following particulars of rapid sand filters are given below.

| | |
|---|---|
| Size of filter unit | - 8000 x 5000mm |
| Size of inlet chamber | - 5000 x 1000mm |
| Depth of filtration tank | - 3500mm |
| Depth of Filtration Chamber | - 2600 mm |
| Thickness of Filter media | - 1350 mm |
| Wall thickness at top | -450mm |
| Wall thickness of bottom | - 600mm |
| Thickness of foundation | -450mm |
| Diameter of main drain | - 380mm |
| Diameter of laterals | -80mm @ 300mm c/c |
| Diameter of air laterals | -70mm @300mmc/c |
| Diameter of air pipe | -150mm |

Slope of lateral - 1 in 50
Diameter of inlet pipe - 300mm
Diameter of wash water drain pipe- 300mm
Number of wash water drain pipe- 3 Nos
Size of wash water trough- 300mm x 450mm
Free board - 300mm
Diameter of wash water inlet-200mm

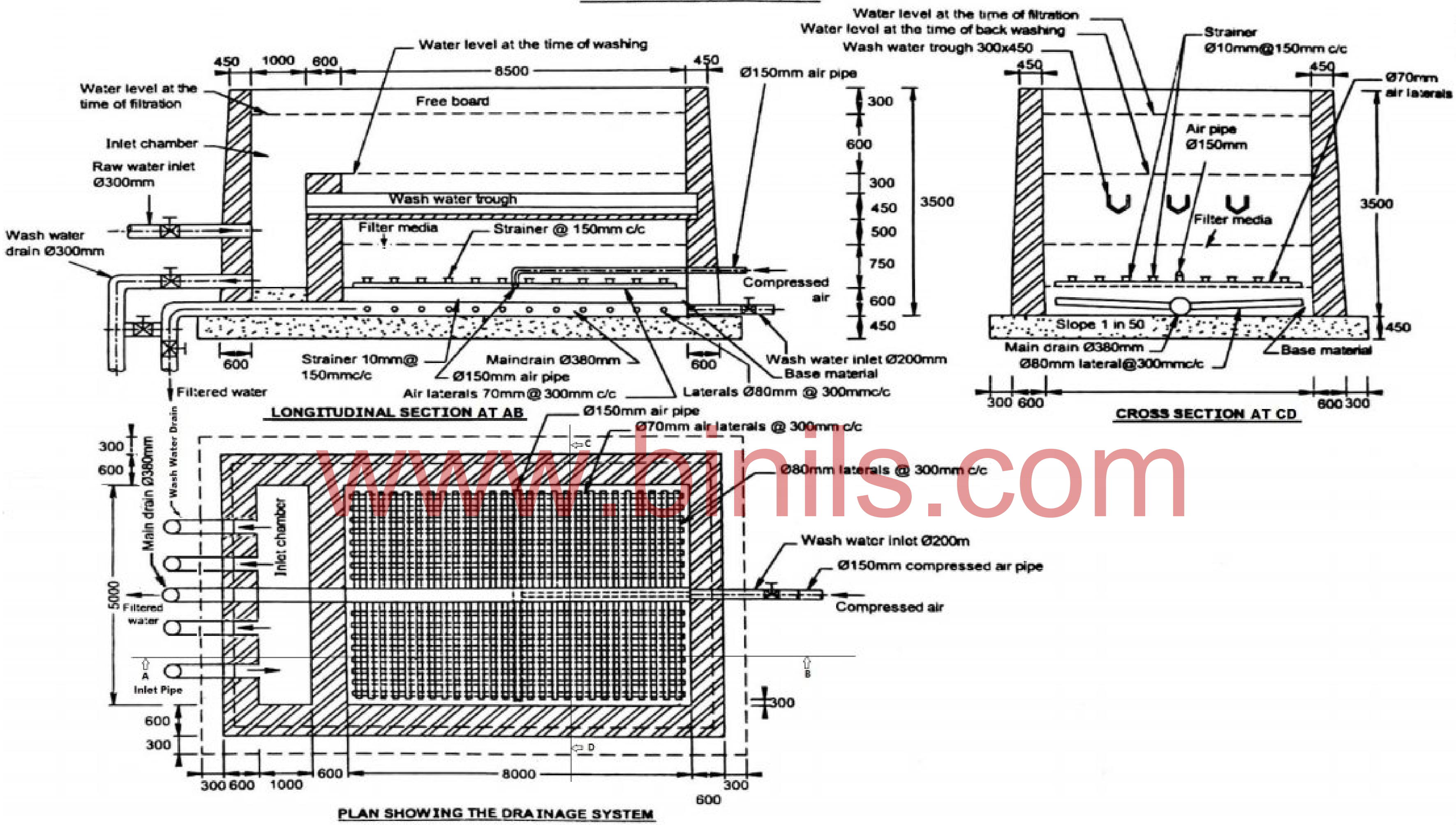


Assume any other data suitably if required.

**Draw the following views to a suitable scale**

1. Plan of the filter unit
2. Longitudinal section of the filter unit.
3. Cross section of filter unit.

## 2. RAPID SAND FILTER



## 3. a) SEPTIC TANK WITH DISPERSION TRENCH

Septic tank is a type of sedimentation tank. It is a water tight tank in which sewage is retained for sufficient time to permit sedimentation is called a septic tank. It is a rectangular tank whose length is 2 to 4 times more than the breadth. Free board of 0.3 to 0.45m is provided. 'T' shaped outlet pipe is provide to a depth of 150mm below the liquid level.

Baffle wall is provided at 1/5 length of the tank from the inlet pipe. The floor is provided with all sides sloping towards one point to facilitate de-sludging operation. R.C.C cover slab with man hole is provided on the top of the tank.

Ventilation is provided with vent pipe.The vent pipe is made of PVC of 50 to 100mm diameter and 3m height. It prevents foul smell and birds for nesting.

It can be disposed-off on land by

1. Disposal by soak pit
2. Disposal by absorption (or) dispersion trenches

**1. Disposal by soak pit**

Soak pit is also called seepage pitwhere space is restricted as in towns. Soak pit may be used particularly in areas where rainfall is not heavy. No underground drinking water supply line should be situated within a radius of at least 60m from a disposal site or soak pit. The pit is laid with brick or concrete blocks with dry joints which should be packed with clean coarse aggregate. The lining above the inlet level should be finished with cement mortar 1:3 to form a masonry ring to support the R.C.C covers.



**2. Disposal by Dispersion trench**

They are also called soakage trenches. The effluent is discharged through open jointed pipes placed in trenches. Trenches should be 0.5 to 1m deep and 0.3m to 1m wide excavated to a slight gradient. It should be provided with 150mm to 250mm of washed gravel or crushed stone. The open jointed pipes shall be made of unglazed earthen ware or concrete, have a minimum internal diameter of 75mm to 100mm. The dispersion trench should not be longer than 30m and placed should not closer than 1.8m.

Following are the particulars of a septic tank with dispersion trench.

**Septic Tank**

| | |
|---|---|
| Cleaning Interval | - 2 years |
| Length of tank | - 10.50m |
| Breath of tank | - 3.00m |
| Width of walls | - 300mm |
| Foundation concrete in CC 1:4:8 | - 200mm |

Wearing coat is provided at a slope of 1 in 20 above the foundation concrete

| | |
|---|---|
| Depth of liquid | - 1.20m |
| Free board | - 0.40m |
| Distance of baffle wall from inlet end | - 2.0m |
| Height of 50mm thick baffle wall | - 750mm |
| Distance of partition baffle wall from inlet | - 7.0m |
| Height of 50mm thick partition baffle wall | - 1500mm |
| Outlet Chamber | - 1000x1000x550 mm |

**Dispersion trench**

| | |
|---|---|
| Number of trenches | - 3Nos |
| Length of trench | - 30m |
| Width of trench | - 1m |
| Slope of pipe | - 1 in 100 |
| Depth below ground level | - 0.9m |
| Diameter of inlet and outlet pipes | - 100mmφ |

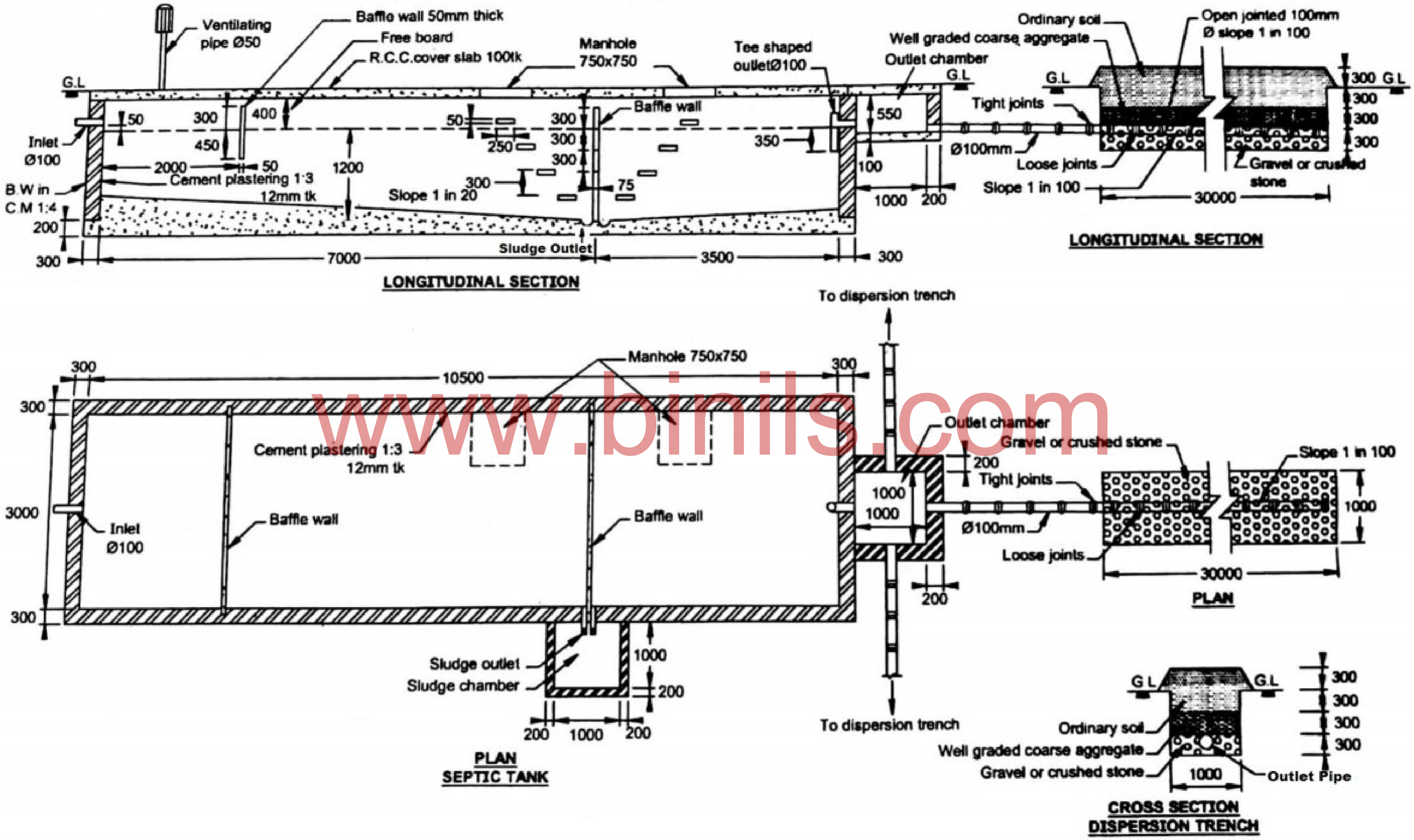
Any more data required may be assumed suitably.



**Draw the following views with suitable scale**

1. Sectional plan of septic tank and dispersion trench.
2. Longitudinal section of septic tank and dispersion trench.
3. Cross section of dispersion trench.

## 3.(a) SEPTIC TANK WITH DISPERSION TRENCH



**3. b) SEPTIC TANK WITH SOAK PIT**

Following are the particulars of a septic tank with soak pit.

**Septic tank**

| | | |
|---|---|---|
| Length of tank | = | 3.0m |
| Breadth of tank | = | 1.50m |
| Depth of liquid | = | 1.80m |
| Free board | = | 0.3m |

Distance of baffle wall from inlet end = 450mm

Tank walls of B.W in C.M 1:3 300mm thick

| | | |
|---|---|---|
| Diameter if inlet and outlet | = | 100mm |
| Precast R.C.C cover slab | = | 100mm thick |
| Diameter of ventilating pipe | = | 50mm |
| Size of distribution chamber | = | 750mm x 750mm |
| Size of manhole | = | 750mm x 750mm |
| Foundation concrete in CC 1:4:8 | = | 200mm |

Wearing coat is provided at a slope of 1 in 20

Distribution Chamber = 750x750x400mm



**Soak pit**

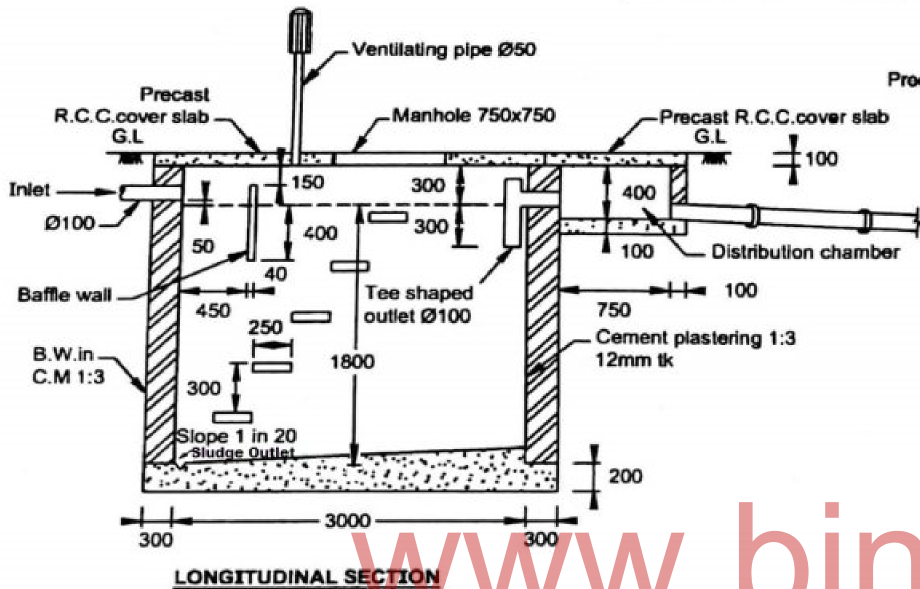
| | | |
|---|---|---|
| Inner diameter | - | 1.5m |
| Depth below invert level of inlet pipe | - | 2m |
| B.W in Cm 1:5 dry open joint below inlet pipe | - | 200mm |
| Depth below ground level | - | 2.6m |
| Cover slab in CC 1:2:4 | - | 100mm |
| B.W in Cm 1:5 above inlet pipe with plastering | - | 200mm |

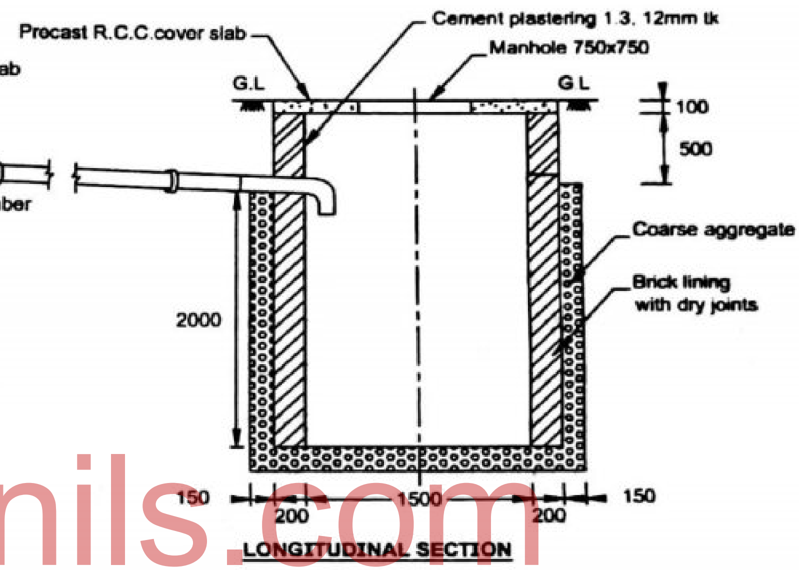
Any more data required may be assumed suitably.

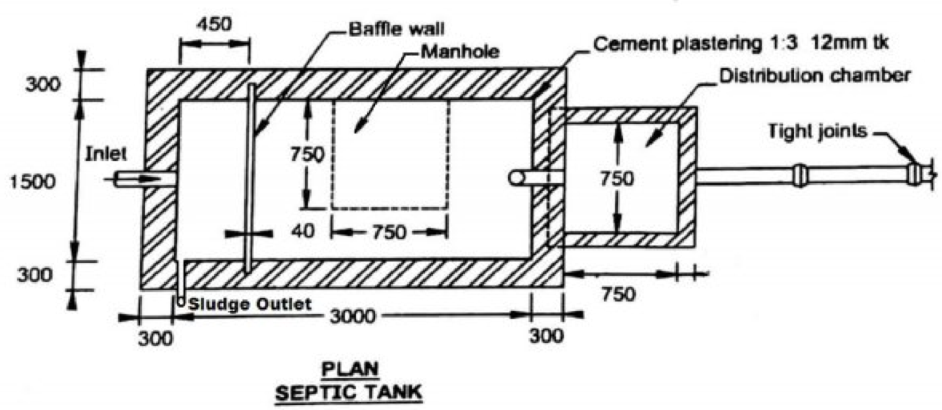
**Draw the following views to a suitable scale**

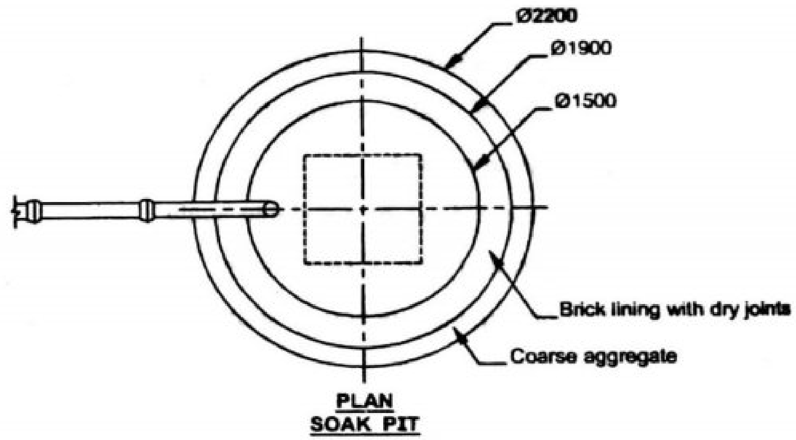
1. Sectional plan of septic tank
2. Longitudinal section of septic tank

## 3.(b) SEPTIC TANK WITH SOAK PIT



## 4. BIO-GAS PLANT (FLOATING TYPE)

Bio gas is obtained by anaerobic fermentation of organic materials. Bio gas is used for cooking and lighting. The Bio-gas plant consists of the following parts.

1. Inlet tank
2. Digester
3. Outlet tank
4. Gas holder

**Inlet tank**

In this tank, the raw cowdung is mixed with water and then allowed to pass through an inlet pipe into the digester.

**Digester**

The digester is a deep well, connected by inlet and outlet pipes.

**Gas holder**

A mild steel gas - storage drum, inverted over the slurry goes up and down around a guide pipe corresponding to the accumulation of gas.

The following are the particulars of a floating type bio-gas plant.



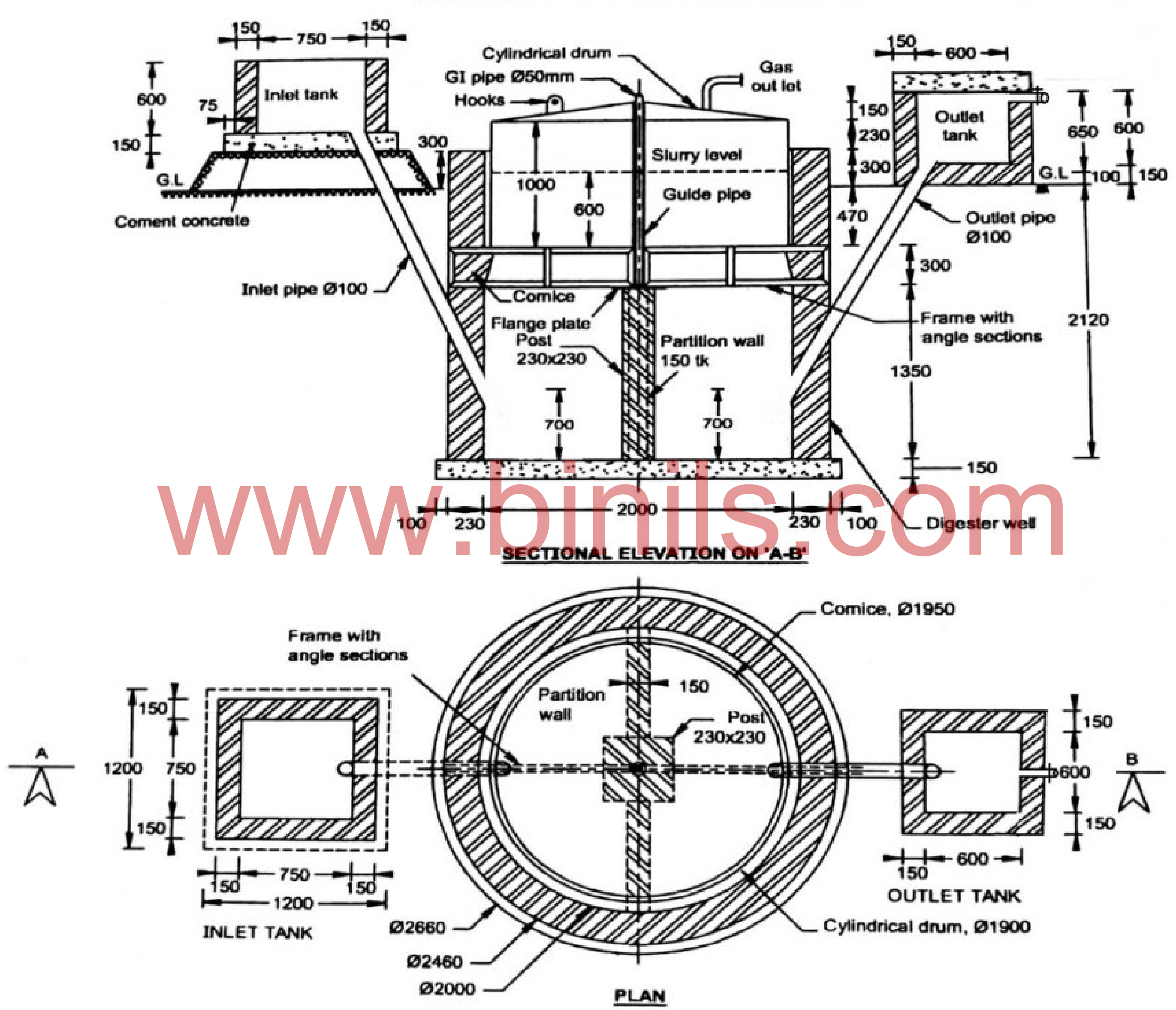
1. Dia of cylindrical drum - 1900mm
2. Height of drum - 1000mm
3. Dia of digester well - 2000mm
4. Height of digester well from foundation of cornice- 1350mm
5. Height of inlet and outlet at the digester well - 700mm
6. Thickness of foundation concrete for digester well- 150mm
7. Thickness of brick wall in C.M 1:4 - 230mm
8. Thickness of partition wall - 150mm
9. Size of brick pillar at the centre - 230mm x 230mm
10. Size of cornice - 75mm x 300mm
11. Size of inlet tank -750 x 750 x 600mm
12. Size of outlet tank -600 x 600 x 600mm
13. Diameter of inlet and outlet pipe - 100mmφ

Any more data required may be assumed suitably.

**Draw the following views to a suitable scale.**

1. Top plan
2. Sectional elevation

# 4. BIO GAS PLANT (FLOATING TYPE)



## 5. TWO SPAN PIPE CULVERT

Pipe culverts are provided when discharge of stream is small. Usually one or more pipes of diameter not less than 300mm are provided side by side. These pipes may be of cement concrete, cast iron or steel. Pipe culvert should be provided with suitable concrete bedding at bottom. The gradient of the pipe should not be less than 1 in 1000. A minimum clearance of 150mm is maintained between the H.F.L and the crowns of the pipe. An earth cushion of minimum depth of 450mm should be provided at the top of pipes. R.C.C Hume pipes are commonly used.

The specifications for a two span pipe culvert are given below.

**Hydraulic Particulars**

**Road and stream**

Width of road - 5000mm
Bed level of stream - + 20.00
Road level - + 22.10
Water level - + 21.80
Thickness of W.B.M road - 250mm



**Pipes**

Number of pipes - 2 Nos
Diameter of concrete Hume pipe - 1000mm
c/c distance of pipes - 1600mm
Type of joint - Collar joint in C.M 1:2
Width of concrete seating for pipes at top - 3300mm
Width of concrete seating for pipes at bottom - 2700mm
Thickness of concrete seating for pipes - 500mm

**Retaining wall**

Top level - +22.20m
Bottom level - + 19.20m
Top width - 500mm
Bottom width - 1200mm
Front face vertical
Width of foundation concrete - 1600mm
Thickness of foundation concrete - 300mm

**Parapet**

| | |
|---|---|
| Length | - 4100mm |
| Thickness | - 400mm |
| Height | - 600mm |
| Coping | - 100mmtk |

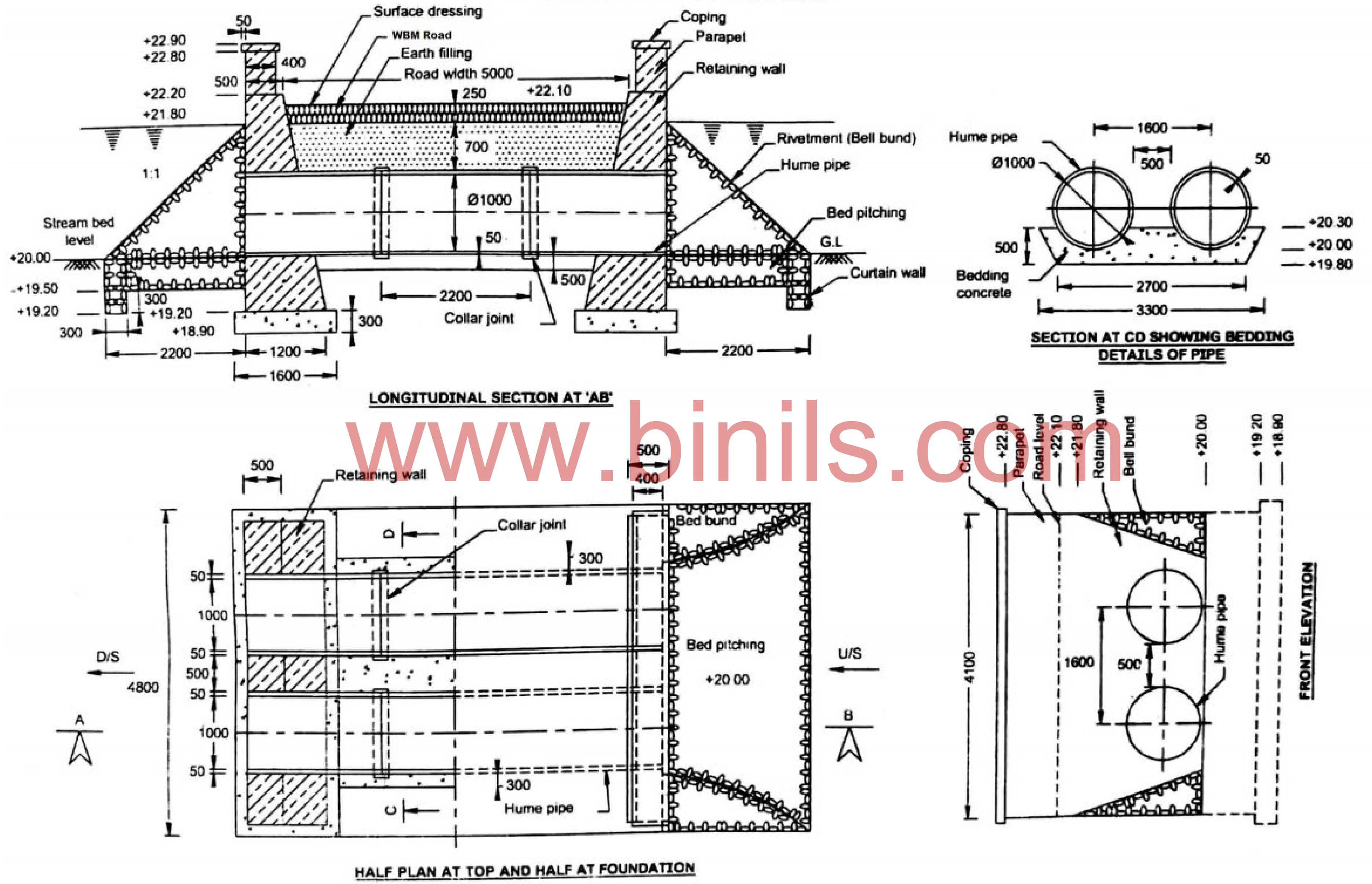
**Earth filling**

| | |
|---|---|
| Earth filling above the pipe | - 700mm |
| Thickness of surface dressing | - 10mm |

**Draw the following views of the pipe culvert**

1. Half plant at top and half plan at foundation.
2. Longitudinal section
3. Front elevation
4. Section showing bedding details of the pipe

## 5. TWO SPAN PIPE CULVERT



## 6. TWO SPAN TEE BEAM BRIDGE WITH SQUARE RETURNS

These types of bridges are constructed when the width of the drain is to be crossed by a road is wider. It consists of 'Tee' beams supported on piers and abutments.

**Abutment**

Abutments are provided with wing walls.The wing walls are constructed on both sides of abutments to protect the earthen banks. The wing walls may be of straight, splayed or return. The depth of foundation is based on the scour depth. Cut water and ease water shall be provided for piers and abutments.

**Piers**

The intermediate supports of abridge super structure are known as piers. The pier end of upstream side is called cut water and on the downstream side is known as ease water. The R.C.C piers are normally rectangular in cross section.

**Approach road**

The approach road width is reduced at the point of crossing. Road kerbs are provided at the end of the deck slab. IRC recommends that a minimum straight length of 15m on either side of a bridge has to be provided. Suitable handrails and parapet are provided at the bridge. The width of approach should be equal to the width of bridge.



Following are the particulars of a two span 'T' Beam bridge with square returns.

**Hydraulic particulars**

**Drain**

| | |
|---|---|
| Bed level of canal | - + 50.00 |
| Full supply level (F.S.L) | - + 51.30 |
| Bed width of canal | - 6600mm |
| Top level of Road | - + 52.50 |
| Clear width of road way | - 4000mm |
| Top width of approach road way | - 5000mm |
| Top of foundation for all walls | - + 49.70 |
| Bottom level of foundation for all walls | - + 49.40 |
| Offset of foundation concrete | - 200mm |
| Top of parapet | - + 53.35 |
| Top of kerb | - + 52.65 |
| Size of kerb | - 300 x 150mm |

**Abutment**

| | |
|---|---|
| Top width | - 600mm |
| Bottom width | - 1200mm |
| Water face vertical | |
| Length of abutment | - 5700mm |
| Size of bed block | - 600 x 600 x 150mm |
| Width of foundation concrete | - 1600mm |
| Thickness of foundation concrete | - 300mm |

**Pier**

| | |
|---|---|
| Top and bottom width | - 600mm |
| Length of pier | - 5700mm |

**Return wall in C.R masonry C.M 1:5**

| | |
|---|---|
| Length of return wall | - 3500mm |
| Top width | - 600mm |
| Bottom width | - 1200mm |
| Front face vertical | |

**Tee Beam**



| | |
|---|---|
| Size of beam | - 150 x 300mm |
| Thickness of R.C.C deck slab | - 200mm |

**Parapet**

| | |
|---|---|
| Thickness of parapet | - 300mm |
| Size of parapet pillars | - 300mm x 700mm |
| Spacing of parapet pillars | - 2500mm |

Provide 25mmφ G.I pipe for hand rails

Length of rough stone revetment on both side U/s and D/s 2000mm

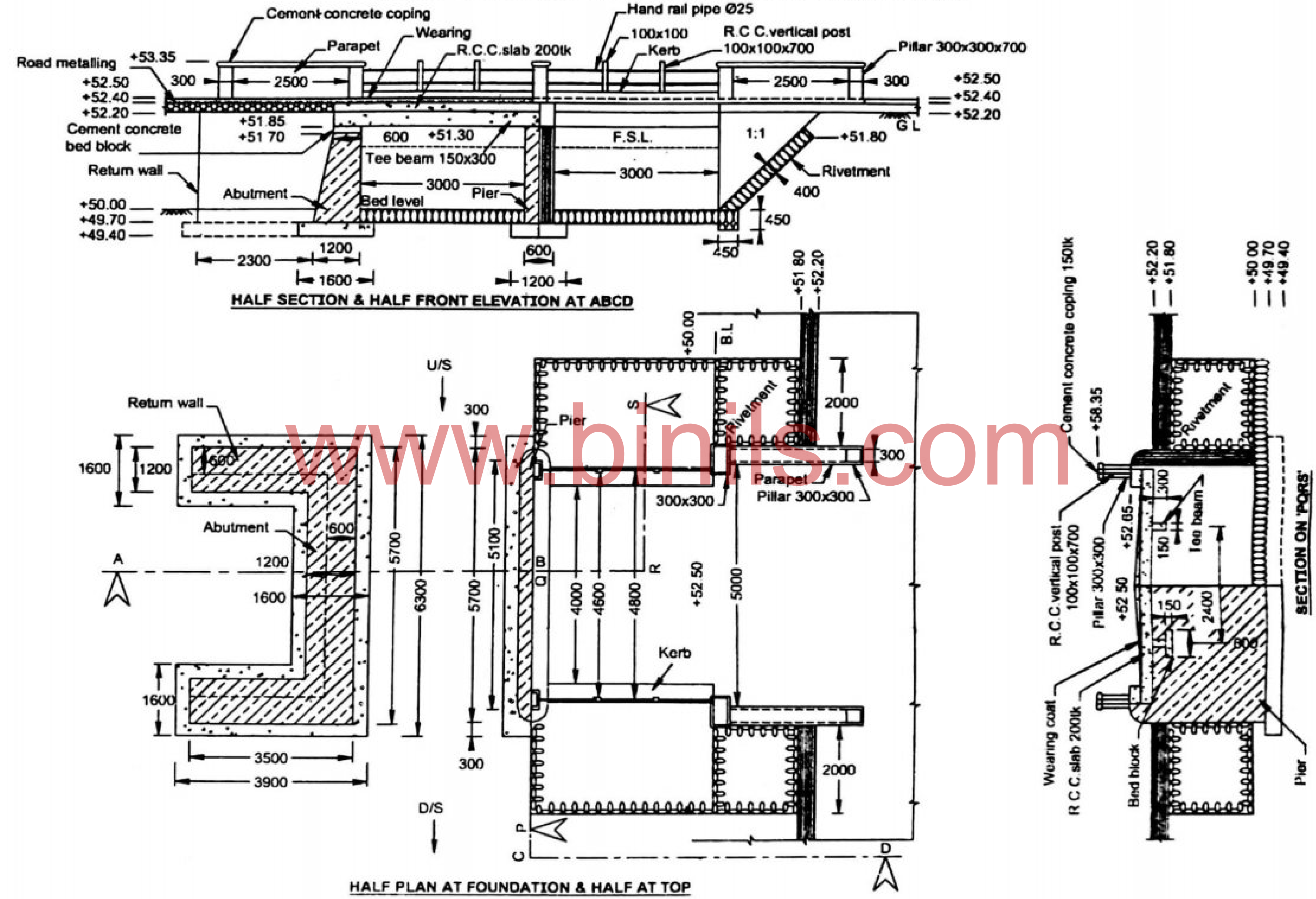
| | |
|---|---|
| Thickness of revetment | - 400mm |
| Size of RCC post | - 100x100x700mm |

Assume any other data required suitably

**Draw the following views to a suitable scale**

1. Half plan at foundation and half plan at top
2. Longitudinal sectional elevation
3. Cross section

## 6. TWO SPAN TEE BEAM BRIDGE WITH SQUARE RETURNS



## 7) SIMPLY SUPPORTED ONE WAY SLAB

When the slab is supported on two opposite sides alone by walls or beams is said to be one way slab. When Ly/Lx ratio is greater than 2, one way slabs are provided.

The load on the way slab is transferred to the two supports only, hence the main reinforcement is provided along the shorter span direction 50% of the main reinforcements are bend to the top for length of 0.1 ***l*** from the face of the support.

The bars in longer direction of the slab are called distribution or transverse steel. Distributors are placed in the upper layer and tied with the main steel bars to keep them in correct position during concreting.

**Problem**

The following are the particulars of a simply supported one way roof slab.



| | |
|---|---|
| Size of room | = 3.10 m x 7m |
| Clear span | = 3.10m |
| Width of supporting walls | = 230 mm |
| Total thickness of slab | = 120 mm |
| Clear cover | =15 mm |
| Main reinforcement | = 10mm dia Fe 415 Bars @140 mm c/c |
| Distributors | =8mm dia Fe 415 Bars @ 250 mm c/c |

50% of main Reinforcement can be bent up 0.1 from the face of the support.

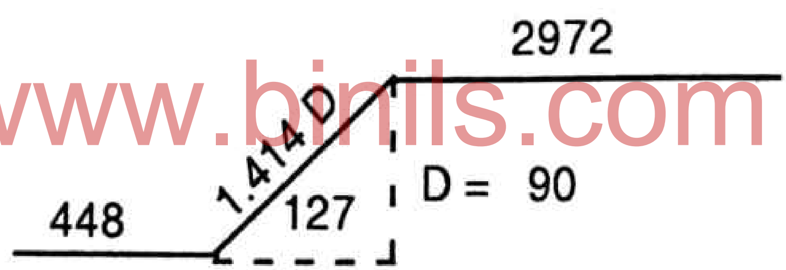
Cover: For tensile, compressive, shear or any other reinforcement in Slabs, minimum cover shall not be less then 15mm, and the side Cover 25 mm.

Anchorage and curtailment of reinforcement may be adopted with standard values. Assume any other data required suitably.

**Draw to a suitable scale**

1. Plan at bottom showing reinforcement arrangements.
2. Plan at top showing reinforcement arrangements.
3. Cross section of the slab showing reinforcement details.
4. Prepare bar bending schedule for 1m width to slab

CRANK LENGTH CALCULATION

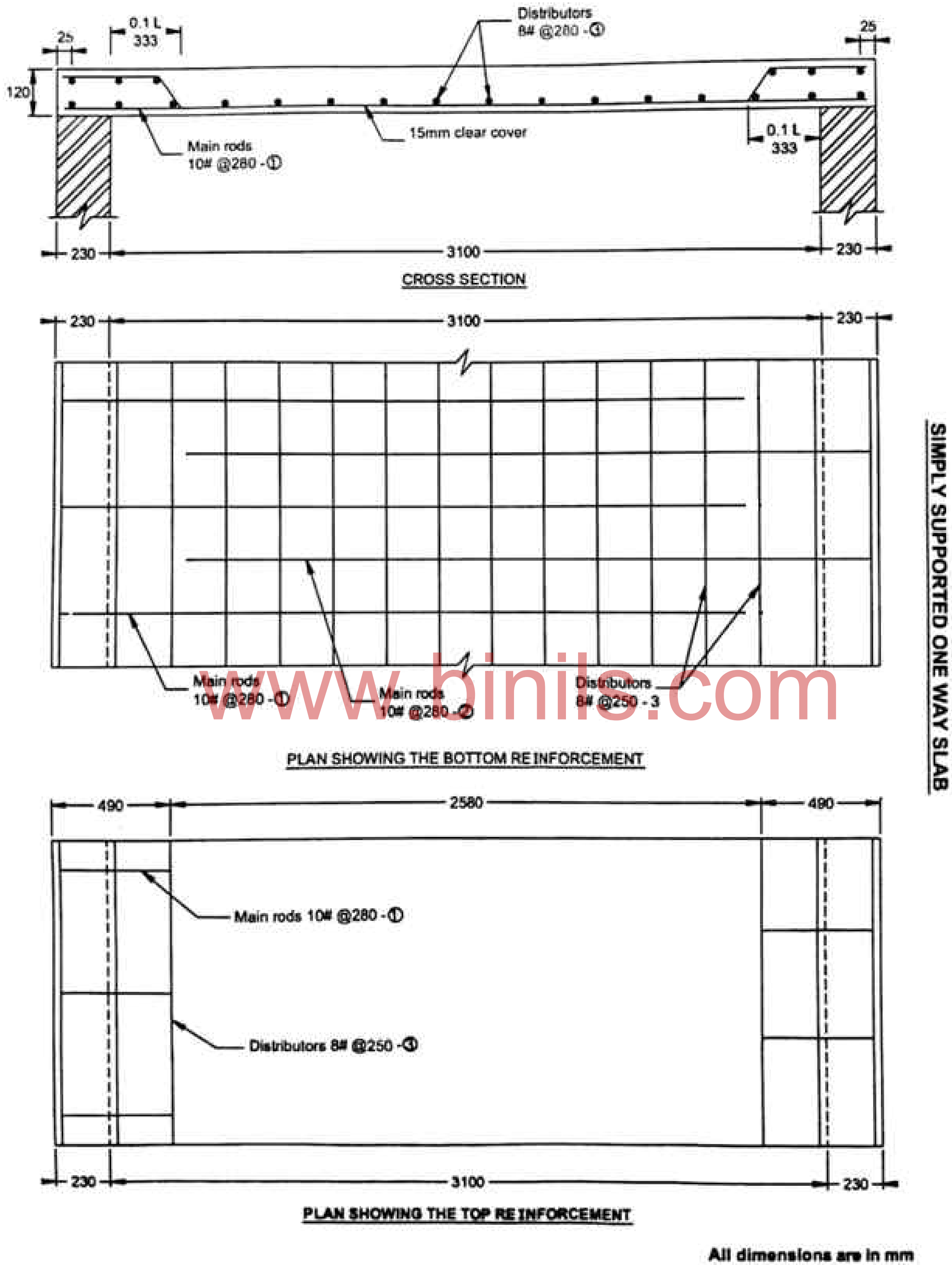




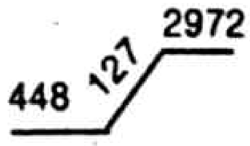
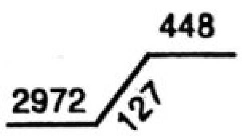
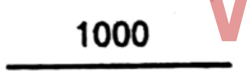
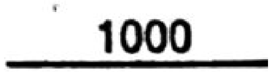

1.414 X D =1.414 x 90 =127.26

Where D = Depth of slab – top @ Bottom cover

D = 120 – (2 x 15) = 90


Distributors
8# @280 - 3
0.1 L
333
25
25
120
Main rods
10# @280 - 1
15mm clear cover
0.1 L
333
230
3100
230
CROSS SECTION
230
3100
230
Main rods
10# @280 - 1
Main rods
10# @280 - 2
Distributors
8# @250 - 3
PLAN SHOWING THE BOTTOM REINFORCEMENT
490
2580
490
Main rods 10# @280 - 1
Distributors 8# @250 - 3
230
3100
230
PLAN SHOWING THE TOP REINFORCEMENT
All dimensions are in mm
SIMPLY SUPPORTED ONE WAY SLAB

BAR BENDING SCHEDULE

| Type No. | Size | Shape | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 10# |   | 3.547 | $\frac{1000}{280} = 3.70$ | 6.2 | 81.36 | Main Reinforcement |
| 2. | 10# |   | 3.547 | $\frac{1000}{280} = 3.70$ | 6.2 | 81.36 | Main Reinforcement |
| 3. | 8# |   | 1.000 | $\frac{3510}{250} + 1 = 15.04$ | 4.0 | 60.00 | Distributors |
| 4. | 8# |   | 1.000 | $\left[\frac{448}{250} + 1\right] \times 2$ =5.58≈ 6 | 4.0 | 24.00 | Supporting main bar |
| | | | | | Total weights | 246.72 | |
| Add 5% extra for wastage in cutting & others | | | | | | 12.34 N | |
| Total quantity of steel required | | | | | | 259.06 N | Say 260 N |

## 8) SIMPLY SUPPORT TWO WAY SLAB (CORNERSNOT HELD DOWN)

A slab is called 'two way slab' when the load on it is distributed in both directions to all its four supports. Two way slabs are provided whenly/lx ratio is less than 2 [ Ly/Lx< 2 ].

Since two way slabs deflect in both directions the tension reinforcement (main reinforcement) is provided in bothshorter span and longer span.

50% of the reinforcement are curtailed or cranked at 0.1 Lx and 0.1 Ly for shorter and longer direction respectively. Remaining 50% of the reinforcements should be extended in to the supports.

**Problem**

The following are the particulars of a simply supported two way slab in which corners are not held down.

| | | |
|---|---|---|
| Size of the room | = | 4.50 x 6.10 m |
| Width of support | = | 300 mm |
| Thickness of slab | = | 150 mm |
| Clear cover | = | 15 mm |
| Edge cover | = | 25 mm |



**Reinforcement details:**

| | |
|---|---|
| Reinforcement along shorter span | = 10 mm Fe 415 @ 200 mm C/C |
| Reinforcementalong longer span | =10 mm Fe 415 @ 220 mm C/C |
| Distributors in both directions | = 8 mmFe 415 @ 290 mm |

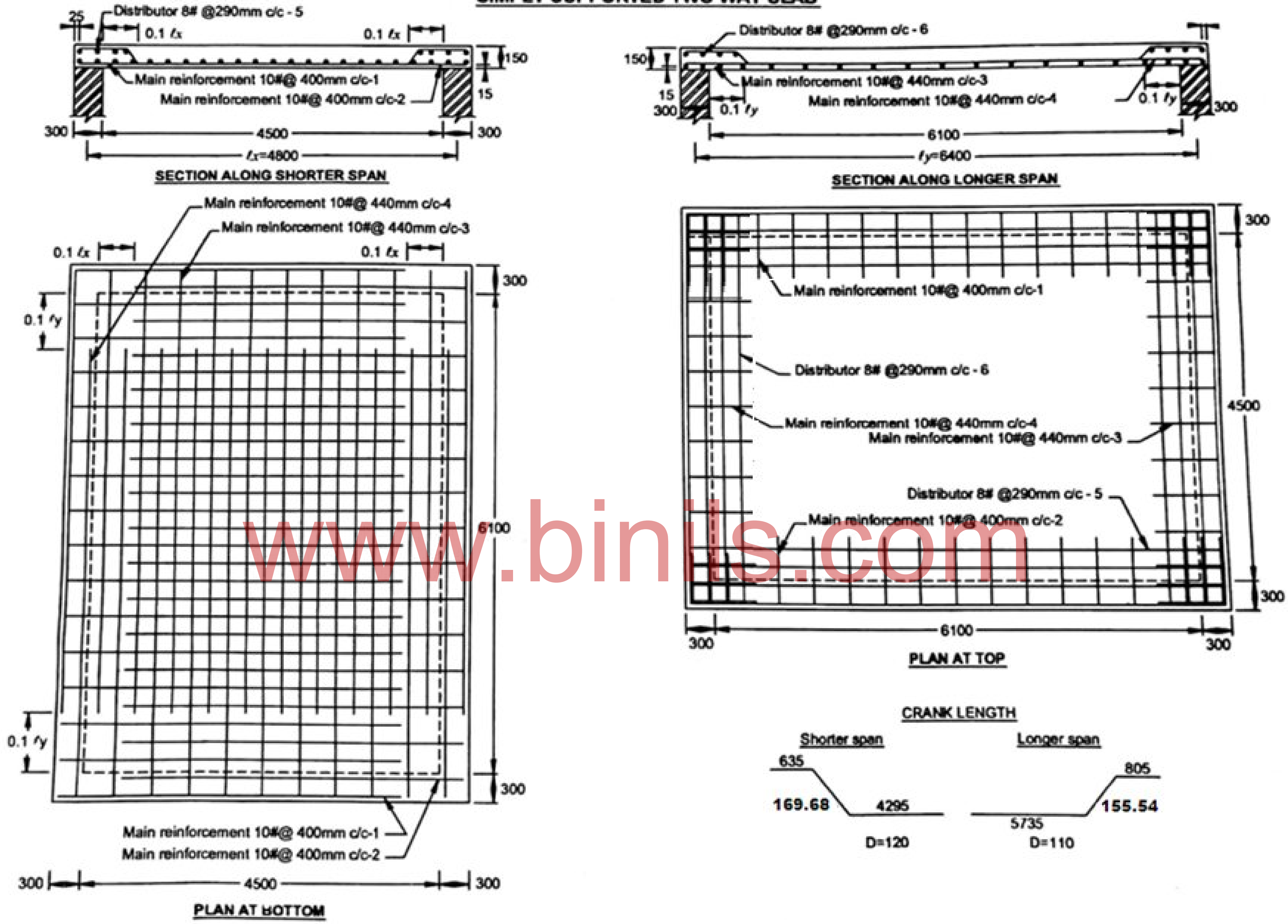
Anchorage and curtailment of reinforcement may be adopted with standard values and any more data required may be assumed suitably.

**Draw the following views to a suitable scale**

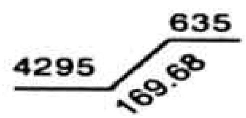
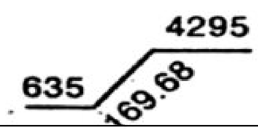
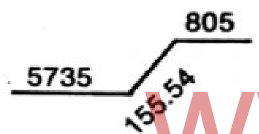
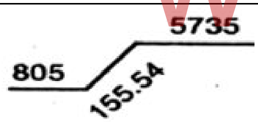
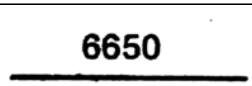
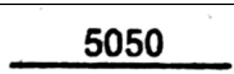
1. Plan at bottom showing reinforcement arrangements.

2. Plan at top showing reinforcement arrangements.
3. Cross section of the slab showing reinforcement details.
4. Prepare bar bending schedule for 1m width of slab.

# SIMPLY SUPPORTED TWO WAY SLAB



BAR BENDING SCHEDULE

| Type No. | Size | Shape | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 10# |   | 5.100 | $\frac{6650}{400} + 1 = 17.6$ (say 18) | 6.2 | 569.16 | Main Reinforcement along shorter span |
| 2. | 10# |   | 5.100 | $\frac{6650}{400} = 16.6$ (say 17) | 6.2 | 537.54 | Main Reinforcement along shorter span |
| 3. | 10# |   | 6.696 | $\frac{5050}{440} + 1 = 12.47$ (say 12) | 6.2 | 498.18 | Main reinforcement along longer span |
| 4. | 10# |   | 6.696 | $\frac{5050}{440} = 11.47$ (say 11) | 6.2 | 456.66 | Main reinforcement along longer span |
| 5. | 8# |   | 6.650 | $\frac{635}{290} + 1 = 3010$ (say 3+3 = 6) | 4.0 | 159.60 | Distributor along longer span |
| 6. | 8# |   | 5.050 | $\frac{805}{290} + 1 = 3.7$ (say 4) 4+4 = 8 | 4.0 | 161.60 | Distributor along shorter span |
| | | | | | Total weights | 2382.74 | |
| Add 5% for wastage in cutting, bending overlapping etc | | | | | | 119.13 | |
| | | | | | | 2501.87 N | |

## 9) RESTRAINED TWO WAY SLAB

In restrained two way slabs, the corners are restrained and not allowed to lift away from the supports. If this is done, torsion is induced at corners and the slab be suitably reinforced for torsion.

Slabs are considered as divided in each direction into middle strip and edge strips. The middle strip being $3/4^{th}$ of the width and each edge strip $1/8^{th}$ of the width. Reinforcement in edge strip parallel to the edge, shall comply with the minimum reinforcement requirements and the requirements for tension.

Torsion reinforcement shall be provided at any corner where the slab is simply supported on both edges meeting at that corner. It shall consist of top and bottom reinforcement, each layer of bars placed parallel to the sides of the slab and extending from the edges to a minimum distance of $1/5^{th}$ the shorter span.



**Problem**

The following are the details of a simply supported slab of a reading room of dimension 5m x7m which is discontinuous along all of its four edges. The corners of the slab are prevented from lifting.

| | |
|---|---|
| Width of support | =300mm |
| Thickness of slab | =150mm |
| Clear cover of reinforcement | =15mm |

**Reinforcement details**

In middle strip

Rft. along shorter span = 10mm dia Fe 415 bars @100mm c/c

Rft. along longer span = 10mm dia Fe415bars @ 150mm c/c

Edge strip

10mm Fe415 bars @ 150 mmc/c along both spans.

Torsion reinforcement

Both at top and bottom8mmdia Fe 415 bars @ 100mm c/c in both directions forming a mesh.

Use standard anchorage and curtailment of reinforcement may be adopted with standard values.

Assume any other data required suitably.

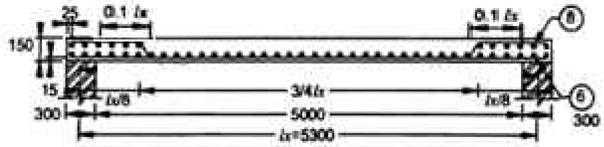


**Draw the following views to a suitable scale.**

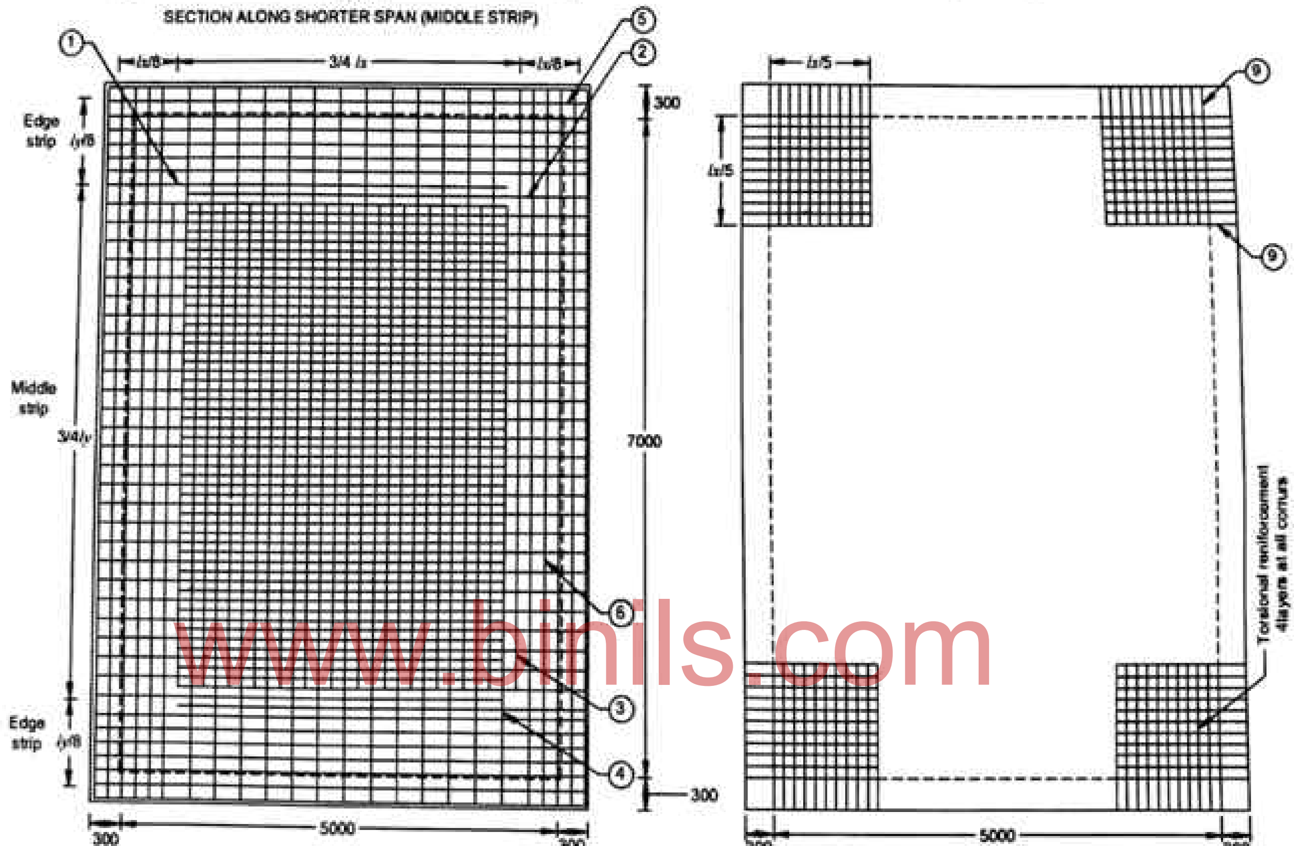
1. Plan showing the arrangement of reinforcement at bottom.
2. The plan showing arrangement of reinforcement at top.
3. The cross section along shorter span middle strip.
4. The cross section along longer span middle strip.
5. Prepare a bar bending schedule.

## RESTRAINED TWO WAY SLAB

1. Mainreinforcement along shorter span 10# @ 200mm c/c
2. Mainreinforcement along shorter span 10# @ 200mm c/c
3. Mainreinforcement along longer span 10# @ 300mm c/c
4. Mainreinforcement along longer span 10# @ 300mm c/c
5. Reinforcement along shorter span edge strip 10# @ 150mm c/c
6. Reinforcement along longer span edge strip 10# @ 150mm c/c
7. Distributor at top along shorter span 10# @ 150mm c/c
8. Distributor at top along longer span 10# @ 150mm c/c
9. Torsion reinforcement 8# @ 100mm c/c

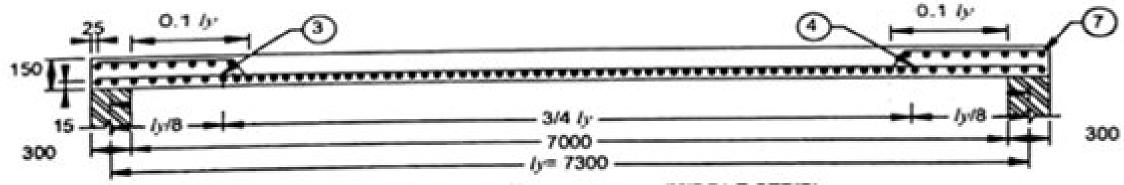



SECTION ALONG SHORTER SPAN (MIDDLE STRIP)

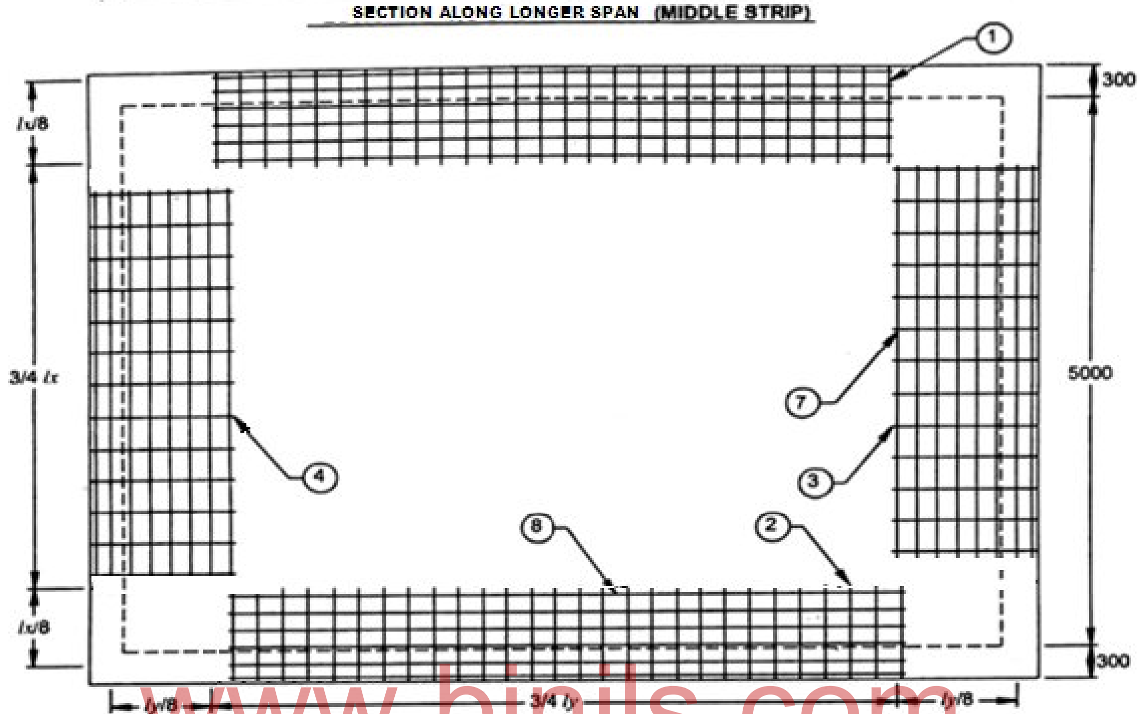



BOTTOM PLAN

BOTTOM PLAN SHOWING TORSION REINFORCEMENT

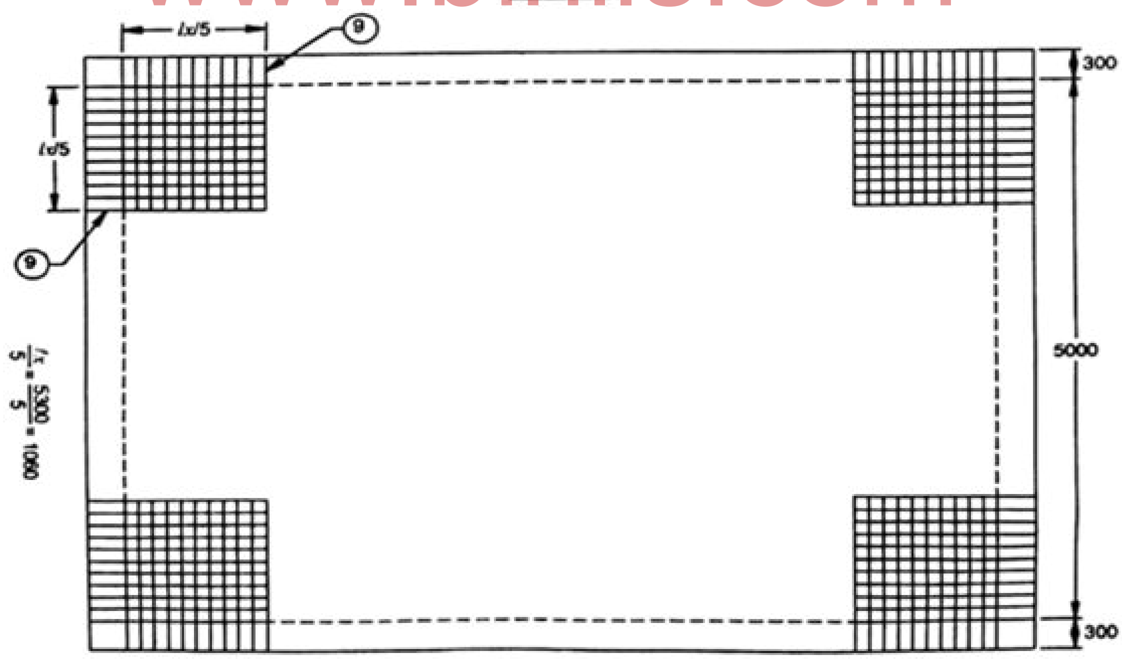



SECTION ALONG LONGER SPAN (MIDDLE STRIP)



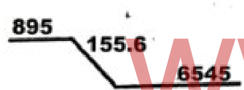

TOP PLAN

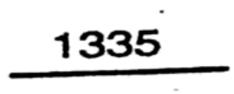





TOP PLAN SHOWING TORSION REINFORCEMENT

BAR BENDING SCHEDULE

| Type No. | Size Grade | Shape Dimension | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 10# |  4745, 169.7, 685 | 5.60 | $\frac{5475}{200} = 27.4$ say 28 | 6.17 | 987.27 | Main Reinforcement along shorter span (middle strip) |
| 2. | 10# |  685, 169.7, 4745 | 5.60 | $\frac{5475}{200} = 27.4$ say 28 | 6.17 | 987.27 | Main Reinforcement along shorter span (middle strip) |
| 3. | 10# |  6545, 155.6, 895 | 7.60 | $\frac{3975}{300} = 13.25$ Say 14 | 6.17 | 656.11 | Main Reinforcement along longer span (middle strip) |
| 4. | 10# |  895, 155.6, 6545 | 7.60 | $\frac{3975}{300} = 13.25$ Say 14 | 6.17 | 656.11 | Main Reinforcement along longer span (middle strip) |
| 5. | 10# | 5550 | 5.550 | $\frac{912.5}{150} = 6.08$ 6+6 = 12 | 6.17 | 410.92 | Reinforcement along shorter span (edge strip) |
| 6. | 10# | 7550 | 7.550 | $\frac{662.5}{150} = 4.42$ 5+5 = 10 | 6.17 | 465.84 | Reinforcement along longer span (edge strip) |
| 7. | 10# | 3825 | 3.825 | $\frac{895}{150} + 1 = 6.97$ 7+7 = 14 | 6.17 | 330.40 | Distributor at top along shorter span. |
| 8. | 10# | 5375 | 5.375 | $\frac{685}{150} + 1 = 5.57$ 6+6 = 12 | 6.17 | 397.96 | Distributor at top along longer span. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9. | 8# |  | 1..335 | $\frac{1060}{100}+1=11.60$ Say 12 12+12 = 24 | 3.95 | 126.55 | Torsion reinforcement |
| | | | | | Total weights | 5018.44 N | |
| | | | | | INCL 5%EXTRA 5269.34 | | |
| | | | | | | Say 5270 N | |

## 10. SINGLY REINFORCED SIMPLY SUPPORTED BEAM

A singly reinforced simply supported beam is a structural member supported on bearing walls or columns and subjected to roof or floor loads and reinforced on the tension side only.

**Problem**

The following are the details of a singly reinforced simply supported fixed beam.

1. Size of beam =300 x 450 mm
2. Clear span =4000 mm
3. Width of support =300 mm
4. Clear cover to rft = 25 mm
5. Reinforcement details:

   Main reinforcement (tensile) = 16 mmdia Fe 415 bars - 5 Nos

   Hanger rods =12 mmdia Fe 415 bars- 2 Nos

   Stirrups = 8mm dia 2 legged Fe415 steel @ 160 mm c/c



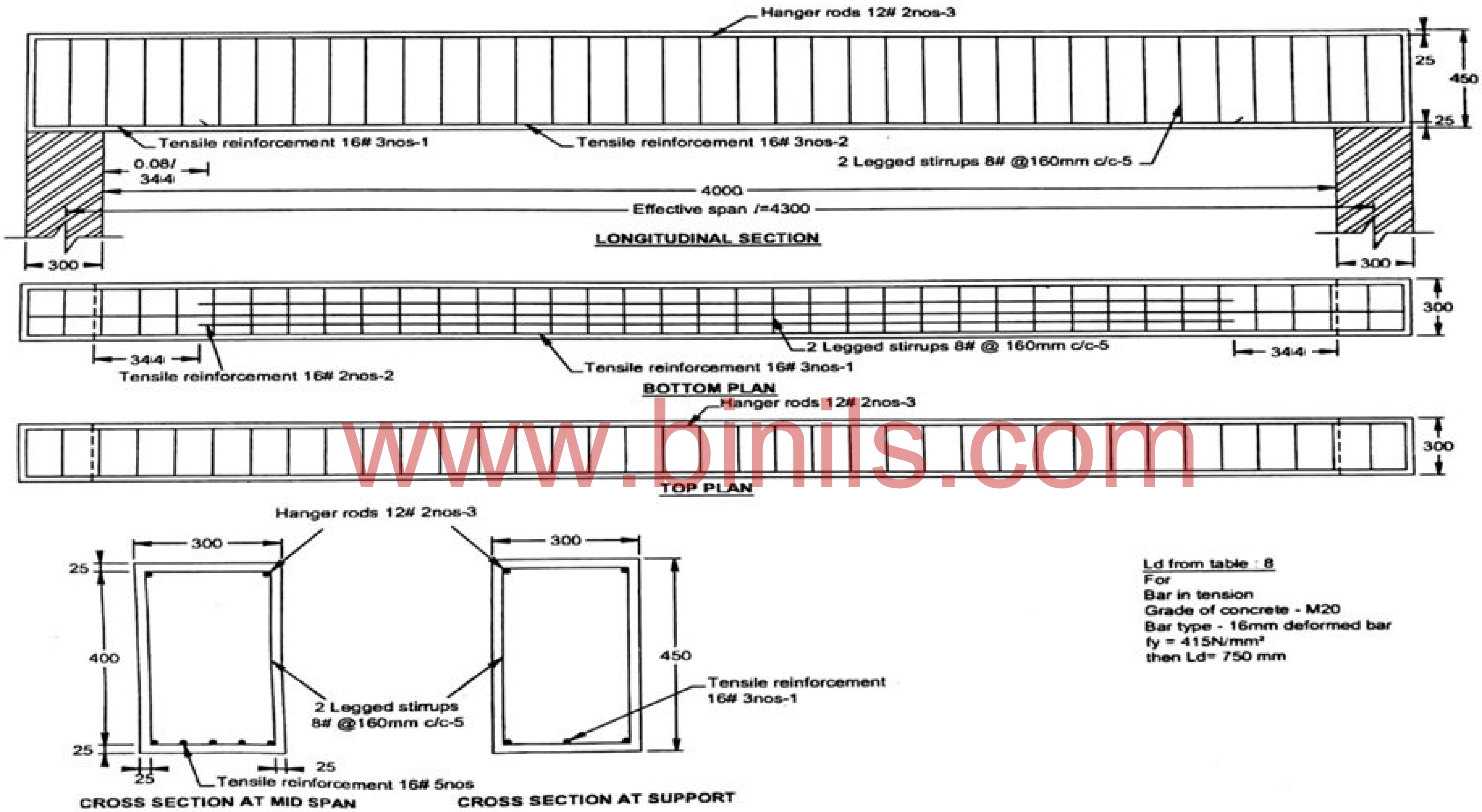
Anchorage and curtailment of reinforcement may be adopted with standard values.

Assume any other data required suitably.

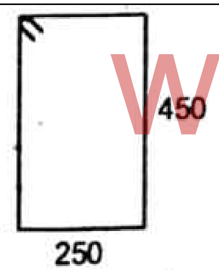
Draw the following views to a suitable scale.

1. Longitudinal section of the beam showing reinforcement details.
2. Top and bottom plan showing arrangement of reinforcement details.
3. Cross sectional view of the beam at mid span and at supports.
4. Prepare a bar bending schedule.

## SINGLY REINFORCED SIMPLY SUPPORTED BEAM



BAR BENDING SCHEDULE

| Type No. | Size Grade | Shape Dimension | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 16# | 4550 | 4.550 | 3 | 15.78 | 215.39 | Tensile reinforcement |
| 2. | 16# | 3312 | 3.312 | 2 | 15.78 | 104.53 | Tensile reinforcement (Curtailed) |
| 3. | 12# | 4550 | 4.550 | 2 | 8.88 | 80.80 | Hanger rods |
| 4. | 8# |   (250 + 450) 2 + 20d 1400 + (20 x 8) = 1560 | 1.560 | $\frac{4550}{150} + 1 = 31.33$ | 3.95 | 193.05 | Stirrups |
| | | | | | Total weights | 593.77 | |
| Add 5% of above total weight for wastage | | | | | | 29.69 | |
| | | | | | | 623.46 N Say 624 N | |

## 11) DOUBLY REINFORCEMENT BEAM

Doubly reinforced beams are reinforced both on the tension and compression zones. If the depth of beam is restricted for any reasons, it becomes necessary section by providing reinforcements on the compression side.

Curtailment of main reinforcement is made for a length of 0.08l from the support on either side.

**Problem**

The following are the details of a doubly reinforced beam.

1. Clear span =4000 mm
2. Width of support =300 mm
3. Size of beam =300 x 500 mm

Reinforcement details

MID SPAN

Tensile reinforcement =4 Nos16mmdia Fe415 steel

Compressive reinforcement =2Nos16mmdia Fe 415 steel

AT SUPPORT

Tension = 3 Nos #16mm, Fe415

Compression = 2 Nos #16mm, Fe415

Shear reinforcement =8mmdia Fe 415bars 2 leggedstirrups at 160 mm c/c up to a distance of 800mm from the edge of the support on both sides. Beyond this point use these shear stirrups @ 300 mm c/c.

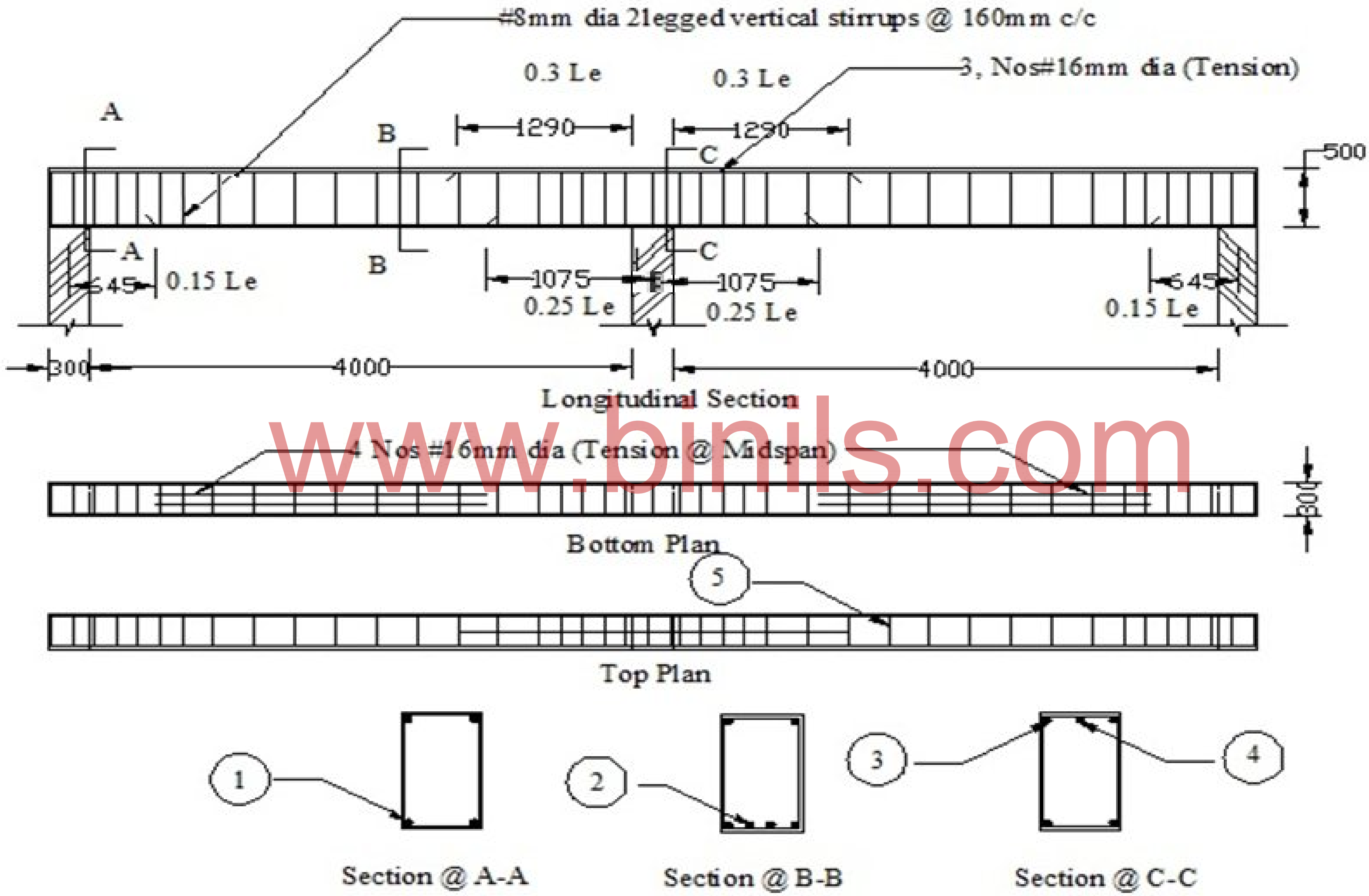
Anchorage and curtailment of reinforcement may be adopted with standard values.

Assume any other data required suitably.

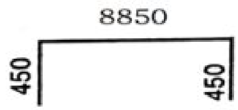
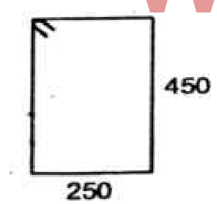
**Draw the views to a suitable scale**

1. The longitudinal section of the beam.
2. The c/s of the beam at mid span.
3. The cross section of the beam at support.
4. The top and bottom plan of reinforcement.
5. Prepare the bar bending schedule for the beam.

# DOUBLY REINFORCED CONTINUOUS BEAM



BAR BENDING SCHEDULE

| Type No. | Size Grade | Shape Dimension | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 16# | 8850 | 8.850 | 2 | 15.78 | 279.06 | Tensile reinforcement |
| 2. | 16# | 2580 | 2.580 | 4 | 15.78 | 153.38 | Tensile reinforcement (Curtailed) |
| 3. | 16# |  8850, 450, 450 | 8.850 | 2 | 15.78 | 279.06 | Compressive reinforcement |
| 4. | 16# | 2880 | 2.880 | 1 | 15.78 | 45.45 | Compressive reinforcement (Curtailed) |
| 5. | 8# |  450, 250<br>(250 + 450) 2 + 20d<br>1400 + (20 x 8)<br>= 1560 | 1.560 | $\frac{800}{160}+1=6$<br>2x6 = 12<br>$\frac{2700}{300}-1=8$<br>12 + 8 = 20<br>For two spans<br>20+19=39 | 3.95 | 240.32 | Stirrups |
| | | | | | Total weights | 880.19 | |
| | | | | | Add 5% of above total weight etc | 44.01 | |
| | | | | | | 924.20 N Say 925N | |

## 12. TEE BEAMS SUPPORTING CONTINUOUS SLAB

A slab having three or more supports is called a continuous slab. Slabs spanning in one direction supported at ends and also at intermediate points on beams shall be designed for maximum sagging moment (+ve bending moment) at spans and hogging moment (negative bending moment) at supports.

Tension Reinforcement is to be provided at the bottom of mid span section and at the top of support sections.

**Problem**

The following are the particulars of a continuous one way slab over the beams.

| | |
|---|---|
| Size of room | = 12m x 4m |
| Spacing of 'T' beams | = 3m c/c |
| Depth of Tee beams | = 450 mm overall |
| Breadth of web or rib | = 250 mm |
| Width of support | = 250 mm |
| Thickness of slab | = 120 mm |



**Main Reinforcement in Tee beam**

| | |
|---|---|
| Main Tensile reinforcement | = 20 mmdia Fe 415 bars 5 Nos |
| Hanger rods | =12 mmdia Fe 415 bars 2 Nos |
| Shear reinforcement | =2 legged stirrups 8mmdia Fe 415 steel @250 mm c/c |

**Reinforcement in slab**

Main reinforcement for positive moment at ends spans

= 10mmdia Fe415 bars @ 300 mm c/c

Main reinforcement for negative moment at support next end support

=10mmdia Fe415 bars @ 290 mm c/c

Main reinforcement for positive moment at interior span

=10mmdia Fe415 steel 230 mm c/c

Distribution = 8mmdia Fe415 steel 340mm c/c

Reinforcement at top at support

=16 mmdia Fe415 steel 2 Nos for a length 0.1 $l$

(orLd) whichever is greater.

Anchorage and curtailment of reinforcement may be adopted with standard values.

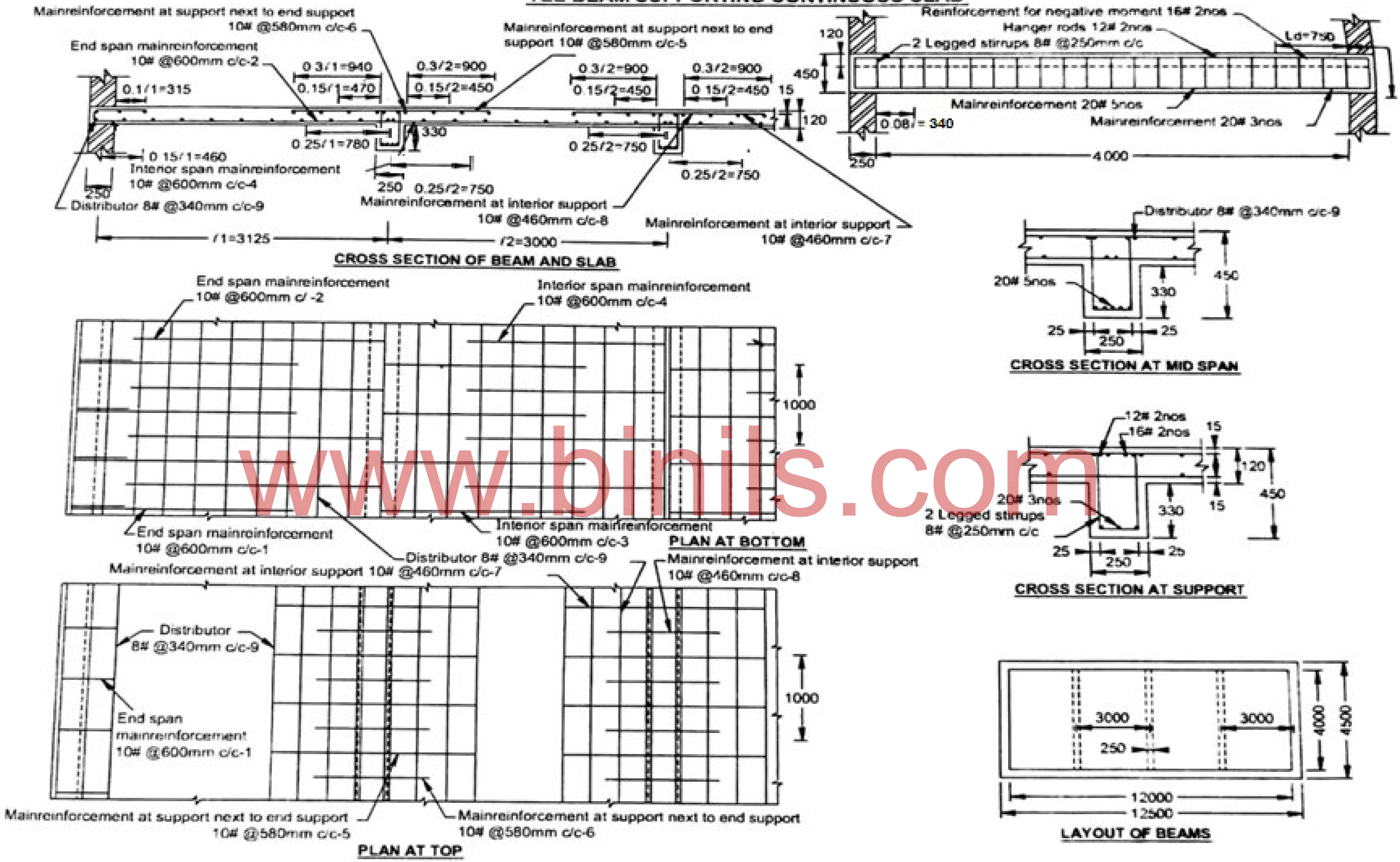


Assume any other data required suitably.

Draw the following views to a suitable scale.

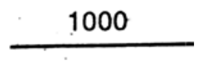
1. The layout of beams
2. Plan showing reinforcement details at bottom and at top
3. The cross section of beam and slab for end span and interior span showing reinforcement details.
4. Longitudinal section of Tee beam.
5. Cross section of beam at mid span and at supports.
6. Prepare a bar bending schedule for all spans except beam portion for 1m width of slab.

## TEE BEAM SUPPORTING CONTINUOUS SLAB



BAR BENDING SCHEDULE FOR TEE BEAM

| Type No. | Size Grade | Shape Dimension | Length In m | No. of span | Number | Weight/ Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1. | 10# | 90, 540, 2440 | 3.070 | 2 | $\frac{1000}{600} = 1.67\ say\ 2$ | 6.17 | 75.77 | Main reinforcement at end span |
| 2. | 10# | 2665 | 2.665 | 2 | $\frac{1000}{600} = 1.67\ say\ 2$ | 6.17 | 65.77 | Main reinforcement at end span |
| 3. | 10# | 2250 | 2.250 | 2 | $\frac{1000}{600} = 1.67\ say\ 2$ | 6.17 | 55.53 | Main reinforcement at interior span |
| 4. | 10# | 2250 | 2.250 | 2 | $\frac{1000}{600} = 1.67\ say\ 2$ | 6.17 | 55.53 | Main reinforcement at interior span |
| 5. | 10# | 2090 | 2.090 | 2 | $\frac{1000}{580} = 1.72\ say\ 2$ | 6.17 | 51.58 | Main reinforcement at next to end support |
| 6. | 10# | 1170 | 1.170 | 2 | $\frac{1000}{580} = 1.72\ say\ 2$ | 6.17 | 28.88 | Main reinforcement at next to end support |
| 7. | 10# | 2050 | 2.050 | 2 | $\frac{1000}{460} = 2.17\ say\ 2$ | 6.17 | 50.59 | Main reinforcement at interior support |
| 8. | 10# | 1150 | 1.150 | 2 | $\frac{1000}{460} = 2.17\ say\ 2$ | 6.17 | 23.38 | Main reinforcement at interior support |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9. | 8# |  | 1.000 | 2 | $\frac{3225}{340}+1=10.48\ say\ 11$<br>$\frac{3000}{340}+1=9.80\ say\ 10$<br>$\frac{540}{340}+1=2.58\ say\ 3$<br>$\frac{2090}{340}+1=7.14\ say\ 8$<br>$\frac{2050}{340}+1=7.03\ say\ 8$ | 3.95 | 86.90 | Distributor at end span |
| | | | | | | Total weights | 723.03 | |

Adding 5% of above total weight for wastage 36.15

Total quantity of steel required 759.18 Say 760 N

## 13. DOG –LEGGED STAIRCASE

Staircase is a structural form provided in building to facilitate easy vertical movements of persons from one floor to another.

Dog legged stairs are one of the different stairs adopted and in which the succeeding flight goes in the opposite direction.

The two flights are not separated with the gap and are suited where the width of room is sufficient to accommodate the width of two flights.

**Problems**

The following are the particulars of a dog legged staircase

| | |
|---|---|
| Clear size of staircase room | = 5.90 x 3.40 m |
| Width of supporting wall | = 230 mm |
| Height of the floors | = 3.30 m |
| Width of Landing | =1600mm |
| Number of flight | =2 Nos |
| Rise of steps | =150 mm |
| Tread of steps | =270mm |
| Main reinforcement | = 10mmdia Fe415 steel @ 120mm c/c |
| Distributors | =8mmdia Fe415 steel @ 160 mm c/c |



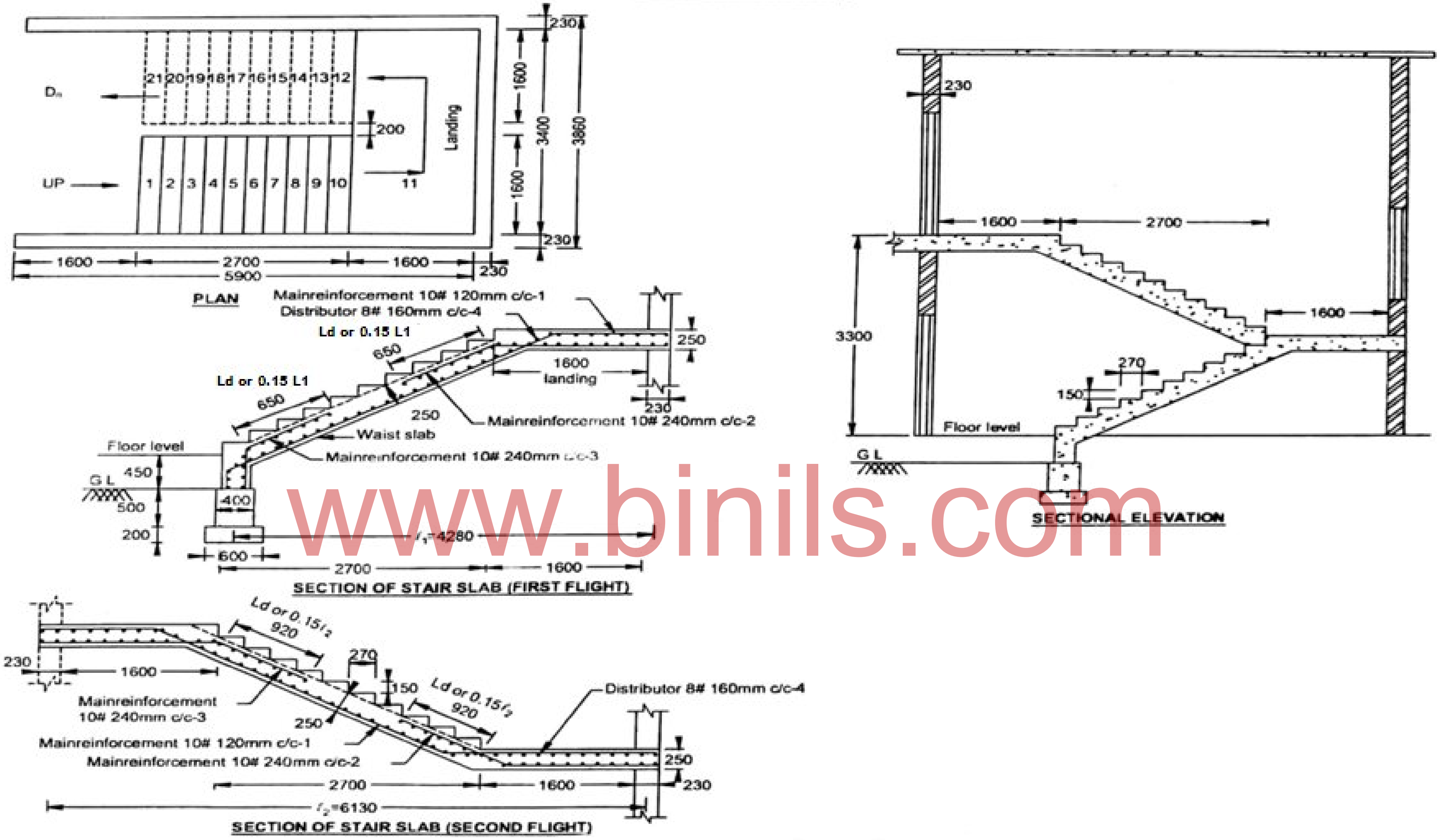
50% of the main reinforcement is provided at the bottom of landing slab and extended to the top of waist slab for a length of 0.15 *l*(or) Ld whichever is greater.

Assume any other data required suitably.

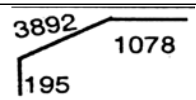
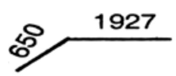
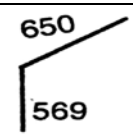
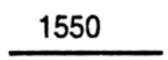
**Draw the following views to a suitable scale**

1. Plan and elevation of dog legged stair.
2. Section of waist slab.
3. Prepare a bar bending schedule.

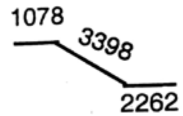
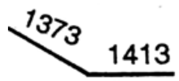
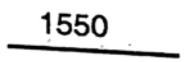
DOG LEGGED STAIRCASE



Bar bending schedule for First flight

| **Type No.** | **Size grade** | **Shape Dimension** | **Length in m** | **Number** | **Weight/Unit length in N/m** | **Total weight in 'N'** | **Remarks** |
|---|---|---|---|---|---|---|---|
| 1. | 10# |  | 5.165 | $\frac{1550}{120}+1=13.92\ say\ 14$ | 6.17 | 446.15 | Main reinforcement |
| 2. | 10# |  | 2.577 | $\frac{1550}{240}+1=7.46\ say\ 8$ | 6.17 | 127.20 | Main reinforcement |
| 3. | 10# |  | 1.219 | $\frac{1550}{240}+1=7.46\ say\ 8$ | 6.17 | 60.17 | Main reinforcement |
| 4. | 8# |  | 1.550 | $\frac{195}{160}+1=2.22\ say\ 3$<br>$\frac{3892}{160}=24.33\ say\ 25$<br>$\frac{1078}{160}=6.74\ say\ 7$<br>$\frac{650}{160}+1=5.10\ say\ 6$<br>$\frac{1927}{160}=12.04\ say\ 12$<br>$\frac{569}{160}+1=4.56\ say\ 5$<br>$\frac{650}{160}=4.120\ say\ 5$<br>Total= 63 | 3.95 | 385.72 | Distributor |
| Total weights 1019.24 | | | | | | | |
| Add 5% of above total weight for wastage during cutting, bending etc 50.96 N | | | | | | | |
| Total quantity of steel required 1070.20 N | | | | | | | |
| say 1075 N | | | | | | | |

Bar bending schedule for Second flight

| **Type No.** | **Size grade** | **Shape Dimension** | **Length in m** | **Number** | **Weight/ Unit length in N/m** | **Total weight in 'N'** | **Remarks** |
|---|---|---|---|---|---|---|---|
| 1. | 10# |  | 6.738 | $\frac{1550}{120}+1=13.92\ say\ 14$ | 6.17 | 582.03 | Main reinforcement |
| 2. | 10# |  | 2.786 | $\frac{1550}{240}+1=7.46\ say\ 8$ | 6.17 | 137.52 | Main reinforcement |
| 3. | 10# |  | 2.847 | $\frac{1550}{240}+1=7.46\ say\ 8$ | 6.17 | 140.53 | Main reinforcement |
| 4. | 8# |  | 1.550 | $\frac{1078}{160}+1=7.74\ say\ 8$<br>$\frac{3898}{160}=24.33\ say\ 22$<br>$\frac{2262}{160}=14.14\ say\ 15$<br>$\frac{1373}{160}+1\ =9.58\ say\ 10$<br>$\frac{1413}{160}=8.83\ say\ 9$<br>$\frac{1927}{160}\ =13.04\ say\ 13$<br>$\frac{920}{160}=5.75\ say\ 6$<br>Total= 83 | | 508.17 | |
| Total weights1368.25N | | | | | | | |
| Add 5% of above total weight for wastage during cutting, bending etc 68.4 N | | | | | | | |
| Total quantity of steel required 1436.66 N | | | | | | | |
| Say 1440 N | | | | | | | |

## 14. LINTEL CUM SUNSHADE

Lintels are horizontal structural elements provided over the openings on walls (doors, windows, ventilators etc) to carry the masonry over them. Lintel beams are designed as small rectangular beams of width always equal to the thickness of wall.

In the external openings it may be cast monolithically with sunshade. In sunshade the tension develops at top. The reinforcements of sunshade are well anchored into the lintel.

**Problem**

The following are the details of a lintel cm sunshade.

| | |
|---|---|
| Clear span of lintel | =2.10m |
| Bearing on either side | =300 mm |
| Size of lintel | =300 x 200 mm |
| Width of support | =300 mm |
| Width of sunshade | =900mm |
| Thickness of sunshade | =70 mm @ support and 50 mm @ free end. |



**Reinforcement details**

| | |
|---|---|
| Main reinforcement (tension) | =12mm Fe415 bars 5Nos |
| Hanger rods | =10mm Fe415 bars 2 Nos |
| Shear reinforcement | = 8mm Fe415 bars 2 legged stirrups @ 175 mm c/c |

**Sunshade**

Main reinforcement = 10 mm Fe 415 bars @ 230 mm c/c

Distributor = 8 mm Fe 415 bars @ 300 mm c/c

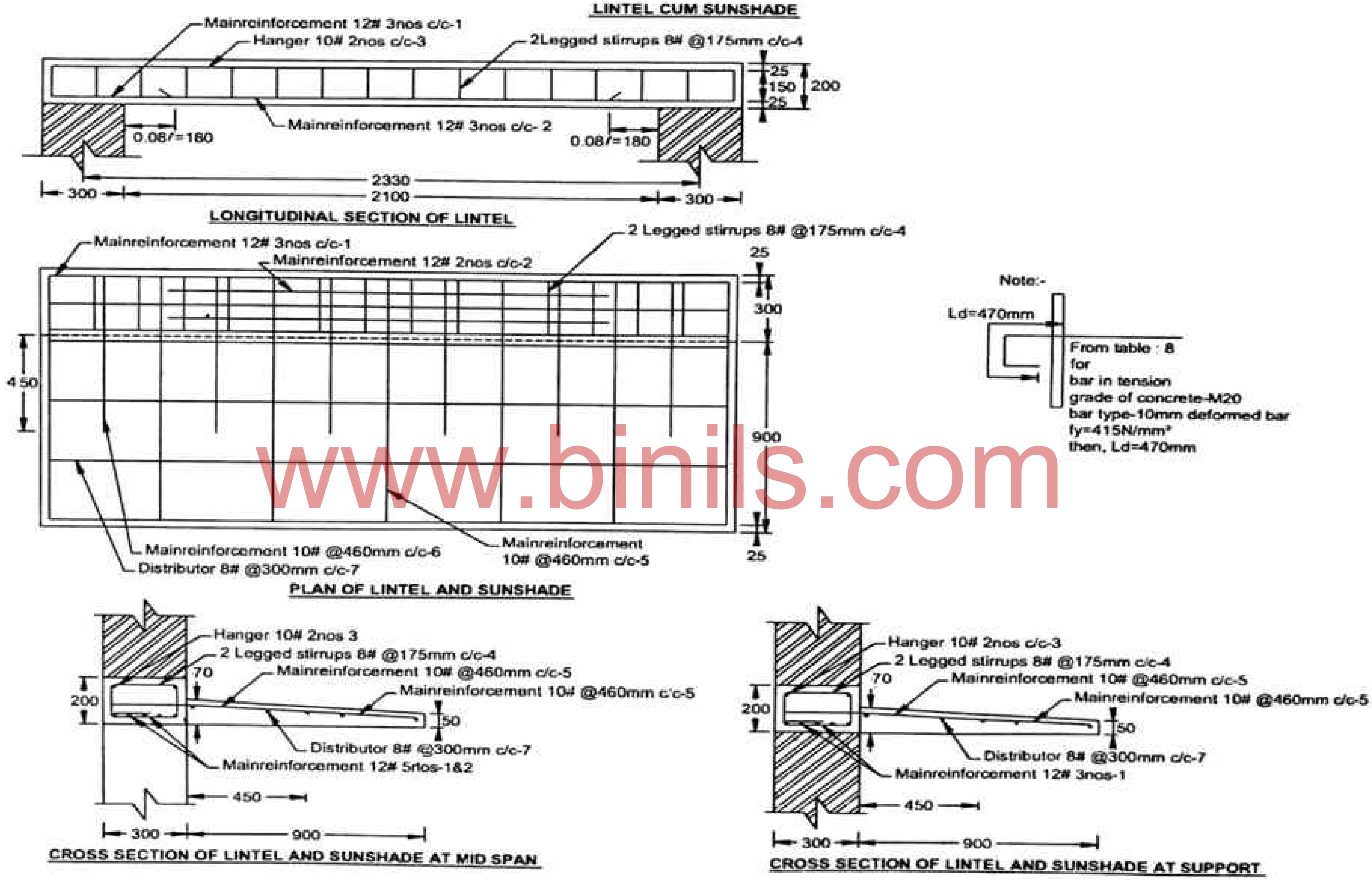
Anchorage and curtailment of reinforcement may be adopted with standard values.

Assume any other suitable data if not given

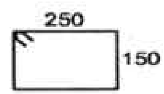
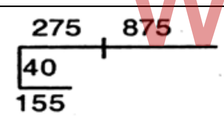
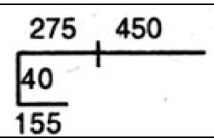
Draw the following views to a suitable scale

1. Longitudinal section of lintel
2. Cross section of lintel and sunshade at mid span and at support.
3. Prepare a bar bending schedule for the lintel cum sunshade.

LINTEL CUM SUNSHADE



BAR BENDING SCHEDULE

| Type No. | Size Grade | Shape Dimension | Length In m | Number | Weight/ Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | 12# | 2650 | 2.650 | 3 | 8.88 | 70.59 | Main reinforcement |
| 2. | 12# | 1740 | 1.740 | 2 | 8.88 | 30.90 | Main reinforcement |
| 3. | 10# | 2650 | 2.650 | 2 | 6.17 | 32.70 | Hanger rods |
| 4. | 8# |  (250+150)2 + 2d<br>800+(20x8)=960 | 0.960 | $\frac{2250}{175}+1=15.57\ say\ 16$ | 3.95 | 60.67 | Stirrups |
| 5. | 10# |  | 1.345 | $\frac{2550}{460}+1=6.54\ say\ 7$ | 6.17 | 58.09 | Main reinforcement |
| 6. | 10# |  | 0.920 | $\frac{2550}{460}=5.54\ say\ 6$ | 6.17 | 34.06 | Main reinforcement |
| 7. | 8# | 2650 | 2.650 | $\frac{875}{300}+1=3.92\ say\ 4$ | 3.95 | 41.87 | Distributor |
| Total weights | | | | | | 328.88 | |
| Add 5% of above total weight etc | | | | | | 16.44 | |
| | | | | | | 345.32 N Say 350 N | |

## 15. R.C.C COLUMN WITH SQUARE ISOLATED FOOTING

A column is a vertical compression member provided to carry a compressive load and whose effective length exceeds three times its least laterals dimensions. Columns are used to transmit the load from super structure to foundation. Based on the shape of columns, it is classified into square, rectangular and circle.

The foundation provided for a R.C. column is called a 'Column base' or a 'Column footing'. The main function of column base is to transfer the load carried by the column safely on a larger area of the soil. Individual footings are generally square and supports a central column.

**Problems**

The following are the particulars of a R.C.C square column with square footing.

Column size = 400mm x 400 mm



Clear cover = 40 mm

Size of footing = 2100mm x 2100 mm

Thickness of footing = 600 mm

Bottom cover = 50 mm

Side cover = 75mm

**Reinforcement details**

Main reinforcement = 20 mm Fe415 bars 8Nos

Lateral ties = 8 mm Fe415 bars @ 250 mm c/c

Footing =12mm Fe415 bars @ 150 mm c/c

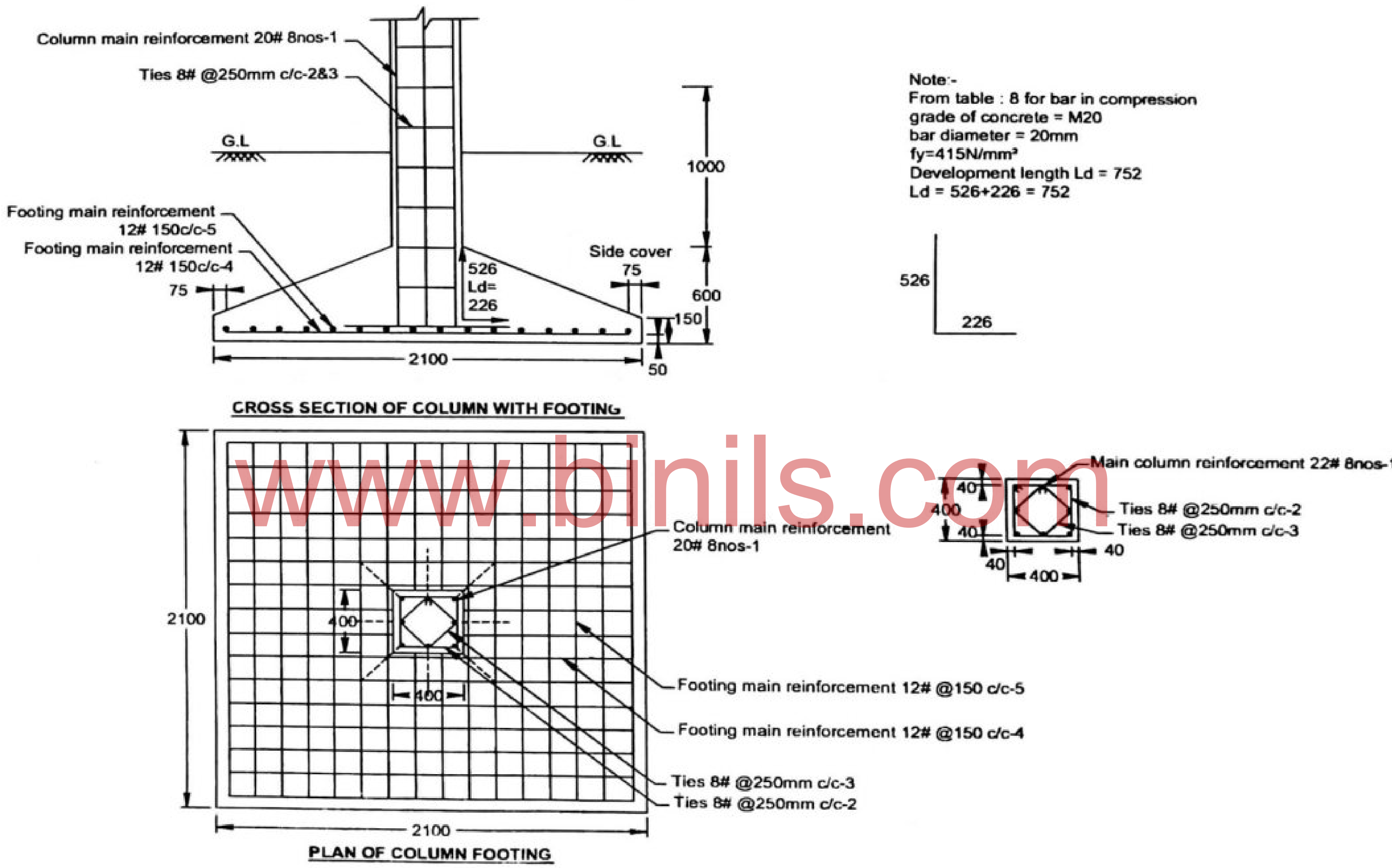
Anchorage and curtailment of reinforcement may be adopted with standard values.

Assume any other data required suitable

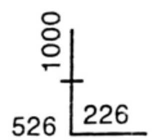
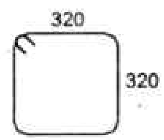
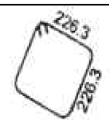
**Draw the following views to a suitable scale**.

1. Plan column with reinforcement details
2. Sectional view of column with footing
3. Plan of footing showing reinforce details
4. Prepare a bar bending schedule for column and footing (for 1m ht of column)

## R.C.C.COLUMN WITH FOOTING (SQUARE)




BAR BENDING SCHEDULE FOR R.C.C COLUMN WITH FOOTING (SQUARE)

| Type No. | Size | Shape | | Length In m | Number | Weight/Unit length in N/m | Total weight in 'N' | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Column | Footing | | | | | |
| 1. | 20# |  | | 1.752 | 8 | 24.66 | 345.63 | Main Reinforcement |
| 2. | 8# |  (320+320)2+20d<br>1280+(20x8)=1440 | | 1.440 | $\frac{1526}{250} = 6.10\ say\ 6$ | 3.95 | 34.13 | Lateral ties |
| 3. | 8# |  (226.3+226.3)2+20d<br>905.2+(20x8)=1065.2 | | 1.065 | $\frac{1526}{250} = 6.10\ say\ 6$ | 3.95 | 25.24 | Lateral ties |
| 4. | 12# | | 1950 | 1.950 | $\frac{1950}{150} = 13$ | 8.88 | 225.10 | Main Reinforcement |
| 5. | 12# | | 1950 | 1.950 | $\frac{1950}{150} = 13$ | 8.88 | 225.10 | Main Reinforcement |
| Total weights | | | | | | | 855.20+42.76 =897.96 | |
| Add 5% of above total weight etc | | | | | | | Say 900 N | |

# Annexure

**Development Length for fully stressed plain Bars**

$f_y$ = 250 N/mm² for bars up to 20 mm diameter

= 240 N/mm² for bars over 20 mm diameter

(Tabulated values are in millimeters)

| Bar Diameter | Tension Bars for Grade of Concrete | | | | | Compression Bars for Grade of Concrete | | | |
|---|---|---|---|---|---|---|---|---|---|
| | M15 | M20 | M25 | M30 | | M15 | M20 | M25 | M30 |
| 1 | 2 | 3 | 4 | 5 | | 6 | 7 | 8 | 9 |
| mm | | | | | | | | | |
| 6 | 326 | 272 | 233 | 218 | | 261 | 218 | 186 | 174 |
| 8 | 435 | 363 | 311 | 290 | | 348 | 290 | 249 | 232 |
| 10 | 544 | 453 | 388 | 363 | | 435 | 363 | 311 | 290 |
| 12 | 653 | 544 | 466 | 435 | | 522 | 435 | 373 | 348 |
| 16 | 870 | 725 | 621 | 580 | | 696 | 580 | 497 | 464 |
| 18 | 979 | 816 | 699 | 653 | | 783 | 653 | 559 | 522 |
| 20 | 1088 | 906 | 777 | 725 | | 870 | 725 | 621 | 580 |
| 22 | 1148 | 957 | 820 | 766 | | 919 | 766 | 656 | 612 |
| 25 | 1305 | 1088 | 932 | 870 | | 1044 | 870 | 746 | 696 |
| 28 | 1462 | 1218 | 1044 | 974 | | 1169 | 974 | 835 | 780 |
| 32 | 1670 | 1392 | 1193 | 1114 | | 1336 | 1114 | 955 | 896 |
| 36 | 1879 | 1566 | 1342 | 1253 | | 1503 | 1253 | 1074 | 1002 |

Note 1 : The development lengths given above are for a stress of 0.87 $f_y$ in the bar.

Note 2 : It is important to note that hook should normally be provided for plain bars in tension. Threfore, the straight length required in such cases is equal to the value taken from the table minus the anchorage value of hook.

**Development Length for fully stressed deformed Bars**

$f_y$ = 415 N/mm²

(Tabulated values are in millimeters)

| Bar Diameter | Tension Bars for Grade of Concrete | | | | Compression Bars for Grade of Concrete | | | |
|---|---|---|---|---|---|---|---|---|
| | M15 | M20 | M25 | M30 | M15 | M20 | M25 | M30 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| mm | | | | | | | | |
| 6 | 338 | 282 | 242 | 226 | 271 | 226 | 193 | 181 |
| 8 | 451 | 376 | 322 | 301 | 361 | 301 | 258 | 241 |
| 10 | 564 | 470 | 403 | 376 | 451 | 376 | 322 | 301 |
| 12 | 677 | 564 | 484 | 451 | 542 | 451 | 387 | 361 |
| 16 | 903 | 752 | 645 | 602 | 722 | 602 | 516 | 481 |
| 18 | 1015 | 846 | 725 | 677 | 812 | 677 | 580 | 542 |
| 20 | 1128 | 940 | 806 | 752 | 903 | 752 | 645 | 602 |
| 22 | 1241 | 1034 | 887 | 827 | 993 | 827 | 709 | 662 |
| 25 | 1410 | 1175 | 1007 | 940 | 1128 | 940 | 806 | 752 |
| 28 | 1580 | 1316 | 1128 | 1053 | 1264 | 1053 | 903 | 842 |
| 32 | 1805 | 1504 | 1289 | 1203 | 1444 | 1203 | 1032 | 963 |
| 36 | 2031 | 1693 | 1450 | 1354 | 1625 | 1354 | 1161 | 1083 |



Note : The development lengths given above are for a stress of 0.87 $f_y$ in the bar.

**Development Length for fully stressed deformed Bars**

$f_y$ = 500 N/mm² (Tabulated values are in millimeters)

| Bar Diameter | Tension Bars for Grade of Concrete | | | | | Compression Bars for Grade of Concrete | | | |
|---|---|---|---|---|---|---|---|---|---|
| | M15 | M20 | M25 | M30 | | M15 | M20 | M25 | M30 |
| 1 | 2 | 3 | 4 | 5 | | 6 | 7 | 8 | 9 |
| mm | | | | | | | | | |
| 6 | 408 | 340 | 291 | 272 | | 326 | 272 | 232 | 218 |
| 8 | 544 | 453 | 388 | 363 | | 435 | 363 | 312 | 290 |
| 10 | 680 | 566 | 485 | 453 | | 544 | 453 | 388 | 363 |
| 12 | 816 | 680 | 583 | 544 | | 653 | 544 | 466 | 435 |
| 16 | 1088 | 906 | 777 | 725 | | 870 | 725 | 621 | 580 |
| 18 | 1223 | 1020 | 874 | 816 | | 979 | 816 | 699 | 653 |
| 20 | 1359 | 1133 | 971 | 906 | | 1088 | 906 | 727 | 725 |
| 22 | 1495 | 1246 | 1068 | 997 | | 1196 | 997 | 854 | 798 |
| 25 | 1699 | 1416 | 1214 | 1133 | | 1359 | 1133 | 971 | 906 |
| 28 | 1903 | 1586 | 1359 | 1269 | | 1523 | 1269 | 1088 | 1015 |
| 32 | 2175 | 1813 | 1554 | 1450 | | 1740 | 1450 | 1243 | 1160 |
| 36 | 2447 | 2039 | 1748 | 1631 | | 1958 | 1631 | 1398 | 1305 |

Note : The development lengths given above are for a stress of 0.87 $f_y$ in the bar.

**Reinforcement characteristics – Area, Weight and Perimeter**

| Size | Area | Weight | Perimeter | Length per Kn | | Size | Area | Weight | Perimeter | Length per Kn |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| mm | mm² | (N/m) | (mm) | (m) | | mm | mm² | (N/m) | (mm) | (m) |
| 6 | 28.3 | 2.22 | 18.90 | 450.5 | | 22 | 380.1 | 29.8 | 69.1 | 33.6 |
| 8 | 50.3 | 3.95 | 25.10 | 253.2 | | 25 | 490.9 | 38.54 | 78.5 | 26.0 |
| 10 | 78.5 | 6.17 | 31.40 | 162.1 | | 28 | 615.7 | 48.30 | 88.0 | 20.7 |
| 12 | 113.1 | 8.88 | 57.70 | 112.5 | | 32 | 804.2 | 63.13 | 100.5 | 15.9 |
| 14 | 153.9 | 12.06 | 44.00 | 82.9 | | 36 | 1017.9 | 79.90 | 113.1 | 12.5 |
| 16 | 201.1 | 15.78 | 50.30 | 63.3 | | 40 | 1256.6 | 98.64 | 125.7 | 10.1 |
| 18 | 254.5 | 20.00 | 56.50 | 50.0 | | 45 | 1590.4 | 124.90 | 141.4 | 8.0 |
| 20 | 314.2 | 24.66 | 62.80 | 40.5 | | 50 | 1963.5 | 154.10 | 157.1 | 6.5 |