DESIGN OF ELEVATED SERVICE RESERVOIR

1.0 INTRODUCTION :

For storage of large quantities of liquids like water, oil, petroleum, acid and sometime gases also, containers or tanks are required. These structures are made of masonry, steel, reinforced concrete and pre stressed concrete.

Out of these, masonry and steel tanks are used for smaller capacities. The cost of steel tanks is high and hence they are rarely used for water storages. Reinforced concrete tanks are very popular because, besides the construction and design being simple, they are cheap, monolithic in nature and can be made leak proof.

Generally no cracks are allowed to take place in any part of the structure of Liquid Retaining R-C.C. tanks and they are made water tight by using richer mix (not less than M 30) of concrete. In addition some times water proofing materials also are used to make tanks water tight.

1.1) CLASSIFICATION OF R.C.C. TANKS :

In general they are classified in three categories depending on the situation.

1. Tanks resting on ground.
2. Tanks above ground level (Elevated tanks).
3. Under ground tanks.

1.2. TANKS RESTING ON GROUND:

These are used for clear water reservoirs, settling tanks, aeration tanks etc. these tanks directly rest on the ground. The wall of these tanks are subjected to water pressure from inside and the base is subjected to weight of water from inside and soil reaction from underneath the base. The tank my be open at top or roofed.

Ground water tank is made of lined carbon steel, it may receive water from a water well or from surface water allowing a large volume of water to be placed in inventory and used during peak demand cycles.

FIG NO 1.1: . TANKS RESTING ON GROUND

1.3.<u>ELEVATED TANKS:</u> These tanks are supported on staging which may consist of masonry walls, R.C.C tower or R.C.C. column braced together- The walls are subjected to water pressure from inside. The base is subjected to weight of water, wt- of walls and wt. roof. The staging has to carry load of entire tank with water and is also subjected to wind loads.

Water tank parameters include the general design of the tank, choice of materials of construction, as well as the following.

1. Location of the water tank (indoors, outdoors, above ground or underground) determines color and construction characteristics.

2. Volume of water tank will need to hold to meet design requirements.

3. Purpose for which the water will be used, human consumption or industrial determines concerns for materials that do not have side effects for humans.

4. Temperature of area where water will be stored , may create concern for freezing and delivery of off setting heat.

5. Delivery pressure requirements, domestic pressures range from 35-60 PSI, the demand for a given GPM (gallons per minute) of delivered flow requirements.

6. How is the water to be delivered to the point of use, into and out of the water tank i.e. pumps, gravity or reservoir.

7. Wind and Earthquake design considerations allow a design of water tank parameters to survive seismic and high wind events.

8. Back flow prevention, are check valve mechanisms to allow single direction of water flow.

9. Chemical injection systems for algae, bacteria and virus control to allow long term storage of water.

10. Algae in water tanks can be mitigated by removing sunlight from access to the water being stored.

FIG NO 1.2 : ELEVATED TANKS

1.4. UNDER GROUND TANKS : These tanks are built below the ground level such as clarifiers filters in water treatment plants, and septic tanks .The walls of these tanks are subjected to water pressure from inside and earth pressure from outside. The base of the tanks is subjected to water pressure from inside and soil reaction from underneath. Always these are covered at top. These tanks should be designed for loading which gives the worst effect.

The design principles of underground tanks are same as for tanks resting on the ground. The walls of the underground tanks are subjected to internal water pressure and outside earth pressure. The section of wall is designed for water pressure and earth pressure acting separately as well as acting simultaneously.

Whenever there is possibility of water table to rise, soil becomes saturated and earth.

TYPE OF TANKS :

From the design consideration storage tanks are further classified according to their shape and design principles as

(1) circular tanks.

(2) Rectangular tanks.

(3) Intze type tanks.

4) Spherical tanks.

5) conical bottom tanks.

6) PSC Tanks.

1.6 CIRCULAR TANKS: Generally circular tanks rest on the ground or are elevated ones. Under ground circular tanks are also constructed. The circular tanks may be designed either with flexible base connection with wall or with a rigid connection between walls and base, In the former case the expansion and contraction of side walls are possible but in latter case the walls are monolithic with base. The walls of tanks are subjected to hydrostatic pressure which is maximum at base and zero at top. Usually for design of circular tanks, the theory of thin cylinders is applied for design of wall thickness and for calculation of maximum hoop tension.

FIG NO 1.3 :CIRCULAR TANK

Maximum hoop tension is given by formula P = (WHD/2)

And area of steel required for this tension is given by

$$Ast = (WHD / 2f)$$

for the calculation of thickness of wall, the permissible tensile stress in concrete is equated to expression given below,

$$ct = \frac{(WHD / 2)}{100t + (m-1) Ast}$$

In all the above cases

W = Wt. of water/Cu.m.

D = Diameter of Tank,

H = Height of the tank.

Ast = Area of steel required.

m = Modular ratio

t = Thickness of wall

f and ct are permissible tensile stresses in steel and concrete respectively. As the pressure is maximum at base and reduced to zero at the top, the reinforcement is also gradually reduced to a minimum requirement from bottom to top. The main reinforcement consists of circular hoops to take care of hoop tension and is placed on both faces of wall. The distribution steel is placed vertically and is tied to main reinforcement.

Though it is assumed that the connection between walls and base is flexible, in reality there is some moment at the joint- Hence it is impossible to get an ideal flexible joint. When the joint is not flexible and restricted up to certain height from base, the wall acts as a cantilever and beyond that it acts as simply supported.

1.7. RECTANGULAR TANKS: For smaller capacities circular tanks are uneconomical and their form work is costly. Rectangular tanks are constructed when small capacity tanks are required . These may be resting on ground, elevated or under ground . Tanks should be preferably square in plan and it is desirable that larger side should not be greater than twice the smaller side and for Rectangular tanks.

FIG NO 1.4 :RECTANGULAR TANK

Walls of the tanks either resting on ground or elevated are subjected to water pressure from inside and when under ground they are subjected to internal water Pressure and out side earth pressure.

In rectangular tanks moments are caused in two directions, hence exact analysis is rather difficult, they are designed by approximate methods. For tanks in which ratio of length to breadth is less than 2, tank walls are designed as continuous frame subjected to pressure varying from zero at top to maximum at H/4 or 1 meter from the base which ever is more.

The bottom H/4 or 1 m whichever is more is designed as a cantilever. Besides, the walls are also subjected to direct pull or tension due to the hydrostatic force on the other side walls. The section is to be designed for bending and direct tension.

$$h = H/4 \text{ or } 1.0 \text{ m}$$

The direct tension in long walls = W(H-h) L/2

= W(H-h) B/2

where W = Wt. of water/Cum

H = Height of tank in m.

B = Breadth of the tank in m.

L = Length of the tank in m.

h = H/4 or 1 meter .whichever is more

For rectangular walls in which ratio of length to breadth is greater than 2 the long walls are designed as cantilevers for maximum moment of Wh3 / 6 and short walls as slabs supported on long walls. The bottom height H/4 or 1 m. of short wall, whichever is more is designed as cantilever.

In this also the direct tension caused due to pressure on the other walls should be taken into account and the reinforcement is to be provided for .

When tanks are open at top, the walls of the tanks can also be designed as (a) All the wall s spanning horizontally as slabs (b) All the walls as cantilevers.

1.8 Intze tanks : This is a special type of elevated tank used for very large capacities. Circular tanks for very large capacities prove to be uneconomical when flat bottom slab is provide.

Intze type tank consist of top dome supported on a ring beam which rests on a cylindrical wall .The walls are supported on ring beam and conical slab. Bottom dome will also be provided which is also supported by ring beam

The conical and bottom dome are made in such a manner that the horizontal thrust from conical base is balanced by that from the bottom dome. The conical and bottom domes are supported on a circular beam which is in turn, supported on a number of columns . For large capacities the tank is divided into two compartments by means of partition walls supported on a circular beam.

Following are the components

(1) Top dome.

(2) Ring Beam supporting the top dome.

(3) Cylindrical wall.

(4) Ring beam at the junction of the cylindrical wall and the conical shell.

(5) Conical shell.

(6) Bottom dome.

(7) The ring girder.

(8) Columns braces.

(9) Foundations.

1.9. PRESTRESSED TANKS : The pre-stressed water tanks are built to hold liquids in large quantities. In circular tanks circumferential pre-sstress is provided to resist hoop tension produced by internal liquid pressure.

Pre-load Corporation of America has developed a system by which continuous pre-stressing can be done. It consists of a machine called marry-go-round which is supported by a trolley that moves at the top of the tank. The marry-go-round releases wire from a drum, tensions it through a die and wraps it round the tank walls. The wire is anchored at the bottom of the tank and the wrapping is done after pre-stressing the wall, the tank is filled and steel is covered by guniting.

The concrete is fully hardened in tank before the tensioned wire is wrapped around to cause hoop compression. The tank is covered with a dome of small rise. The ring beam is provided to support the dome. The dome may be also pre-stressed.

2.0MATERIALS USED AND THEIR DESIGN REQUIREMENTS

Following are the materials which are used in the construction of R.C.C. Water Tanks.

i) Concrete.

(ii) Steel.

iii) Water Proofing materials.

iv)Minimum Reinforcement.

2.1CONCRETE :Design of liquid retaining structure is different from an ordinary R.C.C. Structure as it is required that the concrete should not crack and it should be of high quality and strength and should be leak proof.

The design of the concrete mix shall be such that the resultant concrete is sufficiently impervious. Efficient compaction preferably by vibration is essential.

The permeability of the thoroughly compacted concrete is dependent on water cement ratio. Increase in water cement ratio increases permeability, while concrete with low water cement ratio is difficult to compact.

Other causes of leakage in concrete are defects such as segregation and honey combing. All joints should be made water-tight as these are potential sources of leakage.

Use of small size bars placed properly, leads to closer cracks but of smaller width. The risk of cracking due to temperature and shrinkage effects may be minimized by limiting the changes in moisture content and temperature to which the structure as a whole is subjected.

The risk of cracking can also be minimized by reducing the restraint on the free expansion of the structure with long walls or slab founded at or below ground level, restraint can be minimized by the provision of a sliding layer. This can be provided by founding the structure on a flat layer of concrete with interposition of some material to break the bond and facilitate movement.

Generally concrete mix weaker than M-30 is not used. To get high quality and impervious concrete, the proportion of fine and coarse aggregate to cement is determined carefully and water cement ratio is adjusted accordingly. Depending up on the exposure conditions, the grade of concrete is decided .

2.2 STEEL: Steel used reinforcement should confirm to IS: 1786: 1985

Since steel and concrete are assumed to act together; it has to be checked whether the tensile stress in concrete is within limits, so as to avoid cracks in concrete. The tensile stress in steel will be limited by the requirement that the permissible tensile stresses in concrete is not exceeded.

The permissible stresses in steel reinforcement is as follows for calculation of strength.

(a)Permissible tensile stresses in member in direct tension

= 1500 Kg/Cm^2

(b) Tensile stress in member in bending

on liquid retaining face of member = 1500 Kg/Cm^2

On faces away from liquid for members less than 225 mm thick

= 1500.Kg/Cm^2

(c) On faces away from liquid for members 225 mm. thick or more

= 1900 Kg/Cm^2

2.3. MINIMUM REINFORCEMENT: The minimum reinforcement in each of two directions shall have an area of 0.24% of Cross-Sectional area of concrete up to 100 mm thick.

For section of thickness greater than 100 mm and less than 450 mm. The reinforcement in each direction in shall be linearly reducing from 0.24% cross-sectional area to 0.16% cross-sectional area. For section greater than 450 mm thick reinforcement in each direction should be kept at 0.16% cross sectional area.

2.4. WATER PROOFING MATERIALS: Primary considerations in water tanks, besides, strength, is water tightness of tank. Complete water-tightness can be obtained by using a high strength concrete. In addition water proofing materials can be used to further enhance the water tightness.

To make concrete leak proof or water tight, internal water proofing or water proof linings are frequently used. In the method of internal water proofing, admixtures are used. The object of using them is to fill the pores of the concrete and to obtain a dense and less permeable concrete. Some of the most commonly used admixtures are hydrated lime in quantity varying from 8 to 15 percent, by weight of cement of, powdered iron fillings, which expands upon oxidation and fills the pores of concrete. Other agents like powdered chalk or talc, Sodium silicate Zinc sulphate, Calcium chloride etc.., are also most extensively used.

In waterproof linings, paints, asphalts, coaltar, waxes, resins and bitumens are used. These materials have a property to repel the water.

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Design of 150 KL ELSR

3.0 INTRODUCTION:

3.1 General

The tank is proposed of Circular type with Slabs to form the base and another Slab forming the roofing. Floor beams along the periphery of the Circular slab is proposed to transfer the loads to the Supporting Structure.

The following Primary Loads considered in the Design of the tank portion

a) Dead Load

b) Live Load acting on Roof slab

c) Water Load inside the tank up to top of the Rectangular wall including free board.

d) Combination of all the above loads.

3.2 DESIGN BASIS

(a) The Circular wall has been designed for Hoop Tension & Bending moment

(b) The Floor beam has been designed for a bending between the supporting columns.

(c) The columns are designed for direct load and bending due to wind/seismic effect.

3.3 Material Specifications

a) Grade of Concrete M30

b) Grade of steel - High yield deformed bars with yield stress of 415 N/mm^2

3.3.1) Strength parameters

a) Concrete For Container Portion = M 30

3.3.2) Permissible stresses

Direct tension stress σct	=	15	kg/cm²
Direct compressive stress σ_{CC}	=	80	kg/cm²
Bending tensile stress σ_{Cbt}	=	20	kg/cm²
Bending comp stress σcbc	=	100	kg/cm²

Characteristic comp strength f_{ck}	=	30	kg/cm^2
Shear	=	22	kg/cm^2
Average Bond	=	10*1.4	
Local Bond	=	17*1.4	

3.3.3) Strength parameters

a) Concrete For Staging Portion = M 20

The staging will be designed with M20 concrete and executed with M25 .

3.3.4) Permissible stresses

Direct tension stress σct	=	12	kg/cm^2
Direct compressive stress σ_{CC}	=	50	kg/cm^2
Bending tensile stress σ_{Cbt}	=	17	kg/cm^2
Bending comp stress σcbc	=	70	kg/cm^2
Characteristic comp strength f_{ck}	=	20	kg/cm^2
Shear	=	17	kg/cm^2
Average Bond	=	8*1.4	
Local Bond	=	13*1.4	
(b) Steel HYSD Fe	=	415	N/mm^2

3.4) Permissible stresses (Water Retaining members)

Tensile Stress in members under direct tension	=	1500	kg/cm^2
Tensile stress in members in bending :			
a) On Liquid retaining face of members	=	1500	kg/cm^2
b) On face away from liquid for members less than 225 mm	=	1500	kg/cm^2
c) On face away from liquid for members 225 mm or more	=	1900	kg/cm^2
Tensile stress in Shear Reinforcement :			
a) For members less than 225 mm	=	1500	kg/cm^2

b) For members 225 mm or more	=	1750	kg/cm^2
Compressive stress in columns subjected to direct load	=	1750	kg/cm^2

3.5) <u>Min Area of Reinforcement for Walls:</u>

Min Area of Reinforcement for 100 mm thick Wall	=	0.24	%
Min Area of Reinforcement for 450 mm thick or more	=	0.16	%

3.6) <u>For M30 Concrete ; Design Constants :</u>

σ_{st}	=	1500	kg/cm^2
σ_{cbc}	=	100	kg/cm^2
m = 280 / (3 x σ_{cbc})	=	9.33	
r = σst / σ cbc	=	15	
K = m / (m+r)	=	0.38	
j = 1 - (K / 3)	=	0.87	
Q = 0.5 x σ_{cbc} x k x j	=	16.53	
σst	=	1900	kg/cm^2
σcbc	=	100	kg/cm^2
m = 280 / (3 x σcbc)	=	9.33	
r = σst / σ cbc	=	15	
K = m / (m+r)	=	0.33	
j = 1 - (K / 3)	=	0.89	
Q = 0.5 x σ cbc x k x j	=	14.69	
σst	=	2300	kg/cm^2
σcbc	=	100	kg/cm^2
m = 280 / (3 x σcbc)	=	9.33	
r = σst / σ cbc	=	23	
K = m / (m+r)	=	0.29	
j = 1 - (K / 3)	=	0.9	
Q = 0.5 x σ cbc x k x j	=	13.05	

For Un Cracked Section :

Permissible Bending Tension	=	20	kg/cm^2
$M.R = Qbd^2 = (1/6)\ xb\ x\ d^2\ x\ f$			
$Q = (f / 6)$	=	3	
Considering Reinforcement Q	=	3.33	

For M20 Concrete ;
Design Constants :

σ_{st}	=	1900	kg/cm^2
σ_{cbc}	=	70	kg/cm^2
$m = 280 / (3 \times \sigma_{cbc})$	=	13.33	
$r = \sigma st / \sigma\ cbc$	=	27.14	
$K = m / (m+r)$	=	0.33	
$j = 1 - (K / 3)$	=	0.89	
$Q = 0.5 \times \sigma_{cbc} \times k \times j$	=	10.28	

σst	=	2300	kg/cm^2
σcbc	=	70	kg/cm^2
$m = 280 / (3 \times \sigma cbc)$	=	13.33	
$r = \sigma st / \sigma\ cbc$	=	32.86	
$K = m / (m+r)$	=	0.29	
$j = 1 - (K / 3)$	=	0.9	
		9.14	
$Q = 0.5 \times \sigma\ cbc \times k \times j$	=		

3.7) Design Data :

Capacity	=	150	KL
Staging	=	12	M
Seismic Zone	=	III	

R.C.C to be M30 for container .

Staging to be Designed with M20 Concrete and executed with M25 Concrete .

3.8) Hydraulic features :

Ground level	=	340.725	
Lowest water level (LWL)	=	352.725	
Max water level (MWL)	=	355.725	
Dead storage	=	0.15	
Free board	=	0.3	
Effective Water depth H =355.725-352.725	=	3.000	

3.9) Member sizes :

No of columns Supporting the ESR	=	5	
No of Columns inside Container	=	1	
No of Braces	=	3	Levels
Size of Container	=	8.00 Φ	
Size of Column Supporting ESR	=	400 Φ	
Size of Column inside Container	=	200 Φ	
Braces	=	250x	350
Roof beam	=	200x	300
Floor beam	=	300x	600
Floor Ring beam	=	300x	300
The of side wall	=	200	mm

3.10) Loads

Wind pressure	=	150	kg/m^2
Live Load on Roof	=	100	kg/m^2
Live Load on Walkway Slab	=	300	kg/m^2
Density of concrete	=	2500	kg/m^3
Density of water	=	1000	kg/m^3

3.11) Soil Parameters :

Safe bearing capacity of soil (SBC) (Assumed)	=	6.5	t/m²
Depth of foundation	=	3	m
Depth of Ground Water table is at	=	7	m
Seismic Zone	=	III	

3.12) Capacity Calculations:

Depth of Water between MWL & LWL (Live Storage) h	=	3	m
Required Capacity of Tank V1 = Π/4 D^2 h	=	150	m^3
Inner Diameter of Tank Required	=	7.979	m
Inner Diameter of Tank Provided D	=	8	m
Volume of Tank V_1	=	150.8	m^3
Consider freeboard of the Cylindrical Portion (FB) =	=	0.3	m
Volume of Free board Portion V_2	=	15.08	m^3
Height of Dead Storage Portion	=	0.15	m
Volume of Dead Storage Portion V_3	=	7.54	m^3
Total Volume	=	172.62	m^3
Total Height of the Cylindrical Portion (h) =	=	3.45	m
Volume of Internal Column	=	0.108	m^3
Net Volume of Tank V_1	=	150.692	m^3

3.13) DESIGN OF ROOF SLAB :-

Let the Thickness of Slab be	=	120	mm
Width of Panel	=	4.1	m
Effective Span of Slab	=	3.63	m
Density of Concrete	=	2500	kg/m^3
Dead Wt of Slab =0.12 x2500	=	300	kg/m^2
Floor Finish	=	100	kg/m^2
Live Load	=	100	kg/m^2
Total	=	500	kg/m^2
L_y / L_x	=	1	

Refer Table :27 , IS 456 /2000 , CASE - 4 - Two adjacent edges Discontinuous

Negative moment Co efficient at continuous edge	=	0.047	
Positive moment Co efficient at Mid span	=	0.035	
Negative B.M =0.047*500*3.63^2	=	309.66	Kg-m
+ B.M =0.035*500*3.63^2	=	230.59575	Kg-m
Effective thickness	=	9.1	cm
Area of Steel Required at Support			
-ve Ast = (309.66 X100)/(1900x0.89x9.1)	=	2.01	cm^2
Area of Steel Required at Span			
-ve Ast = (230.59575 X100)/(1500x0.87x9.1)	=	1.94	cm^2
Min. area of steel required (Astmin) = (0.12/100)x12x100	=	1.44	cm^2
Max. dia. Of bar (f_{max} = D / 8)	=	15	mm
Min. area of steel required on each face (Astmin) = 1.44/2	=	0.72	cm^2
Max. allowble spacing (S_{max}) ar per IS 456	=	27.3	mm
Dia. Of bar (f)	=	8	mm
Area of Bar	=	50	mm^2
Required Spacing	=	24.88	cm
Provided Spacing	=	20	cm
Provided Area	=	250	mm^2

Provide 8 dia tor @ 200 c/c bothways at bottom & alternate bars bent
Provide 8 dia tor @ 400 c/c bothways at top

Check for Deflection :

L / d	=	26
% of Compression Reinforcement P_c	=	0
Multiplication Factor for Tension Reinforcement	=	2.00
Multiplication Factor for Compression Reinforcement	=	1
Modified L/ d Ratio	=	52.00
Actual L/d Ratio	=	39.89

Hence, SAFE

3.14 DESIGN OF ROOF BEAM :-

Length of Span	=	4.1	m
Let Width of Beam	=	20	cm
Let Depth of Beam	=	30	cm
Clear Cover	=	3	cm
Effective Depth	=	26.4	cm
Load from Slab = (π / 8) x 4.1^2 x 500	=	3300.64	kg
U.D.L	=	90	kg/m
S.F = (3300.64+90x4.1) / 2	=	1834.82	kg
- ve B.M = (5/48) x 3300.64x4.1+90x4.1^2/12	=	1535.72	Kg-m
Net - ve B.M = 1535.72-1834.82x0.2/3	=	1413.4	Kg-m
+ ve B.M = 0.6x (5/48) x 3300.64x4.1+ 0.5 x90x4.1^2/12	=	908.83	Kg-m
Area of steel required for Support = 1413.4x100 / (1900x0.89x26.4)	=	3.44	cm^2
Min Area of Steel = 0.85 bd / fy	=	1.08	cm^2

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	12	mm	16	Mm
Area of Bar	=	1.13	cm2	2.01	cm2
Required no of Bars	=	3.04	no's	0.59	no's
Provide no of Bars	=	2	no's	1	no's
Provided Area of Steel	=	2.26	cm2	2.01	cm2

Provide 2-12tor through + 1-16 tor extra at Supports (4.27sqcm)

Area of steel required for Span = 908.83x100 / (1500x0.87x26.4)	=	2.64	cm^2

At Bottom :

		Straight Bars		Extra Bars	
Dia of Bar	=	12	mm	16	Mm
Area of Bar	=	1.13	cm2	2.01	cm2
Required no of Bars	=	2.34	no's	0.19	no's
Provide no of Bars	=	2	no's	1	no's
Provided Area of Steel	=	2.26	Cm2	2.01	cm2

(4.27sqcm) Provide 2-12tor through + 1-16 TOR extra at bottom

% of Steel Provided = 100 x4.27 / (20x26.4)	=	0.81	
Permissible shear stress in concrete (tc)	=	4.092	kg/cm2
Nominal shear stress (tv) = Vu/bd =1834.82/ (20*26.4)	=	3.475	kg/cm2
Net Shear force =1834.82-(4.092*20*26.4)	=	-325.76	kg
Stirrup Dia	=	8	mm
No of legs	=	2	
Area of Bar	=	1.01	cm2

Spacing required is Min. of following

Max.		300	mm
0.75*d	=	198	mm

Minimum Shear Reinforcement = Asv / bSv >= (0.4/0.87fy)

Sv <= 0.87fyAsv / 0.4b

Sv < =	=	45.58	cm
0.75 d	=	19.8	cm
	=	30	cm
Provided Spacing is Lesser of above two cases	=	19.80	cm
Say	=	18.00	cm

Provide 8 dia tor @180 c/c through out

3.15) DESIGN OF SIDE WALL:-

LWL	=	352.725	m
MWL	=	355.725	m
Free board	=	0.3	
Dead Storage	=	0.15	
Height of Wall	=	3.45	m
Let the thickness of Wall	=	200	mm
Design Depth of Water H	=	3.45	m
Diameter of Wall D	=	8	m
H^2/Dt	=	7.44	
Max Loading at Base	=	3450	kg/m^2
Loading at Top	=	0	kg/m^2
Refer Appendix			
From IS 3370 -PART -IV -1967			
Design for Fixed Condition :			
Max Bending moment Coefficient for Water face	=	-0.0158	
Max Bending moment Coefficient for Outer face	=	0.0042	
Max Bending Moment at Water face	=	646.75	Kg-m
Max Bending Moment at Outer face	=	171.02	Kg-m
Uncracked depth required = $\sqrt{646.75/3}$	=	14.68	cm
Considering Steel Contribution, thickness required	=	13.94	cm
How ever Provided Overall thickness is 20cm O.K			
clear cover	=	30	mm
Effective thickness	=	165	mm
Min. area of steel required (Astmin) = (0.217/100)x20x100	=	4.34	cm^2
Area of Steel Required on Water face			
-ve Ast = (646.75 X100)/(1500x0.87x16.5)	=	3	cm^2
Dia. Of bar (f)	=	10	mm
Area of Bar	=	79	mm^2
Required Spacing	=	26.33	cm
Provided Spacing	=	25	cm
Provided Area	=	316	mm^2

Area of Steel Required on Outer face			
-ve Ast = (171.02 X100)/(1500x0.87x16.5)	=	0.79	cm^2
Dia. Of bar (f)	=	10	mm
Area of Bar	=	79	mm^2
Required Spacing	=	36.41	cm
Provided Spacing	=	25	cm
Provided Area	=	316	mm^2

3.16 DESIGN OF FLOOR SLAB :-

Let the Thickness of Slab is	=	250	mm
Width of Panel	=	4100	mm
Effective Span	=	3.7	
Density of Concrete	=	2500	kg/m^3
Dead Wt of Slab =0.25 x2500	=	625	kg/m^2
Water Load on Slab	=	3450	kg/m^2
Floor Finish	=	50	kg/m^2
Total	=	4125	kg/m^2
- ve B.M = 0.032 x 4125x3.7^2	=	1807.08	Kg-m
+ ve B.M = 0.75 x 1807.08	=	1355.31	Kg-m
σ bt = 1807.08x6 / 25^2	=	17.35	kg/cm^2
Permissible Bending Tension	=	18	kg/cm^2
Provided Thickness is O.K			
Effective thickness	=	21.5	cm
-ve Ast = (1807.08 X100)/(1500x0.87x21.5)	=	6.44	cm^2
+ve Ast = (1355.31 X100)/(1500x0.87x6.44)	=	4.83	cm^2
Minimum Area of Steel	=	5.15	cm^2
Dia. Of bar (f)	=	10	mm
Area of Bar	=	79	mm^2
Required Spacing	=	12.27	cm
Provided Spacing	=	12	cm
Provided Area	=	658.33	mm^2

Provide 10dia tor @ 12 cm c/c bothways at top

Dia. Of bar (f)	=	10	mm
Area of Bar	=	79	mm^2
Required Spacing	=	16.36	cm
Provided Spacing	=	16	cm
Provided Area	=	493.75	mm^2

Provide 10dia tor @ 16 cm c/c bothways at bottom

Provide 10 dia tor @ 160 c/c bothways at bottom & alternate bars bent
Provide 10 dia tor @ 160 c/c bothways at top

Check for Deflection :

L / d	=	26
% of Compression Reinforcement P_c	=	0
Multiplication Factor for Tension Reinforcement	=	1.51
Multiplication Factor for Compression Reinforcement	=	1
Modified L/ d Ratio	=	39.28
Actual L/d Ratio	=	19.07

Hence, SAFE

3.17) DESIGN OF FLOOR BEAM :-

Length of Span	=	4.1	m
Let Width of Beam	=	30	cm
Let Depth of Beam	=	60	cm
Clear Cover	=	3	cm
Effective Depth	=	56.2	cm
Load from Slab = (π / 8) x 4.1^2 x 4125	=	27230.25	kg
U.D.L	=	262.5	kg/m
S.F = (27230.25+262.5x4.1) / 2	=	14153.25	kg
- ve B.M = (5/48) x 27230.25x4.1+262.5x4.1^2/12	=	11997.3	Kg-m
Net - ve B.M = 11997.3-14153.25x0.4/3	=	10110.2	Kg-m
+ ve B.M = 0.6x (5/48) x 27230.25x4.1+ 0.5 x262.5x4.1^2/12	=	7161.61	Kg-m

Check for Non Cracking :

$b_f = (L_o / 6) + b_w + 6D_f$

D_f	=	25	cm
$L_o = 0.7\ L$	=	287	cm
$b_f = (L_o / 6) + b_w + 6D_f$	=	227.83333	cm
Area of flange Portion A1	=	5695.8333	cm^2
Area of Web Beam Portion A2	=	1050	cm^2
Total Area A	=	6745.8333	cm^2
Y	=	17.17	cm
Moment of Inertia I	=	1278794.6	cm^4
Z	=	74478.429	cm^3
Bending Tension σ_{bt}	=	13.57	kg/cm^2
Allowable Bending Tension	=	18	kg/cm^2

Hence Safe

How ever Provided Overall depth is 60cm O.K

Area of steel required for Support = 10110.2x100 / (1500x0.87x56.2)	=	13.79	cm^2
Min Area of Steel = 0.85 bd / fy	=	3.45	cm^2

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	20	Mm
Area of Bar	=	2.01	cm2	3.14	cm2
Required no of Bars	=	6.86	no's	2.47	no's
Provide no of Bars	=	3	no's	3	no's
Provided Area of Steel	=	6.03	cm2	9.42	cm2

Provide 3-16tor through + 3-20 tor extra at Supports (15.45sqcm)

Area of steel required for Span = 7161.61x100 / (1900x0.89x56.2)	=	7.54	cm^2

At Bottom :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	12	Mm
Area of Bar	=	2.01	cm2	1.13	cm2
Required no of Bars	=	3.75	no's	1.34	no's
Provide no of Bars	=	3	no's	2	no's
Provided Area of Steel	=	6.03	cm2	2.26	cm2

Provide 3-16tor through + 2-12 TOR extra at mid span (8.29sqcm)

% of Steel Provided = 100 x15.45 / (30x56.2)	=	0.92	
Permissible shear stress in concrete (tc)	=	3.872	kg/cm2
Nominal shear stress (tv) = Vu/bd =14153.25/ (30*56.2)	=	8.395	kg/cm2
Net Shear force =14153.25-(3.872*30*56.2)	=	7625.06	kg
Stirrup Dia	=	8	mm
No of legs	=	2	
Area of Bar	=	1.01	cm2
Spacing Required = (1.01*1900*56.2)/7625.06	=	14.1	cm

Spacing required is Min. of following

(0.85*fy *n*π /4 * d2 / (tv - tc)B	=	145	mm
Max.		300	mm
0.75*d	=	422	mm

Minimum Shear Reinforcement = Asv / bSv >= (0.4/0.87fy)

Sv <= 0.87fyAsv / 0.4b

Sv < =	=	30.39	cm
0.75 d	=	42.15	cm
	=	30	cm
Provided Spacing is Lesser of above two cases	=	14.14	cm
Say	=	14.00	cm

3.18) DESIGN OF FLOOR RING BEAM :-

Length of Span	=	6.44	m
Let Width of Beam	=	30	cm
Let Depth of Beam	=	30	cm
Clear Cover	=	3	cm
Effective Depth	=	26.4	cm
Results from STAAD Pro			
Max Bending Moment at Support	=	11.26	KN-m
Max Bending Moment at Span	=	11.25	KN-m
Max Shear Force	=	34.8	KN
Max Bending Moment at face of Support	=	4.485	KN-m
Un-cracked depth required = √44850x(30x3.33)	=	21.19	cm
How ever Provided Overall depth is 30cm O.K			
Area of steel required for Support = 11.26x10000 / (1500x0.87x26.4)	=	3.27	cm^2
Min Area of Steel = 0.85 bd / fy	=	1.62	cm^2

At Top :

		Straight Bars	
Dia of Bar	=	12	mm
Area of Bar	=	1.13	cm2
Required no of Bars	=	2.89	no's
Provide no of Bars	=	3	no's
Provided Area of Steel	=	3.39	cm2

Provide 3-12tor through (3.39sqcm)

Area of steel required for Span = 11.25x10000 / (1900x0.89x26.4)	=	2.52	cm2

At Bottom :

		Straight Bars	
Dia of Bar	=	12	mm
Area of Bar	=	1.13	cm2
Required no of Bars	=	2.23	no's
Provide no of Bars	=	3	no's
Provided Area of Steel	=	3.39	cm2

Provide 3-12tor through at bottom (3.39sqcm)

% of Steel Provided = 100 x3.39 / (30x26.4)	=	0.43	
Permissible shear stress in concrete (tc)	=	4.594	kg/cm2
Nominal shear stress (tv) = Vu/bd =3480/ (30*26.4)	=	4.394	kg/cm2
Net Shear force =3480-(4.594*30*26.4)	=	-158.45	kg
Stirrup Dia	=	8	mm
No of legs	=	2	
Area of Bar	=	1.01	cm2
Spacing Required = (1.01**26.4)/-158.45	=	-2.4	cm
Spacing required is Min. of following			
(0.85*fy *n*π /4 * d2 / (tv - tc)B	=	-3275	mm
Max.		300	mm
0.75*d	=	198	mm
Minimum Shear Reinforcement = Asv / bSv >= (0.4/0.87fy)			
Sv <= 0.87fyAsv / 0.4b			
Sv < =	=	30.39	cm
0.75 d	=	19.8	cm
	=	30	cm
Provided Spacing is Lesser of above two cases	=	19.80	cm
Say	=	18.00	cm
Provide 8 dia tor @180 c/c through out			

3.19) Design of one meter wide gallery slab :

Length of Walkway	=	1	m
Depth of Slab Required = L /7	=	142.857	mm
Provided thickness of at Support	=	150	mm
Thickness at free end	=	100	mm
Loading :			
(1) Self Wt of Slab =0.125x2500	=	312.5	kg/m²
(2) Live Load	=	300	kg/m²
(3) Finishes	=	50	kg/m²
Total Load W =	=	662.5	kg/m²
Max B.M = WL^2 /2 =662.5x1^2/2	=	331.25	Kg-m
Clear Cover	=	2.5	cm
Effective Depth	=	12.5	cm
Ast Required =33125 / (2300x0.9x12.5)	=	1.28	cm²

Min Area of Steel	=	0.12	%
Ast = (0.12/100) x15 x 100	=	1.8	cm²

Note : The Floor Slab Top Reinforcement Should Extend up to end of Walk way Slab.

3.20) Design of Column inside Container :

Size of Column	=	200 Φ	
Clear Cover	=	40	mm
Start IL	=	356.025	m
Floor Level	=	352.575	m
Total Height of Column	=	3.45	m
Clear Ht of Column	=	3.45	m
Effective Length of Column	=	4.14	m
L/d	=	20.7	>12
It will Designed as Long Column			
Reduction factor = 1.25 – (20.7 /48)	=	0.82	
Axial load (Unfactored)	=	7632	kgs
Max B.M (Unfactored)	=	0	Kg-m
Max B.M (Unfactored)	=	0	Kg-m
Design Load = 7632/0.82	=	9307.32	kg
Say	=	10000	kg
Load carrying capacity =60(a-0.01a) +1900 x 0.01a			
10000 = 60a -0.6a+19a			
a	=	127.55	cm2
Provided C/S Area	=	314.16	cm2
Min % of Steel Required	=	0.8	%
Min Area of Steel Required	=	2.51	cm2
Provide dia of bar	=	12	mm
Area of Bar	=	1.13	cm2
Required no of Bars	=	2.22	no's
Provided no of Bars	=	6	no's
Provide 6 no's 12 tor	=	6.78	cm2

Provide 8 tor @ 150 c/c links

Check in Working Stress Method :

Axial load (Unfactored)	=	7632	kgs
Max B.M (Unfactored)	=	0	kgm
Max B.M (Unfactored)	=	0	kgm
A = Asc +(1.5m-1)At			
(20^2 x ∏/4)+ (1.5*10.98-1)*6.78	=	419.05	cm2
I = (∏d4 / 64) + (1.5m-1) x At x (d/2 - x)2			
d/2	=	10	cm
X	=	4.6	cm
I = (∏ x 20^4 /64) + (1.5*10.98-1)*3.39*(10-4.6)^2	=	9383.23	cm4
Z = I / (d/2)	=	938.32	cm3
σcc Cal = P/ A	=	18.21	kg/cm2
σcbc Cal = My/ Z	=	0	kg/cm2
σcbc Cal = Mz / Z	=	0	kg/cm2
(σcc Cal / σcc) + (σcbcy Cal / σcbc) + (σcbcz Cal / σcbc)	=	0.36	<1
Hence Safe			
Load Carrying Capacity =60x((∏/4 * 20 ^2)-6.78)+1900x6.78	=	31324.76	kgs

Weight of Container :

Roof Slab = π /4 x 8.2^2x500	=	26405.09	kgs
Roof Beam = 4x 0.2x0.18x4.1x2500	=	1476	kgs
Wall = 2πx4.1x3.45x0.2x2500	=	44437.83	kgs
Floor Slab = π /4 x 8.2^2x675	=	35646.87	kgs
Floor Beam = 4x 0.3x0.35x4.1x2500	=	4305	kgs
Floor Ring Beam = 2πx4.1x0.3x0.3x2500	=	5796.24	kgs
Gallery = π /4 x(10.4^2 - 8.4^2) x 662.5	=	19564.27	kgs
Roof Slab Exclusing Live Load Portion = π /4 x 8.2^2x400	=	21124.07	kgs
Gallery Excluding Live load portion =π /4 x (10.4^2 - 8.4^2) x 362.5	=	10704.98	kgs
Weight of Internal Column = π /4 x 0.2^2x3.45x2500	=	270.96	kgs
Water = π /4 x 8^2x3.45x1000	=	173415.91	kgs
Water in free board portion = π /4 x 8^2x0.3x1000	=	15079.64	kgs

Total Wt of container in full condition Excluding Freeboard Portion	=	296238.53	kgs
Total Wt of container Including Freeboard Portion	=	311318.17	kgs
Wt of empty container	=	123761.95	kgs
Wt of Container in full condition excluding Free board & Live load	=	282098.22	kgs

Height of C.G of empty container from top of floor slab will be

(21124.07x3.51+1476x3.6 + 44437.83x1.725 + 270.96x1.725-35646.87x0.125-5796.24x0.15-10704.98x0.075) / 123761.95

C.G of Empty Container	=	1.22	m

Height of C.G of container full from top of floor slab will be

(26405.09x3.51+1476x3.6 + 44437.83x1.725 + 270.96x1.725 + 173415.91x1.725-35646.87x0.125-5796.24x0.15-19564.27x0.075) / 311318.17

C.G of container full	=	1.5	m

3.21) Design of Staging :

No of Columns	=	5	
Column Size	=	400 Φ	
Brace Levels	=	3	
Size of Braces	=	250x	350
Floor Ring Beam	=	300x	300
Depth of foundation below G.L	=	3	m
Height of Wall Portion h3 = (3+0.3+0.15)	=	3.45	m
Height of IV Column Panel	=	3.45	m
Depth of III Brace	=	0.35	m
Height of III Column Panel	=	3.6	m
Depth of II Brace	=	0.35	m
Height of II Column Panel	=	3.6	m
Depth of I Brace	=	0.35	m
Height of I Column Panel	=	2.5	m
Height of Column from top of footing to bottom of Floor beam	=	14.2	M

3.22) WIND ANALYSIS :

Design Wind pressure Pz = 0.60*Vz 2

Basic wind pressure Vb	=	39	m/s
Probability factor k1	=	1.06	
for Category 2, class 'A'& height bet 20m - 50m k2	=	1.056	
Topograhy factor k3	=	1	
Design Wind Speed Vz = Vb*k1*k2*k3			
Vz = 39*1.06*1.056*1	=	43.66	m/s
Pz = 0.60*Vz 2	=	1143.72	N/m2
	=	114.372	Kg/m2
Say Wind Pressure	=	150	Kg/m2

From Appendix D , from Table 23, Circular plan shape, direction of wind pressure to diagonal

Cf	=	0.7	
Cross sectional area of Column ao	=	0.1257	m2
Column is in Circular in Shape, Shape factor	=	0.7	
Wind Load on Column = 150x0.7x0.4	=	42	kg/m
Wind Load on Brace Beams = 150x0.35	=	52.5	kg/m
Wind Load on Container = 150x0.7	=	105	kg/m

These Wind Loads Applied in Staad pro

3.23) EARTHQUAKE ANALYSIS

Seismic Zone = III

Type of Frame : S.M.R.F

DEAD & LIVE LOADS :

A) Container :

Load from Base (Floor) beam	=	296238.53	kg
Container full	=	296238.53	kg
Weight of Water =158.34*1000	=	158340	kg
Container Empty	=	137898.53	kg

B) Staging : (Above top of footing)

Columns =5*14.2* п/4x0.4^2 *2500	=	22305.31	kg
Inner Braces =4*3*4.1*0.25*0.35*2500	=	10762.5	kg

Outer Braces =4*3*5.798*0.25*0.35*2500	=	15219.75	kg
Weight of staging	=	48287.56	kg

Lumped weights :

A) Tank empty

We =137898.53 + (48287.56/3)	=	153994.38	kg

B) Tank full

Wf =296238.53 + (48287.56/3)	=	312334.3833	kg

Stiffness of Staging (carried out in staad pro 2007): Refer (Appendix -)

Delta	=	3.34	mm
load applied	=	1000	Kg
K = Load applied / Delta	=	299401.2	kg/m

Fundamental period:

T = 2*Π √W/(g*K)

A) Tank Empty

W	=	153994.38	kg
G	=	9.81	
K	=	299401.2	
T = 2*Π √153994.38/(9.81*299401.2)	=	1.439	sec

B) Tank full

W	=	312334.38	kg
G	=	9.81	
K	=	299401.2	
T = 2*Π √312334.38/(9.81*299401.2)	=	2.049	sec

Average acceleration coefficient :

Assuming a damping of 5 percent of critical for the above periods the average acceleration coefficient from fig 2 of I.S. code 1893-2002 for Soft soils

A) Tank empty :

If 0.67 < = T <= 4 , then Sa/g = 1.67 /T	=	1.161

B) Tank full :

Sa/g = 1.67 /T	=	0.815

Horizontal Seismic coefficient:

Ah = Z*I*Sa/(2*R*g)

From IS 1893 (Part-1):2002 , Table 2

Z = 0.16

From IS 1893 (Part-1):2002 , Table 6

I = 1.5

From IITK -GSDMA Guidelines , Table 2

R = 5

These Parameters assigned in STAAD Modeling, and the Lumped mass for Tank Full Condition and Tank Empty Condition is applied at C.G of Tank

The Analysis was done by Different Loading Combinations as Per IS 1893 - 2002.

The Different Loading Conditions for Tank Full condition are

DL+LL+WATERLOAD,1.5(DL+LL+WATERLOAD),1.5(DL+WATERLOAD+EQ+X),
1.5(DL+WATERLOAD+EQ-X), 1.5(DL+WATERLOAD+EQ+Z),
1.5(DL+WATERLOAD+EQ-Z), 1.5(DL+WATERLOAD+WL+X),
1.5(DL+WATERLOAD+WL-X),1.5(DL+WATERLOAD+WL+Z),
1.5(DL+WATERLOAD+WL-z), 1.2(DL+WATERLOAD+LL+EQ+X),
1.2(DL+WATERLOAD+LL+EQ-X),1.2(DL+WATERLOAD+LL+EQ+Z),
1.2(DL+WATERLOAD+LL+EQ-Z),1.2(DL+WATERLOAD+LL+WL+X),
1.2(DL+WATERLOAD+LL+WL-X), 1.2(DL+WATERLOAD+LL+WL+Z)
,1.2(DL+WATERLOAD+LL+WL-Z)

The Different Loading Conditions for Tank Empty condition are

DL+LL,1.5(DL+LL),1.5(DL+EQ+X),1.5(DL+EQ-X),1.5(DL+EQ+Z),
1.5(DL+EQ-Z),1.5(DL+WL+X),1.5(DL+WL-X), 1.5(DL+WL+Z),
1.5(DL+WL-z),1.2(DL+LL+EQ+X),1.2(DL+LL+EQ-X),1.2(DL+LL+EQ+Z),1.2(DL+LL+EQ-Z),
1.2(DL+LL+WL+X),1.2(DL+LL+WL-X),1.2(DL+LL+WL+Z),1.2(DL+LL+WL-Z)

The Column & Brace Beams are Designed for Critical Loading Condition

3.24) Design of External Brace Beams :

Length of Span	=	5.798	m
Let Width of Beam	=	250	mm
Let Depth of Beam	=	350	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	314	mm
d' / d	=	0.0955	

Critical Loading Condition : Refer Appendix

Grade of Concrete	=	M 20	
Grade of Steel	=	Fe415	
F_{ck}	=	20	N/mm^2
F_y	=	415	N/mm^2
Moment at end Support	=	29.85	KN-m
Moment in Span	=	13.60	KN-m
Shear Force	=	16.69	KN
Torsion	=	0.45	KN-m
Equivalent Moment due to Torsion at support (KN-m)	=	35.63	KN-m
Equivalent Moment due to Torsion at Mid Span (KN-m)	=	19.38	KN-m
Equivalent Shear due to Torsion at support (KN)	=	16.73	KN-m
From Table D, $M_{u\ lim} / bd^2$	=	2.76	
M_{ulim}	=	84.53	KN-m

Actual moment is less than limiting moment,therefore, the section to be designed as Singly reinforced beam

For Referring to tables, we need the value of M_u / bd^2

At Supports M_u / bd^2

35.63x1000000 / 250x314^2	=	1.4	
From SP -16, Table : 2 , P_t	=	0.441	
Ast =(0.441/100) x250x314	=	346.2	mm^2

At Span M_u / bd^2

19.38x1000000 / 250x314^2	=	0.8	
From SP -16, Table : 3 , P_t	=	0.229	
Ast =(0.229/100) x250x314	=	179.8	mm^2
At Supports P_c (from SP:16) (%)	=	0.0	%
At Span P_c (from SP:16) (%)	=	0.0	%
Asc required (mm^2) at top	=	0.0	mm^2

Asc required (mm^2) at bottom	=	0.0	mm^2
Minimum Area of Steel = 0.85 x b x d / fy	=	160.78	mm^2

At Bottom :

		Straight Bars	
Dia of Bar	=	12	mm
Area of Bar	=	113.1	mm^2
Required no of Bars	=	1.59	no's
Provide no of Bars	=	2	no's
Provided Area of Steel	=	226.2	mm^2

Provide 2-12tor through (226.2sqmm)

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	12	mm	16	mm
Area of Bar	=	113.1	mm^2	201.06	mm^2
Required no of Bars	=	3.06	no's	0.60	no's
Provide no of Bars	=	2	no's	1	no's
Provided Area of Steel	=	226.2	mm^2	201.06	mm^2

Provide 2-12tor through+1-16tor extra at top (427.26sqmm)

Nominal shear stress (tv) = Vu/bd =16.73x100/(25*31.4)	=	15.287	kg/cm^2
% of Steel Provided Tension reinforcement (in supp)= 100 x427.26/(250x314)	=	0.54	
Design Shear Strength of concrete (tc) (From Table 19 of IS 456- 2000)	=	4.933	kg/cm^2
Maximum Shear stress ζ_{cmax}	=	2.800	kg/cm^2
Minimum Shear Reinforcement Required			
Net Shear force =16.73x100-(4.933*25*31.4)	=	-2199.41	kg
Stirrup Dia	=	8	mm
Stirrup legs	=	2	
Area of Bar	=	100.53	mm^2

$V_{us} = 0.87 \times f_y x A_{sv} \times d / S_v$

Spacing Required = (0.87x415*100.53*314)/-21994.1 = -518.19 mm

Spacing Required is Min. of following

Max Spacing of Shear reinforcement		300	mm
0.75*d	=	236	mm

Minimum Shear Reinforcement = Asv / bSv >= $(0.4/0.87f_y)$

Sv <= 0.87fyAsv / 0.4b

Sv < =	=	362.96	mm
Provided Spacing is Lesser of above four cases	=	235.50	mm

As per IS 13920, Spacing of Hoops for a distance of 2d from face of support shall be Min of below two conditions

Dia of Hoop Bar	=	8	mm
No of Legs	=	2	
2d	=	628	mm
Say	=	650	mm
a.) d/4	=	7.85	cm
b.) 8 times of Dia of Longitudinal Bar = 8 x d_b	=	9.6	cm
Provided Spacing is Lesser of above two cases	=	7.85	cm
Say	=	7.5	cm

As per IS 13920, Spacing of Hoops is for center portion should not Exceed (d/2)

d/2	=	15.7	cm
Say	=	15	cm

<u>Stirrups :</u>

Provide Support to 650 mm , 8 dia tor 2L stirrups @ 7.5 cm c/c

650 to center , 8 dia tor 2L stirrups @ 15 cm c/c

<u>3.25 Design of Internal Brace Beams :</u>

Length of Span	=	4.1	mt
Let Width of Beam	=	250	mm
Let Depth of Beam	=	350	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	314	mm
d' / d	=	0.0955	

<u>Critical Loading Condition : Refer Appendix</u>

Grade of Concrete	=	M 20	
Grade of Steel	=	Fe415	
F_{ck}	=	20	N/mm^2
F_y	=	415	N/mm^2
Moment at end Support	=	39.66	KN-m
Moment in Span	=	32.02	KN-m
Shear Force	=	24.21	KN
Torsion	=	1.04	KN-m
Equivalent Moment due to Torsion at support (KN-m)	=	52.97	KN-m
Equivalent Moment due to Torsion at Mid Span (KN-m)	=	45.33	KN-m
Equivalent Shear due to Torsion at support (KN)	=	24.29	KN-m
From Table D, $M_{u\,lim} / bd^2$	=	2.76	
M_{ulim}	=	84.53	KN-m

Actual moment is less than limiting moment ,therefore, the section to be designed as Singly reinforced beam

For Referring to tables, we need the value of M_u / bd^2

At Supports M_u / bd^2			
52.97x1000000 / 250x314^2	=	2.1	
From SP -16, Table : 2 , P_t	=	0.696	
Ast =(0.696/100) x250x314	=	546.4	mm^2
At Span M_u / bd^2			
45.33x1000000 / 250x314^2	=	1.8	
From SP -16, Table : 3 , P_t	=	0.579	
Ast =(0.579/100) x250x314	=	454.5	mm^2
At Supports P_c (from SP:16) (%)	=	0.0	%
At Span P_c (from SP:16) (%)	=	0.0	%
Asc required (mm^2) at top	=	0.0	mm^2
Asc required (mm^2) at bottom	=	0.0	mm^2
Minimum Area of Steel = 0.85 x b x d / fy	=	160.78	mm^2

At Bottom :

		Straight Bars		Extra Bars	
Dia of Bar	=	12	mm	16	mm
Area of Bar	=	113.1	mm^2	201.06	mm^2
Required no of Bars	=	4.02	no's	1.14	no's
Provide no of Bars	=	2	no's	2	no's
Provided Area of Steel	=	226.2	mm^2	402.12	mm^2

Provide 2-12tor through+2-16tor extra at bottom (628.32sqmm)

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	12	mm	16	mm
Area of Bar	=	113.1	mm^2	201.06	mm^2
Required no of Bars	=	4.83	no's	1.59	no's
Provide no of Bars	=	2	no's	2	no's
Provided Area of Steel	=	226.2	mm^2	402.12	mm^2

Provide 2-12tor through+2-16tor extra at top (628.32sqmm)

Nominal shear stress (tv) = Vu/bd =24.29x100/(25*31.4)	=	15.287	kg/cm^2
% of Steel Provided Tension reinforcement (in supp)= 100 x628.32/(250x314)	=	0.80	
Design Shear Strength of concrete (tc) (From Table 19 of IS 456- 2000)	=	5.737	kg/cm^2
Maximum Shear stress ζ_{cmax}	=	2.800	kg/cm^2
Minimum Shear Reinforcement Required			
Net Shear force =24.29x100-(5.737*25*31.4)	=	-2074.55	kg
Stirrup Dia	=	8	mm
Stirrup legs	=	2	
Area of Bar	=	100.53	mm^2

$V_{us} = 0.87 \times f_y x A_{sv} \times d / S_v$

Spacing Required = (0.87x415*100.53*314)/-20745.5 = -549.37 mm

Spacing Required is Min. of following

Max Spacing of Shear reinforcement		300	mm
0.75*d	=	236	mm

Minimum Shear Reinforcement = Asv / bSv >= $(0.4/0.87f_y)$

Sv <= 0.87fyAsv / 0.4b

Sv <=	=	362.96	mm
Provided Spacing is Lesser of above four cases	=	235.50	mm

As per IS 13920, Spacing of Hoops for a distance of 2d from face of support shall be Min of below two conditions

Dia of Hoop Bar	=	8	mm
No of Legs	=	2	
2d	=	628	mm
Say	=	650	mm
a.) d/4	=	7.85	cm
b.) 8 times of Dia of Longitudinal Bar = 8 x d_b	=	9.6	cm
Provided Spacing is Lesser of above two cases	=	7.85	cm
Say	=	7.5	cm

As per IS 13920, Spacing of Hoops is for center portion should not Exceed (d/2)

d/2	=	15.7	cm
Say	=	15	cm

Stirrups :

Provide Support to 650 mm , 8 dia tor 2L stirrups @ 7.5 cm c/c

650 to center , 8 dia tor 2L stirrups @ 15 cm c/c

3.26) Design of Columns:

Size of Column	=	400 Φ	
GL	=	340.73	m
Start IL	=	353.48	m
Depth of foundation below G.L	=	3.00	m
Total Height of Column	=	15.00	m
Clear Ht of Column	=	3.60	m
Effective Length of Column	=	4.32	m
L/d	=	10.80	<12

It will Designed as Short Column

Critical Loading Condition : Refer Appendix

Column Depth (D_c)	=	0.4	m
Characteristic of concrete (f_{ck})	=	20	N/mm^2
Characteristic strength of steel (f_y)	=	415	N/mm^2
Partial safety factor for loads (□$_f$)	=	1.5	
Clear cover for column (d')	=	0.04	m
Factor Load (Pu) from STAAD results	=	898.573	kN
Moment from analysis along Z- direction(M_{uz})	=	56.636	kN-m
Moment from analysis along Y- direction(M_{uy})	=	0.001	kN-m
Moment due to minimum eccentricity along Z-direction(M_{uz})			
e_{min} = L / 500 +D/30	=	0.021	
M_{uz} = Pu *ez	=	18.9	kN-m
Moment due to minimum eccentricity along Y-direction(M_{uy})			
e_{min} = L / 500 +D/30	=	0.021	
M_{uy} = Pu *ey	=	18.87	kN-m
Final Moment in Z-direction	=	56.636	kN-m
Final Moment in Y-direction	=	18.87	kN-m
Assume reinforcement percentage, p	=	1.5	
p/ f_{ck}	=	0.075	
Uniaxial moment capacity about zz- axis :	=		
d'/D	=	0.1	
$P_u / f_{ck} * D^2$	=	0.281	
$M_u / f_{ck} * D^3$ (from chart 56 of SP-16)	=	0.07	
Uniaxial moment capacity about zz- axis (M_{uz1})	=	89.6	KN-m
Uniaxial moment capacity about YY - axis :	=		
d' / D	=	0.1	
$M_u / f_{ck} * D^3$ (from chart 56 of SP-16)	=	0.07	
Uniaxial moment capacity about yy - axis (M_{uy1})	=	89.6	KN-m
<u>Calculation of P_{uz} :</u>	=		
P_{uz} / A_g (from chart 63 of SP-16)	=	13.5	N / mm^2
Capacity of section of under pure axial load (P_{uz})	=	1696.46	KN
P_u / P_{uz}	=	0.53	
a_n (from SP-16)	=	1.55	
M_{uz} / M_{uz1}	=	0.632	
M_{uy} / M_{uy1}	=	0.211	

$(M_{uy}/M_{uy1})^{\Box n} + (M_{uz}/M_{uz1})^{\Box n}$	=	0.581	< 1
Area of Steel Required (A_{streq})	=	1884.96	mm^2
$A_{st\ req} = p * B_c * D_c$			
Provide	20	8	nos
Hence, provide 8 no.s of 20 mm dia Fe-415 bars			
Area of Steel (A_{st})	=	2513	mm^2

Design of ties :

Minimum diameter of lateral ties = 1/4 Dia Of Long. Bars	=	5	mm
Diameter Of Ties Provided	=	8	mm
C/C Spacing Of Ties Shall Be Least Of The Following :			
Least Lateral Dimension Of Column	=	400	
16 x Diameter Of Long. Bars = 16 x 20	=	320	mm
48 x Diameter Of Ties = 48 x 8	=	384	mm
C/C Spacing Of Ties Required	=	320	mm
Provide spacing of ties	=	320	mm
8tor ties @ 200 mm c/c		200	mm

Check in Working Stress Method :

Axial load (Unfactored)	=	59905	kgs
Max B.M (Unfactored)	=	0	Kg-m
Max B.M (Unfactored)	=	3776	Kg-m
A = Asc +(1.5m-1)At			
(40^2 x ∏/4)+ (1.5*13.33-1)*25.13	=	1733.98	cm2
I = (∏d4 / 64) + (1.5m-1) x At x (d/2 - x)2			
d/2	=	20	cm
X	=	5	cm
I = (∏ x 40^4 /64) + (1.5*13.33-1)*12.565*(20-5)^2	=	179364.95	cm4
Z = I / (d/2)	=	8968.25	cm3
σcc Cal = P/ A	=	34.55	kg/cm2
Σcbc Cal = My/ Z	=	0	kg/cm2
Σcbc Cal = Mz / Z	=	42.1	kg/cm2
(σcc Cal / σcc) + (σcbcy Cal / σcbc) + (σcbcz Cal / σcbc)	=	1.29	>1

If Consider Earthquake loads / Wind Loads , we have to increase Permissible Stresses By 33% ,then

(σcc Cal / 1.33xσcc) + (σcbcy Cal / 1.33xσcbc) + (σcbcz Cal / 1.33xσcbc) = 0.97 <1

Hence Safe

Load Carrying Capacity =50x((∏/4 * 40 ^2)-18.8496)+1900x25.13 = 109322.35 kgs

Confining Links :

Column of Section		400 Φ	
Grade of Concrete fck	=	20	N/mm2
Grade of Steel fy	=	415	N/mm2
Spacing of Circular Hoops :			
Spacing should be lesser of the following :			
1.) 1/4 of Minimum Member Dimension	=	100	mm
2.) 100	=	100	mm
Spacing of Hoops S	=	100	mm
Clear Cover	=	40	mm
Dia of Circular Hoops	=	10	mm
Core Diameter measured to the outside of hoop Dk =400- 2x40+ 2x10	=	340	mm
Area of Concrete Core Ak =(π/4)*340^2	=	90792.03	mm2
Gross area of Column C/S Ag =(π/4)*400^2	=	125663.71	mm2
Area of C/S of bar forming circular hoop is Ash = 0.09 SDkfck/fy ((Ag/Ak)-1)			
Ash = 0.09*100*340*(20/415)*((125663.71/90792.03)-1)	=	56.64	mm2
Provided C/S of bar forming circular hoop	=	78.54	mm2

Provided Circular Hoop bar of dia10mm is O.K

Thus Circular Hoops of Dia 10mm at a spacing of 100mm c/c will be adequate

Provided C/S of bar forming Tie	=	78.54	mm2
h/6	=	600.000	mm
Say	=	600	mm

Provided hoop bar of dia 10mm is O.K

Thus Ties of Dia 10mm at a spacing of 100mm c/c will be adequate for a height of (h/6) i.e. 600mm

3.27) DESIGN OF RAFT FOUNDATION:

Load coming on to the Foundation		=	432311	kgs
Let Self weight of foundation (15%)		=	64846.65	kgs
Total load coming from Foundation		=	497157.65	kgs
	Say	=	500000	kgs
Depth of foundation below G.L		=	3	m
Safe Bearing Capacity of Soil		=	6500	Kg/m^2
Area of Raft Required		=	76.92	m^2
Side of Raft Required		=	8.77	m
Side of Raft to be provided		=	8.8	m
Area of Raft Provided		=	77.44	m^2
Upward Pressure		=	6456.61	kg/m^2
Net upward Pressure		=	5582.53	kg/m^2

3.28) Check for Uplift :

Depth of foundation below ground level = 3 m

Uplift Pressure on Foundation of Structure should be considered as per available water table at site in rainy season. How ever, minimum uplift up to 50% of depth of foundation below ground level for safety purpose may be considered.

Depth of Water table Below G.L = 7 m

So, Depth of Water table is far below Foundation Level

For Uplift, 50% of depth of foundation below ground level should be considered

Unit Wt of Water	=	1000	kg/m^3
Uplift Pressure = 1.5*1000	=	1500	kg/m^2
Upward Load = 8.8^2 x 1500	=	116160	kgs
Self Wt of Raft	=	38720	kgs
Self Wt of Raft Beam	=	12896.4	kgs
Weight of P.C.C	=	18585.6	kgs
Total Dead Wt of Structure Including staging	=	186186.09	kgs
Total Upward Load	=	116160	kgs
Total Downward Load	=	256388.09	kgs

Factor of Safety = Total Downward load / Total Upward load = 2.21 >1.25

Safe against Uplift

3.29) Design of Raft Slab :-

Let the Thickness of Slab is		=	200	mm
Grade of Concrete		=	25	kg/cm²
Grade of Steel		=	415	kg/cm²
Triangular Slab				
Size	b	=	4.1	m
	h	=	5.798	m
Diameter of Inscribed Circle d = 2bh /(b+√(b²+4h²)		=	2.899	m
-Ve B.M = Wd² / 30		=	1563.89	Kg-m
Thickness required = √ 1563.89/11.09		=	11.88	cm
Provided Uniform thickness		=	20	cm
clear cover		=	5	cm
Effective thickness		=	15	cm
Min. area of steel required (Astmin) = (0.12/100)x20x100		=	240	mm^2
Max. dia. Of bar (f $_{max}$ = D / 8)		=	25	mm
Min. area of steel required on each direction (Astmin)		=	120	mm^2
Max. allowble spacing (S_{max}) ar per IS 456		=	45	mm
Area of Steel Required = 1563.89x100 / 2300x0.9x15		=	5.04	cm^2
Dia. Of bar (f)		=	10	mm
Area of Bar		=	79	mm^2
Required Spacing		=	15.67	cm
Provided Spacing		=	15	cm
Provided Area		=	526.67	mm^2

Provide 10 tor @ 150 c/c bothways at top & bottom as Square mesh

Design of Raft Slab :-

Let the Thickness of Slab is	=	200	mm
Grade of Concrete	=	25	kg/cm²
Grade of Steel	=	415	kg/cm²

Span	=	1.501	m
Clear Span	=	1.351	m
Shear Force	=	3771	kg
Bending Moment	=	849.1	Kg-m
Thickness required = √ 849.1/11.09	=	8.75	cm
Provided Uniform thickness	=	20	cm
clear cover	=	5	cm
Effective thickness	=	15	cm
Area of Steel Required = 849.1x100 / 2300x0.9x15	=	2.73	cm^2
Dia. Of bar (f)	=	10	mm
Area of Bar	=	79	mm^2
Required Spacing	=	28.94	cm
Provided Spacing	=	15	cm
Provided Area	=	526.67	mm^2

Provide 10 tor @ 150 c/c bothways at top & bottom as Square mesh

Note : At Corners Provide 5 no's 10 tor at top & bottom

3.30) DESIGN OF RAFT BEAM FB1 :-

Length of Span	=	4.1	m
Let Width of Beam	=	300	mm
Let Depth of Beam	=	400	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	350	mm
Triangular Load = 5582.53x4.1^2/6	=	15640.39	kgs
Shear Force	=	7820.195	kgs
-Ve B.M = (5/48)WL - SF (X/3)			
-Ve B.M = (5/48)WL - SF (X/3)	=	5637.06	Kgm
Area of Steel Required = 5637.06x100 / 2300x0.9x35	=	7.78	cm^2
+Ve B.M =0.6x (5/48)WL	=	4007.8499	Kgm
Area of Steel Required = 4007.8499375x100 / 2300x0.9x35	=	5.53	cm^2

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	16	Mm
Area of Bar	=	201.06	mm^2	201.06	mm^2
Required no of Bars	=	2.75	no's	0.75	no's
Provide no of Bars	=	2	no's	1	no's
Provided Area of Steel	=	402.12	mm2	201.06	mm2

Provide 2-16tor through+1-16tor extra at Mid span (603.18sqmm)

At Bottom :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	16	mm
Area of Bar	=	201.06	mm2	201.06	mm2
Required no of Bars	=	3.87	no's	1.87	no's
Provide no of Bars	=	2	no's	2	no's
Provided Area of Steel	=	402.12	mm2	402.12	mm2

Provide 2-16tor through+2-16tor extra over supports at bottom (804.24sqmm)

Nominal shear stress (tv) = Vu/bd =7820.195/ (30*35)	=	7.448	kg/cm^2
% of Steel Provided Tension reinforcement (in supp)= 100 x603.18/(300x350)	=	0.57	
Design Shear Strength of concrete (tc) (From Table 23 of IS 456- 2000)	=	3.24	kg/cm^2
Maximum Shear stress ζ_{cmax}	=	2.500	kg/cm^2
Minimum Shear Reinforcement Required			
Net Shear force =7820.195-(3.24*30*35)	=	4418.20	kg
Stirrup Dia	=	8	mm
Stirrup legs	=	2	
Area of Bar	=	100.53	mm^2

$V_{us} = 0.87 \times f_y x A_{sv} \times d / S_v$

Spacing Required = (0.87x415*100.53*350)/44182	=	287.53	mm

Spacing Required is Min. of following

Max Spacing of Shear reinforcement		300	mm
0.75*d	=	637	mm

Minimum Shear Reinforcement = Asv / bSv >= (0.4/0.87f_y)
Sv <= 0.87fyAsv / 0.4b

Sv <=	=	302.47	mm
Provided Spacing is Lesser of above four cases	=	300.00	mm
Say	=	180.00	mm

As per IS 13920, Spacing of Hoops for a distance of 2d from face of support shall be Min of below two conditions

Dia of Hoop Bar	=	8	mm
No of Legs	=	2	
2d	=	700	mm
Say	=	700	mm
a.) d/4	=	8.75	cm
b.) 8 times of Dia of Longitudinal Bar = 8 x d_b	=	12.8	cm
Provided Spacing is Lesser of above two cases	=	8.75	cm
Say	=	8.5	cm

As per IS 13920, Spacing of Hoops is for center portion should not Exceed (d/2)

d/2	=	17.5	cm
Say	=	17	cm

Stirrups :
Provide Support to 700 mm , 8 dia TOR 2L stirrups @ 85 mm c/c
700 to center , 8 dia TOR 2L stirrups @ 170 mm c/c

DESIGN OF RAFT BEAM FB2 :-

Length of Span	=	5.798	mt
Let Width of Beam	=	300	mm
Let Depth of Beam	=	800	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	770	mm
Triangular Load = 5582.53x5.798^2/12	=	15638.9	kgs
UDL = 5582.53X1.501	=	8379.38	Kg/m
Shear Force = 15638.9+8379.38x5.798/2	=	32111.27	kgs

-Ve B.M = (5/48)WL + $WL^2/12$ - SF (X/3)

-Ve B.M = (5/48)WL + $WL^2/12$ - SF (X/3)	=	28637.74	Kgm		
Area of Steel Required = 28637.74x100 / 2300x0.9x77	=	17.97	cm^2		
+Ve B.M =0.6x (5/48)WL + 0.5 x $WL^2/12$	=	17404.15	Kgm		
Area of Steel Required = 17404.15x100 / 2300x0.9x77	=	10.92	cm^2		

At Top :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	20	mm
Area of Bar	=	201.06	mm^2	314.16	mm^2
Required no of Bars	=	5.43	no's	1.56	no's
Provide no of Bars	=	3	no's	2	no's
Provided Area of Steel	=	603.18	mm^2	628.32	mm^2

Provide 3-16tor through+2-20tor extra at Mid span (1231.5sqmm)

At Bottom :

		Straight Bars		Extra Bars	
Dia of Bar	=	16	mm	20	mm
Area of Bar	=	201.06	mm^2	314.16	mm^2
Required no of Bars	=	8.94	no's	3.80	no's
Provide no of Bars	=	3	no's	4	no's
Provided Area of Steel	=	603.18	mm^2	1256.64	mm^2

Provide 3-16tor through+4-20tor extra over supports at bottom (1859.82sqmm)

Nominal shear stress (tv) = Vu/bd =32111.27/(30*77)	=	13.901	kg/cm^2
% of Steel Provided Tension reinforcement (in supp)= 100 x1859.82/(300x770)	=	0.81	
Design Shear Strength of concrete (tc) (From Table 23 of IS 456- 2000)	=	3.696	kg/cm^2
Maximum Shear stress ζ_{cmax}	=	1.900	kg/cm^2
Minimum Shear Reinforcement Required			
Net Shear force =32111.27-(3.696*30*77)	=	23573.51	kg
Stirrup Dia	=	8	mm
Stirrup legs	=	2	

Area of Bar	=	100.53	mm^2

$V_{us} = 0.87 \times f_y x A_{sv} \times d / S_v$

Spacing Required = (0.87x415*100.53*770)/235735.1	=	118.56	mm

Spacing Required is Min. of following

Max Spacing of Shear reinforcement		300	mm
0.75*d	=	578	mm

Minimum Shear Reinforcement = Asv / bSv >= $(0.4/0.87f_y)$

Sv <= 0.87fyAsv / 0.4b

Sv <=	=	302.47	mm
Provided Spacing is Lesser of above four cases	=	118.56	mm
Say	=	115.00	mm

As per IS 13920, Spacing of Hoops for a distance of 2d from face of support shall be Min of below two conditions

Dia of Hoop Bar	=	8	mm
No of Legs	=	2	
2d	=	1540	mm
Say	=	1550	mm
a.) d/4	=	19.25	cm
b.) 8 times of Dia of Longitudinal Bar = 8 x d_b	=	12.8	cm
Provided Spacing is Lesser of above two cases	=	12.8	cm
Say	=	10	cm

As per IS 13920, Spacing of Hoops is for center portion should not Exceed (d/2)

d/2	=	38.5	cm
Say	=	20	cm

Stirrups :

Provide Support to 1550 mm , 8 dia tor 2L stirrups @ 100 mm c/c

1550 to center , 8 dia tor 2L stirrups @ 200 mm c/c

DESIGN OF RAFT BEAM FB5 :-

Length of Span	=	1.351	mt
Let Width of Beam	=	300	mm
Let Depth of Beam	=	800	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	770	mm

Triangular Load = 5582.53x1.351^2/4	=	2547.31	kg/m
Shear Force	=	2547.31	kgs
-Ve B.M = 2547.31x1.351/2	=	1720.71	kgm
Area of Steel Required = 1720.71x100 / 2300x0.9x77	=	1.08	cm^2

Note : Extend Reinforcement of FB4 up to end

DESIGN OF RAFT BEAM FB4 :-

Length of Span	=	5.798	mt
Let Width of Beam	=	300	mm
Let Depth of Beam	=	800	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	762	mm
From Slab S2 = 5582.53x1.351/2	=	3771	kg/m
Shear Force = 3771x5.798/2	=	10932.129	kgs
-Ve B.M at Ends	=	1720.71	Kg-m
+Ve B.M at center =3771x5.798^2/8 - 1720.71	=	14125.41	Kg-m
Area of Steel Required = 14125.41x100 / 2300x0.9x76.2	=	8.96	cm^2
Area of Steel Required = 1720.71x100 / 2300x0.9x76.2	=	1.09	cm^2
Min Area of Steel = 0.85 bd / fy	=	4.68	cm^2

At Top :

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		Straight Bars		Extra Bars	
Dia of Bar	=	16	Mm	16	mm
Area of Bar	=	201.06	Mm2	201.06	mm2
Required no of Bars	=	4.46	no's	1.46	no's
Provide no of Bars	=	3	no's	2	no's
Provided Area of Steel	=	603.18	Mm2	402.12	mm2

Provide 3-16tor through+2-16tor extra at Mid span (1005.3sqmm)

At Bottom :

		Straight Bars	
Dia of Bar	=	16	mm
Area of Bar	=	201.06	mm^2
Required no of Bars	=	2.33	no's
Provide no of Bars	=	3	no's

Provided Area of Steel	=	603.18	mm^2
Provide 3-16tor through(603.18sqmm)			
Nominal shear stress (tv) = Vu/bd =10932.129/ (30*76.2)	=	4.782	kg/cm^2
% of Steel Provided Tension reinforcement (in supp)= 100 x1005.3/(300x762)	=	0.44	
Design Shear Strength of concrete (tc) (From Table 23 of IS 456- 2000)	=	2.908	kg/cm^2
Maximum Shear stress ζ_{cmax}	=	4.000	kg/cm^2
Minimum Shear Reinforcement Required			
Net Shear force =10932.129-(2.908*30*76.2)	=	4284.44	kg
Stirrup Dia	=	8	mm
Stirrup legs	=	2	
Area of Bar	=	100.53	mm^2
$V_{us} = 0.87 \times f_y x A_{sv} \times d / S_v$			
Spacing Required = (0.87x415*100.53*762)/42844.4	=	645.54	mm
Spacing Required is Min. of following			
Max Spacing of Shear reinforcement		300	mm
0.75*d	=	572	mm
Minimum Shear Reinforcement = Asv / bSv >= (0.4/0.87f_y)			
Sv <= 0.87fyAsv / 0.4b			
Sv < =	=	302.47	mm
Provided Spacing is Lesser of above four cases	=	300.00	mm
Say	=	180.00	mm
As per IS 13920, Spacing of Hoops for a distance of 2d from face of support shall be Min of below two conditions			
Dia of Hoop Bar	=	8	mm
No of Legs	=	2	
2d	=	1524	mm
Say	=	1550	mm
a.) d/4	=	19.05	cm
b.) 8 times of Dia of Longitudinal Bar = 8 x d_b	=	12.8	cm
Provided Spacing is Lesser of above two cases	=	12.8	cm
Say	=	12	cm
As per IS 13920, Spacing of Hoops is for center portion should not Exceed (d/2)			
d/2	=	38.1	cm

Say	=	20	cm

Stirrups :

Provide Support to 1550 mm , 8 dia tor 2L stirrups @ 120 mm c/c

1550 to center , 8 dia tor 2L stirrups @ 200 mm c/c

DESIGN OF RAFT BEAM FB3 :-

Length of Span	=	1.351	mt
Let Width of Beam	=	300	mm
Let Depth of Beam	=	800	mm
Clear Cover to Main Reinforcement d'	=	30	mm
Effective Depth d	=	770	mm
From FB4 & FB5 = 10932.129+2547.31	=	13479.439	Kg
Triangular load From FS3	=	2547.31	Kg
Shear Force = 13479.439+2547.31	=	16026.749	kgs
Max B.M = 13479.439x1.351+2547.31x1.351/2	=	19931.43	kgm
Area of Steel Required = 19931.43x100 / 2300x0.9x77	=	12.5	cm^2

Note : Extend Reinforcement of FB2 up to end

(3.31) Appendix

From STADD Pro, The Results are as follows:

For Stiffness Calculation :

Node	L/C	X-Trans mm
531	1	4.282
2	1	4.256
3	1	4.256
4	1	4.256
5	1	4.256
6	1	4.26
7	1	4.26
8	1	4.26

9	1	4.26
10	1	4.26
11	1	4.26
12	1	4.26
13	1	4.26
14	1	4.26
15	1	4.26
16	1	4.26
17	1	4.26
18	1	4.26
19	1	4.26
20	1	4.26
21	1	4.26
22	1	4.26
23	1	4.26
24	1	4.26
25	1	4.26
26	1	4.26
27	1	4.26
28	1	4.26
29	1	4.26
30	1	4.26
31	1	4.26
32	1	4.26
33	1	4.26
34	1	4.26
35	1	4.26
36	1	4.26
253	1	4.26
254	1	4.26
255	1	4.26
256	1	4.26
257	1	4.26
258	1	4.26
259	1	4.26

260	1	4.26
261	1	4.26
262	1	4.256
263	1	4.256
264	1	4.256
265	1	4.256
266	1	4.256
267	1	4.256
268	1	4.256
269	1	4.256
270	1	4.256
271	1	4.256
272	1	4.256
273	1	4.26
274	1	4.26
275	1	4.26
276	1	4.26
277	1	4.26
1	1	4.26

<u>For Floor Ring Design :</u>

	Beam	L/C	Node	Fy kN	Mx kNm	Mz kNm
Max Fy	222	4 DL+WATERLOAD+LL	10	34.804	-3.42	11.261
Min Fy	230	4 DL+WATERLOAD+LL	19	-34.805	3.415	11.261
Max Mx	221	4 DL+WATERLOAD+LL	9	-28.144	3.416	-11.228
Min Mx	222	4 DL+WATERLOAD+LL	10	34.804	-3.42	11.261
Max Mz	230	4 DL+WATERLOAD+LL	19	-34.805	3.415	11.261
Min Mz	230	4 DL+WATERLOAD+LL	18	-28.194	3.415	-11.251

For Outer Braces Design :

	Beam	L/C	Node	Fy kN	Mx kNm	Mz kNm
Max Fy	943	21 1.5(DL+WL+WL-Z)	517	16.687	0.452	28.003
Min Fy	944	18 1.5(DL+WL+WL+X)	518	-16.687	0.452	28.003
Max Mx	945	19 1.5(DL+WL+WL-X)	518	2.34	0.452	-11.74
Min Mx	943	20 1.5(DL+WL+WL+Z)	517	2.34	-0.452	-11.74
Max Mz	944	20 1.5(DL+WL+WL+Z)	518	-16.686	0.452	29.851
Min Mz	943	21 1.5(DL+WL+WL-Z)	516	-2.339	0.452	-13.595

For Inner Braces Design :

	Beam	L/C	Node	Fy kN	Mx kNm	Mz kNm
Max Fy	949	18 1.5(DL+WL+WL+X)	518	24.21	0	39.662
Min Fy	950	19 1.5(DL+WL+WL-X)	516	-24.21	0	39.662
Max Mx	950	21 1.5(DL+WL+WL-Z)	520	6.268	1.044	2.592
Min Mx	947	18 1.5(DL+WL+WL+X)	520	6.268	-1.044	2.592
Max Mz	949	18 1.5(DL+WL+WL+X)	518	24.21	0	39.662
Min Mz	950	19 1.5(DL+WL+WL-X)	520	-10.757	0	-32.02

Columns Design :

	Beam	L/C	Node	Fx kN	My kNm	Mz kNm
Max Fx	977	5 1.5(DL+WATERLOAD+LL)	530	1296.933	0	0
Min Fx	915	26 1.2(DL+WL+LL+WL+X)	1	712.707	0	-4.039
Max My	918	20 1.5(DL+WL+WL+Z)	28	898.573	56.642	0
Min My	916	21 1.5(DL+WL+WL-Z)	10	898.573	-56.638	0.002
Max Mz	917	18 1.5(DL+WL+WL+X)	19	898.573	-0.001	56.636
Min Mz	915	19 1.5(DL+WL+WL-X)	1	898.573	0	-56.642

Column inside Container Design :

	Beam	L/C	Node	Fx kN	My kNm	Mz kNm
Max Fx	959	4 DL+WATERLOAD+LL	253	76.318	0	0
Min Fx	959	4 DL+WATERLOAD+LL	446	73.608	0	0
Max My	959	4 DL+WATERLOAD+LL	253	76.318	0	0
Min My	959	4 DL+WATERLOAD+LL	446	73.608	0	0
Max Mz	959	4 DL+WATERLOAD+LL	253	76.318	0	0
Min Mz	959	4 DL+WATERLOAD+LL	446	73.608	0	0

DIAGRAMS:

FOOTING

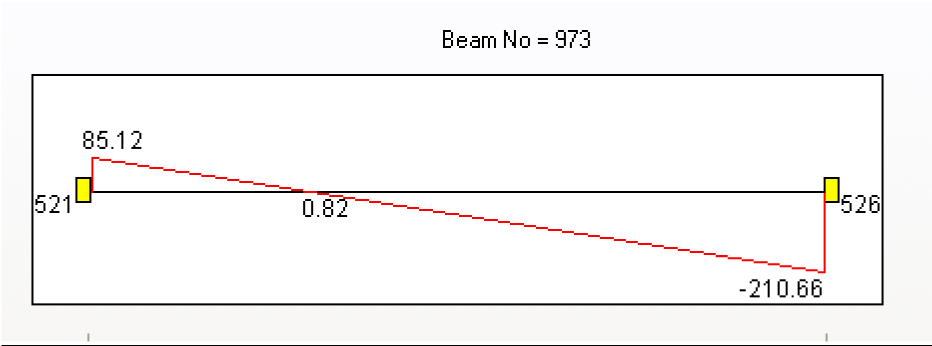

Fig no4.1:Shear bending

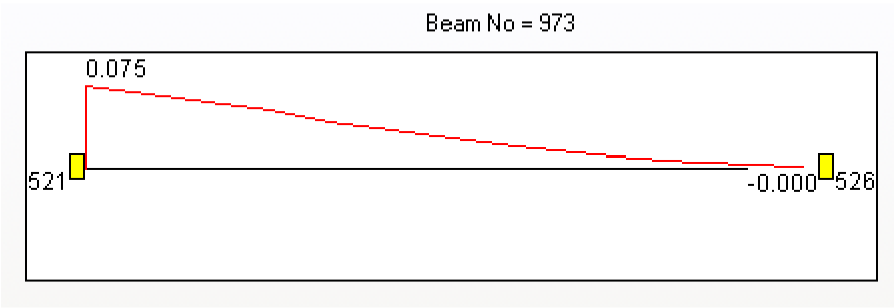

Fig no4.2:deflection

Column

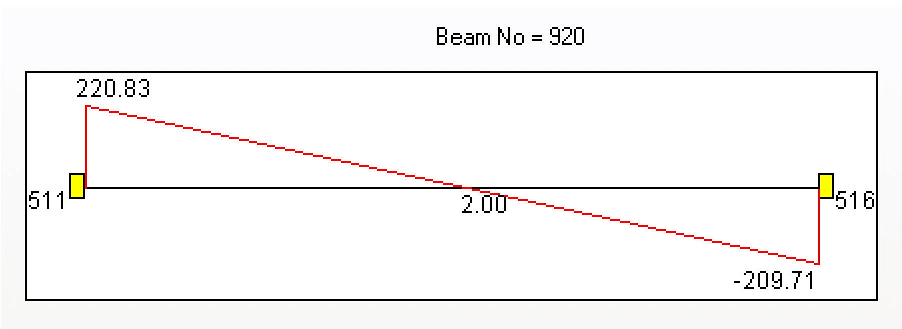

Fig no4.3:Shear bending

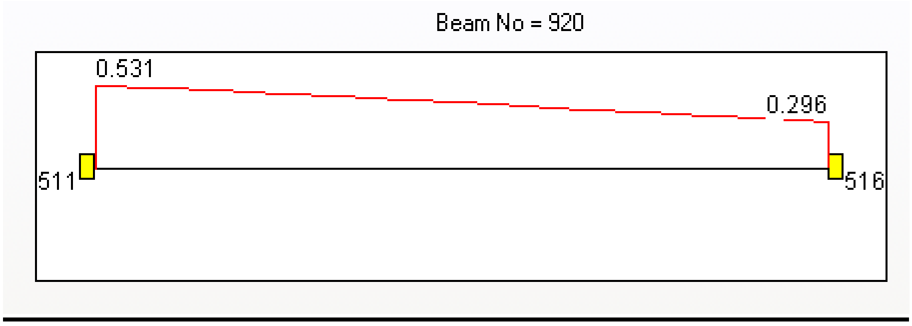

Fig no4.4:deflection

Brace beam

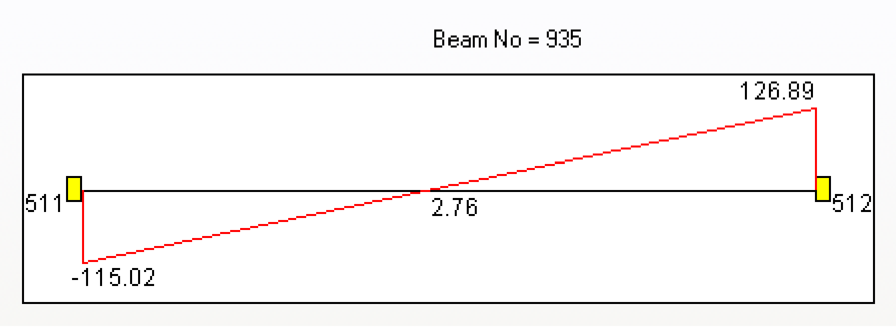

Fig no4.5:Shear bending

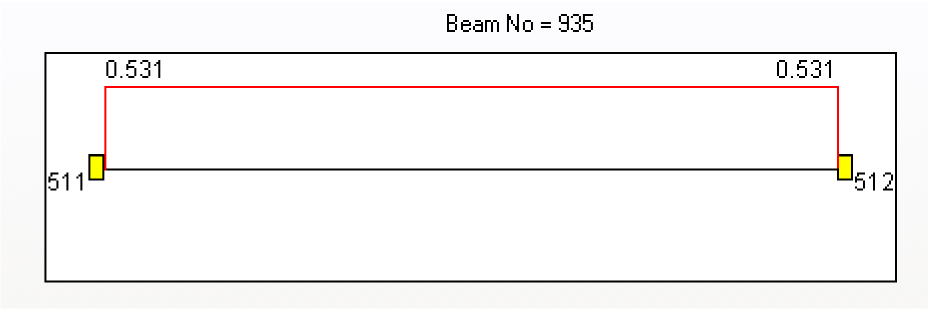

Fig no4.6:deflection

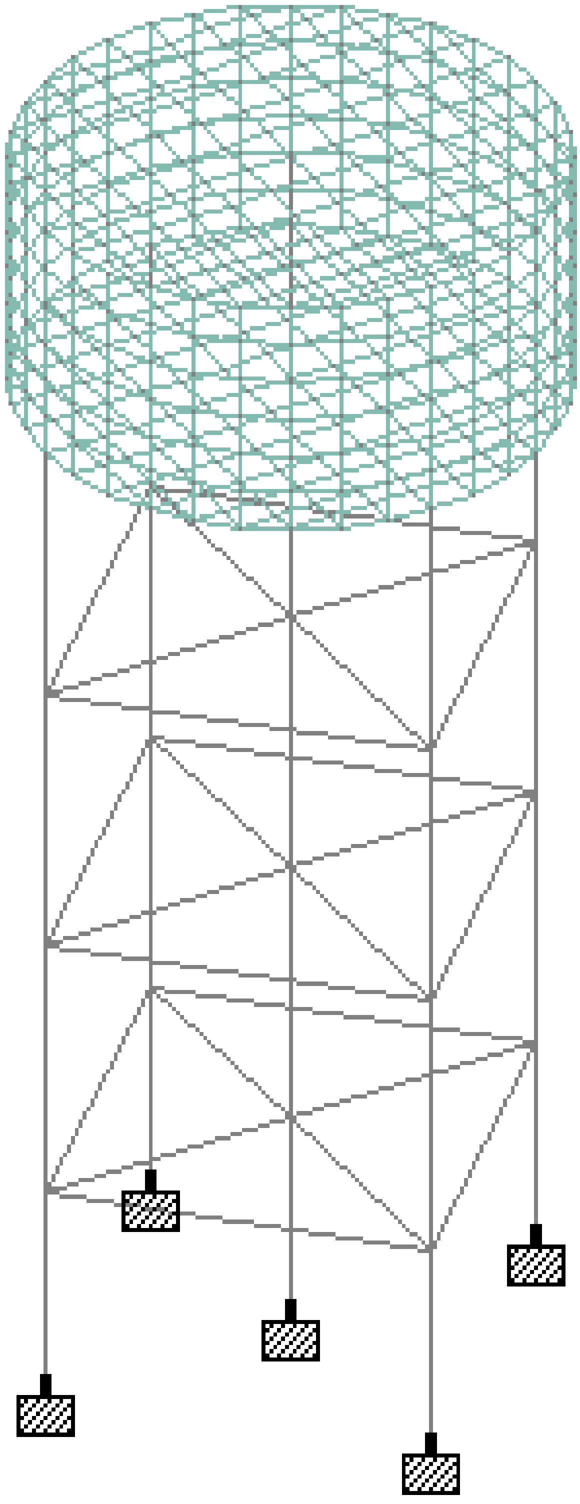

Fig no4.7: our service reservoir

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. 7
LOADTYPE SEISMIC TITLE EQ-X

CENTER OF FORCE BASED ON X FORCES ONLY (METE).
(FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

X = 0.313209544E-16
Y = 0.272499992E+01
Z = 0.215331561E-15

***TOTAL APPLIED LOAD (KN METE) SUMMARY (LOADING 7)

SUMMATION FORCE-X = -51.26
SUMMATION FORCE-Y = 0.00
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 0.00 MY= 0.00 MZ= 139.69

TOTAL REACTION LOAD(KN METE) SUMMARY (LOADING 7)

SUMMATION FORCE-X = 51.26
SUMMATION FORCE-Y = 0.00
SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-
MX= 0.00 MY= 0.00 MZ= -139.69

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 7)

	MAXIMUMS	AT NODE
X =	-1.76057E+00	226
Y =	2.95134E-02	235
Z =	-3.18099E-04	4
RX=	2.58050E-05	340
RY=	-1.17629E-05	56
RZ=	1.26520E-03	517

EXTERNAL AND INTERNAL JOINT LOAD SUMMARY (KN METE)-

JT EXT FX/ EXT FY/ EXT FZ/ EXT MX/ EXT MY/ EXT MZ/
INT FX INT FY INT FZ INT MX INT MY INT MZ

SUPPORT=1
526 0.00 0.00 0.00 0.00 0.00 0.00
-11.73 -87.13 0.00 0.00 0.00 23.80 111111

527 0.00 0.00 0.00 0.00 0.00 0.00
-7.73 0.00 0.00 0.00 0.00 20.06 111111

528 0.00 0.00 0.00 0.00 0.00 0.00
-11.73 87.13 0.00 0.00 0.00 23.80 111111

529 0.00 0.00 0.00 0.00 0.00 0.00
-7.73 0.00 0.00 0.00 0.00 20.06 111111

530 0.00 0.00 0.00 0.00 0.00 0.00
-12.36 0.00 0.00 0.00 0.00 24.39 111111

FOR LOADING - 8
APPLIED JOINT EQUIVALENT LOADS
JOINT FORCE-X FORCE-Y FORCE-Z MOM-X MOM-Y MOM-Z
109 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
110 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
111 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
112 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
113 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
114 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
115 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00
116 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00 0.00000E+00 0.00000E+00

117 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
118 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
119 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
120 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
121 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
122 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
123 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
124 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
125 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
126 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
127 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
128 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
129 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
130 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
131 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
132 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
133 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
134 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
135 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
136 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
137 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00

138 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
139 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
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140 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
141 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
142 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00
143 0.00000E+00 0.00000E+00 1.42398E+00 0.00000E+00
0.00000E+00 0.00000E+00

JOINT DISPLACEMENT (CM RADIANS) STRUCTURE TYPE = SPACE

	3	0.0000	-0.0144	0.0000	0.0000	0.0000	0.0000
	10	1.5316	-0.0217	0.0000	0.0000	0.0000	-0.0001
	11	-1.5317	0.0218	0.0000	0.0000	0.0000	0.0001
	12	0.0000	0.0000	-1.5319	-0.0001	0.0000	0.0000
	13	0.0000	0.0000	1.5319	0.0001	0.0000	0.0000
	4	0.0022	-0.3473	0.0000	0.0000	0.0000	0.0007
	5	0.0032	-0.5210	0.0000	0.0000	0.0000	0.0010
	14	2.6047	-0.5434	0.0000	0.0000	0.0000	0.0008
	15	-2.5982	-0.4553	0.0000	0.0000	0.0000	0.0013
	16	0.0033	-0.4993	2.6022	0.0002	0.0000	0.0010
	17	0.0033	-0.4993	-2.6022	-0.0002	0.0000	0.0010
	18	2.3007	-0.5319	0.0000	0.0000	0.0000	0.0008
	19	-2.2942	-0.4667	0.0000	0.0000	0.0000	0.0012
	20	0.0032	-0.4993	-2.2979	-0.0002	0.0000	0.0010
	21	0.0032	-0.4993	2.2979	0.0002	0.0000	0.0010
	22	2.0837	-0.4520	0.0000	0.0000	0.0000	0.0006
	23	-2.0785	-0.3816	0.0000	0.0000	0.0000	0.0010
	24	0.0026	-0.4168	2.0818	0.0002	0.0000	0.0008
	25	0.0026	-0.4168	-2.0818	-0.0002	0.0000	0.0008
	26	1.8405	-0.4429	0.0000	0.0000	0.0000	0.0007
	27	-1.8354	-0.3907	0.0000	0.0000	0.0000	0.0010
	28	0.0026	-0.4168	-1.8383	-0.0001	0.0000	0.0008
	29	0.0026	-0.4168	1.8383	0.0001	0.0000	0.0008
20	6	1.7345	-0.0289	0.0002	0.0000	0.0000	-0.0001
	7	-1.7345	0.0289	-0.0002	0.0000	0.0000	0.0001
	8	0.0000	0.0055	1.7350	0.0001	0.0000	0.0000

9	0.0000	-0.0055	-1.7350	-0.0001	0.0000	0.0000
1	0.0002	-0.1650	0.0004	0.0000	0.0000	0.0001
2	0.0022	-0.1805	0.0002	0.0000	0.0000	0.0004
3	0.0000	-0.0150	0.0001	0.0000	0.0000	0.0000
10	1.5318	-0.0214	0.0001	0.0000	0.0000	-0.0001
11	-1.5318	0.0214	-0.0001	0.0000	0.0000	0.0001
12	0.0000	-0.0040	-1.5321	-0.0001	0.0000	0.0000
13	0.0000	0.0041	1.5321	0.0001	0.0000	0.0000
4	0.0024	-0.3606	0.0007	0.0000	0.0000	0.0004
5	0.0036	-0.5408	0.0010	0.0000	0.0000	0.0007
14	2.6054	-0.5617	0.0012	0.0000	0.0000	0.0005
15	-2.5982	-0.4749	0.0006	0.0000	0.0000	0.0008
16	0.0036	-0.5100	2.6034	0.0001	0.0000	0.0007
17	0.0035	-0.5266	-2.6016	-0.0001	0.0000	0.0007
18	2.3012	-0.5504	0.0011	0.0000	0.0000	0.0006
19	-2.2941	-0.4861	0.0007	0.0000	0.0000	0.0008
20	0.0036	-0.5243	-2.2972	-0.0001	0.0000	0.0007
21	0.0036	-0.5121	2.2990	0.0001	0.0000	0.0007
22	2.0843	-0.4674	0.0010	0.0000	0.0000	0.0004
23	-2.0786	-0.3979	0.0006	0.0000	0.0000	0.0007
24	0.0029	-0.4260	2.0828	0.0001	0.0000	0.0005
25	0.0028	-0.4393	-2.0812	-0.0001	0.0000	0.0005

JOINT DISPLACEMENT (CM RADIANS) STRUCTURE TYPE = SPACE

JOINT LOAD X-TRANS Y-TRANS Z-TRANS X-ROTAN Y-ROTAN Z-ROTAN

	24	0.0006	-0.4812	2.1114	-0.0005	0.0000	0.0002
	25	0.0006	-0.4195	-2.1136	-0.0006	0.0000	0.0002
	26	1.8616	-0.4595	-0.0011	-0.0006	0.0000	0.0001
	27	-1.8604	-0.4410	-0.0012	-0.0006	0.0000	0.0002
	28	0.0005	-0.4275	-1.8622	-0.0006	0.0000	0.0002
	29	0.0007	-0.4730	1.8598	-0.0005	0.0000	0.0002
511	6	1.3488	0.0257	0.0000	0.0000	0.0000	-0.0009
	7	-1.3488	-0.0257	0.0000	0.0000	0.0000	0.0009
	8	0.0000	0.0000	1.3493	0.0012	0.0000	0.0000
	9	0.0000	0.0000	-1.3493	-0.0012	0.0000	0.0000
	1	0.0000	-0.1233	0.0000	0.0000	0.0000	-0.0001
	2	-0.0005	-0.1287	0.0000	0.0000	0.0000	0.0001

	3	0.0000	-0.0107	0.0000	0.0000	0.0000	0.0000
	10	1.2650	0.0195	0.0000	0.0000	0.0000	-0.0007
	11	-1.2644	-0.0195	0.0000	0.0000	0.0000	0.0007
	12	-0.0001	0.0000	-1.2654	-0.0009	0.0000	0.0000
	13	-0.0001	0.0000	1.2654	0.0009	0.0000	0.0000
	4	-0.0006	-0.2627	0.0000	0.0000	0.0000	0.0000
	5	-0.0008	-0.3940	0.0000	0.0000	0.0000	-0.0001
	14	2.0223	-0.3394	0.0000	0.0000	0.0000	-0.0014
	15	-2.0240	-0.4166	0.0000	0.0000	0.0000	0.0013
	16	-0.0008	-0.3780	2.0239	0.0018	0.0000	-0.0001
	17	-0.0008	-0.3780	-2.0239	-0.0018	0.0000	-0.0001
	18	1.8967	-0.3487	0.0000	0.0000	0.0000	-0.0011
	19	-1.8975	-0.4073	0.0000	0.0000	0.0000	0.0009
	20	-0.0010	-0.3780	-1.8982	-0.0013	0.0000	-0.0001
	21	-0.0010	-0.3780	1.8982	0.0013	0.0000	-0.0001
	22	1.6179	-0.2843	0.0000	0.0000	0.0000	-0.0011
	23	-1.6192	-0.3461	0.0000	0.0000	0.0000	0.0010
	24	-0.0007	-0.3152	1.6192	0.0014	0.0000	-0.0001
	25	-0.0007	-0.3152	-1.6192	-0.0014	0.0000	-0.0001
	26	1.5174	-0.2918	0.0000	0.0000	0.0000	-0.0009
	27	-1.5180	-0.3386	0.0000	0.0000	0.0000	0.0008
	28	-0.0008	-0.3152	-1.5185	-0.0011	0.0000	-0.0001
	29	-0.0008	-0.3152	1.5185	0.0011	0.0000	-0.0001
512	6	1.3493	0.0000	0.0000	0.0000	0.0000	-0.0012
	7	-1.3493	0.0000	0.0000	0.0000	0.0000	0.0012
	8	0.0000	-0.0257	1.3488	0.0009	0.0000	0.0000
	9	0.0000	0.0257	-1.3488	-0.0009	0.0000	0.0000
	1	0.0000	-0.1233	0.0000	-0.0001	0.0000	0.0000
	2	0.0000	-0.1287	0.0005	0.0001	0.0000	0.0000
	3	0.0000	-0.0107	0.0000	0.0000	0.0000	0.0000
	10	1.2654	0.0000	0.0001	0.0000	0.0000	-0.0009
	11	-1.2654	0.0000	0.0001	0.0000	0.0000	0.0009
	12	0.0000	0.0195	-1.2650	-0.0007	0.0000	0.0000
	13	0.0000	-0.0195	1.2644	0.0007	0.0000	0.0000
	4	0.0000	-0.2627	0.0006	0.0000	0.0000	0.0000
	5	0.0000	-0.3940	0.0008	-0.0001	0.0000	0.0000

STAAD SPACE -- PAGE NO. 982

JOINT DISPLACEMENT (CM RADIANS) STRUCTURE TYPE = SPACE

JOINT LOAD X-TRANS Y-TRANS Z-TRANS X-ROTAN Y-ROTAN Z-ROTAN

	14	2.0239	-0.3780	0.0008	-0.0001	0.0000	-0.0018
	15	-2.0239	-0.3780	0.0008	-0.0001	0.0000	0.0018
	16	0.0000	-0.4166	2.0240	0.0013	0.0000	0.0000
	17	0.0000	-0.3394	-2.0223	-0.0014	0.0000	0.0000
	18	1.8982	-0.3780	0.0010	-0.0001	0.0000	-0.0013
	19	-1.8982	-0.3780	0.0010	-0.0001	0.0000	0.0013
	20	0.0000	-0.3487	-1.8967	-0.0011	0.0000	0.0000
	21	0.0000	-0.4073	1.8975	0.0009	0.0000	0.0000
	22	1.6192	-0.3152	0.0007	-0.0001	0.0000	-0.0014
	23	-1.6192	-0.3152	0.0007	-0.0001	0.0000	0.0014
	24	0.0000	-0.3461	1.6192	0.0010	0.0000	0.0000
	25	0.0000	-0.2843	-1.6179	-0.0011	0.0000	0.0000
	26	1.5185	-0.3152	0.0008	-0.0001	0.0000	-0.0011
	27	-1.5185	-0.3152	0.0008	-0.0001	0.0000	0.0011
	28	0.0000	-0.2918	-1.5174	-0.0009	0.0000	0.0000
	29	0.0000	-0.3386	1.5180	0.0008	0.0000	0.0000
513	6	1.3488	-0.0257	0.0000	0.0000	0.0000	-0.0009
	7	-1.3488	0.0257	0.0000	0.0000	0.0000	0.0009
	8	0.0000	0.0000	1.3493	0.0012	0.0000	0.0000
	9	0.0000	0.0000	-1.3493	-0.0012	0.0000	0.0000
	1	0.0000	-0.1233	0.0000	0.0000	0.0000	0.0001
	2	0.0005	-0.1287	0.0000	0.0000	0.0000	-0.0001
	3	0.0000	-0.0107	0.0000	0.0000	0.0000	0.0000
	10	1.2644	-0.0195	0.0000	0.0000	0.0000	-0.0007
	11	-1.2650	0.0195	0.0000	0.0000	0.0000	0.0007
	12	0.0001	0.0000	-1.2654	-0.0009	0.0000	0.0000
	13	0.0001	0.0000	1.2654	0.0009	0.0000	0.0000
	4	0.0006	-0.2627	0.0000	0.0000	0.0000	0.0000
	5	0.0008	-0.3940	0.0000	0.0000	0.0000	0.0001
	14	2.0240	-0.4166	0.0000	0.0000	0.0000	-0.0013
	15	-2.0223	-0.3394	0.0000	0.0000	0.0000	0.0014
	16	0.0008	-0.3780	2.0239	0.0018	0.0000	0.0001
	17	0.0008	-0.3780	-2.0239	-0.0018	0.0000	0.0001
	18	1.8975	-0.4073	0.0000	0.0000	0.0000	-0.0009
	19	-1.8967	-0.3487	0.0000	0.0000	0.0000	0.0011
	20	0.0010	-0.3780	-1.8982	-0.0013	0.0000	0.0001
	21	0.0010	-0.3780	1.8982	0.0013	0.0000	0.0001

	22	1.6192	-0.3461	0.0000	0.0000	0.0000	-0.0010
	23	-1.6179	-0.2843	0.0000	0.0000	0.0000	0.0011
	24	0.0007	-0.3152	1.6192	0.0014	0.0000	0.0001
	25	0.0007	-0.3152	-1.6192	-0.0014	0.0000	0.0001
	26	1.5180	-0.3386	0.0000	0.0000	0.0000	-0.0008
	27	-1.5174	-0.2918	0.0000	0.0000	0.0000	0.0009
	28	0.0008	-0.3152	-1.5185	-0.0011	0.0000	0.0001
	29	0.0008	-0.3152	1.5185	0.0011	0.0000	0.0001
514	6	1.3493	0.0000	0.0000	0.0000	0.0000	-0.0012
	7	-1.3493	0.0000	0.0000	0.0000	0.0000	0.0012
	8	0.0000	0.0257	1.3488	0.0009	0.0000	0.0000

LOAD COMBINATIONS

ELEMENT LOAD
694 TO 843 845 TO 850 PR -1
MEMBER LOAD
221 TO 256 UNI GY -3
LOAD 10 LOADTYPE Wind TITLE WL+X
ELEMENT LOAD
1 TO 9 28 TO 45 64 TO 81 100 TO 117 136 TO 153 172 TO 189 208 TO 216 PR -1.05
MEMBER LOAD
915 916 918 920 921 923 960 961 963 973 974 976 UNI GX 0.42
935 939 943 948 965 970 UNI GX 0.45
LOAD 11 LOADTYPE Wind TITLE WL-X
ELEMENT LOAD
10 TO 27 46 TO 63 82 TO 99 118 TO 135 154 TO 171 190 TO 207 PR -1.05
MEMBER LOAD
916 TO 918 921 TO 923 961 TO 963 974 TO 976 UNI GX -0.42
936 940 944 945 966 967 UNI GX -0.45
LOAD 12 LOADTYPE Wind TITLE WL+Z
ELEMENT LOAD
1 TO 18 37 TO 54 73 TO 90 109 TO 126 145 TO 162 181 TO 198 PR -1.05
MEMBER LOAD
915 TO 917 920 TO 922 960 TO 962 973 TO 975 UNI GZ -0.42
935 936 943 944 965 966 UNI GZ -0.45
LOAD 13 LOADTYPE Wind TITLE WL-Z
ELEMENT LOAD

```
19 TO 36 55 TO 72 91 TO 108 127 TO 144 163 TO 180 199 TO 216
PR -1.05
MEMBER LOAD
915 917 918 920 922 923 960 962 963 973 975 976 UNI GZ 0.42
939 940 945 948 967 970 UNI GZ 0.45
LOAD COMB 4 DL+WATERLOAD+LL
1 1.0 2 1.0 3 1.0
LOAD COMB 5 1.5(DL+WATERLOAD+LL)
1 1.5 2 1.5 3 1.5
LOAD COMB 14 1.5(DL+WL+EQ+X)
1 1.5 2 1.5 6 1.5
LOAD COMB 15 1.5(DL+WL+EQ-X)
7 1.5 1 1.5 2 1.5
LOAD COMB 16 1.5(DL+WL+EQ+Z)
8 1.5 1 1.5 2 1.5
LOAD COMB 17 1.5(DL+WL+EQ-Z)
9 1.5 1 1.5 2 1.5
LOAD COMB 18 1.5(DL+WL+WL+X)
1 1.5 2 1.5 10 1.5
LOAD COMB 19 1.5(DL+WL+WL-X)
1 1.5 2 1.5 11 1.5
LOAD COMB 20 1.5(DL+WL+WL+Z)
1 1.5 2 1.5 12 1.5
LOAD COMB 21 1.5(DL+WL+WL-Z)
1 1.5 2 1.5 13 1.5
LOAD COMB 22 1.2(DL+WL+LL+EQ+X)
6 1.2 1 1.2 2 1.2 3 1.2
LOAD COMB 23 1.2(DL+WL+LL+EQ-X)
7 1.2 1 1.2 2 1.2 3 1.2
LOAD COMB 24 1.2(DL+WL+LL+EQ+Z)
8 1.2 1 1.2 2 1.2 3 1.2
LOAD COMB 25 1.2(DL+WL+LL+EQ-Z)
9 1.2 1 1.2 2 1.2 3 1.2
LOAD COMB 26 1.2(DL+WL+LL+WL+X)
1 1.2 2 1.2 3 1.2 10 1.2
LOAD COMB 27 1.2(DL+WL+LL+WL-X)
1 1.2 2 1.2 3 1.2 11 1.2
LOAD COMB 28 1.2(DL+WL+LL+WL+Z)
1 1.2 2 1.2 3 1.2 12 1.2
LOAD COMB 29 1.2(DL+WL+LL+WL-Z)
1 1.2 2 1.2 3 1.2 13 1.2
```

NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS = 530/ 665/ 5

SOLVER USED IS THE IN-CORE ADVANCED SOLVER

TOTAL PRIMARY LOAD CASES = 11, TOTAL DEGREES OF FREEDOM = 3150

LOADING 6 LOADTYPE SEISMIC TITLE EQ+

LOADING 7 LOADTYPE SEISMIC TITLE EQ-X

LOADING 8 LOADTYPE SEISMIC TITLE EQ+Z

LOADING 9 LOADTYPE SEISMIC TITLE EQ-Z

LOADING 1 LOADTYPE DEAD TITLE DL

SELFWEIGHT Y -1.000

ACTUAL WEIGHT OF THE STRUCTURE = 1574.849 KN

ELEMENT LOAD (UNITS ARE KN METE)

ELEMENT	PRESSURE
694	-1.000000
695	-1.000000
696	-1.000000
697	-1.000000
698	-1.000000
699	-1.000000
700	-1.000000

701	-1.000000
702	-1.000000
703	-1.000000
704	-1.000000
705	-1.000000
706	-1.000000
707	-1.000000
708	-1.000000
709	-1.000000
710	-1.000000
711	-1.000000
712	-1.000000
713	-1.000000
714	-1.000000
715	-1.000000
716	-1.000000
717	-1.000000
718	-1.000000

FOR LOADING - 1
APPLIED JOINT EQUIVALENT LOADS
JOINT FORCE-X FORCE-Y FORCE-Z MOM-X MOM-Y MOM-Z
1 0.00000E+00-1.39020E+01 0.00000E+00 0.00000E+00 0.00000E+00-1.59521E-01
2 0.00000E+00-6.61048E+00 0.00000E+00-8.05500E-03 0.00000E+00-4.56646E-02
3 0.00000E+00-6.12123E+00 0.00000E+00-1.58549E-02 0.00000E+00-4.35777E-02
4 0.00000E+00-6.43222E+00 0.00000E+00-2.31877E-02 0.00000E+00-4.01551E-02
5 0.00000E+00-6.55058E+00 0.00000E+00-2.98090E-02 0.00000E+00-3.55207E-02
6 0.00000E+00-6.55058E+00 0.00000E+00-3.55207E-02 0.00000E+00-2.98090E-02
7 0.00000E+00-6.43222E+00 0.00000E+00-4.01551E-02 0.00000E+00-2.31877E-02
8 0.00000E+00-6.12123E+00 0.00000E+00-4.35777E-02 0.00000E+00-1.58549E-02
STAAD SPACE -- PAGE NO. 55

APPLIED JOINT EQUIVALENT LOADS

JOINT FORCE-X FORCE-Y FORCE-Z MOM-X MOM-Y MOM-Z
9 0.00000E+00-6.61048E+00 0.00000E+00-4.56646E-02 0.00000E+00-8.05500E-03
10 0.00000E+00-1.39020E+01 0.00000E+00-1.59521E-01 0.00000E+00 3.63192E-17
11 0.00000E+00-6.61048E+00 0.00000E+00-4.56646E-02 0.00000E+00 8.05500E-03
12 0.00000E+00-6.12123E+00 0.00000E+00-4.35777E-02 0.00000E+00 1.58549E-02
13 0.00000E+00-6.43222E+00 0.00000E+00-4.01551E-02 0.00000E+00 2.31877E-02
14 0.00000E+00-6.55058E+00 0.00000E+00-3.55207E-02 0.00000E+00 2.98090E-02
15 0.00000E+00-6.55058E+00 0.00000E+00-2.98090E-02 0.00000E+00 3.55207E-02
16 0.00000E+00-6.43222E+00 0.00000E+00-2.31877E-02 0.00000E+00 4.01551E-02
17 0.00000E+00-6.12123E+00 0.00000E+00-1.58549E-02 0.00000E+00 4.35777E-02
18 0.00000E+00-6.61048E+00 0.00000E+00-8.05500E-03 0.00000E+00 4.56646E-02
19 0.00000E+00-1.39020E+01 0.00000E+00-1.38562E-17 0.00000E+00 1.59521E-01
20 0.00000E+00-6.61048E+00 0.00000E+00 8.05500E-03 0.00000E+00 4.56646E-02
21 0.00000E+00-6.12123E+00 0.00000E+00 1.58549E-02 0.00000E+00 4.35777E-02
22 0.00000E+00-6.43222E+00 0.00000E+00 2.31877E-02 0.00000E+00 4.01551E-02
23 0.00000E+00-6.55058E+00 0.00000E+00 2.98090E-02 0.00000E+00 3.55207E-02
24 0.00000E+00-6.55058E+00 0.00000E+00 3.55207E-02 0.00000E+00 2.98090E-02
25 0.00000E+00-6.43222E+00 0.00000E+00 4.01551E-02 0.00000E+00 2.31877E-02
26 0.00000E+00-6.12123E+00 0.00000E+00 4.35777E-02 0.00000E+00 1.58549E-02
27 0.00000E+00-6.61048E+00 0.00000E+00 4.56646E-02 0.00000E+00 8.05500E-03
28 0.00000E+00-1.39020E+01 0.00000E+00 1.59521E-01 0.00000E+00 5.01753E-17

29 0.00000E+00-6.61048E+00 0.00000E+00 4.56646E-02
0.00000E+00-8.05500E-03
30 0.00000E+00-6.12123E+00 0.00000E+00 4.35777E-02
0.00000E+00-1.58549E-02
31 0.00000E+00-6.43222E+00 0.00000E+00 4.01551E-02
0.00000E+00-2.31877E-02
32 0.00000E+00-6.55058E+00 0.00000E+00 3.55207E-02
0.00000E+00-2.98090E-02
33 0.00000E+00-6.55058E+00 0.00000E+00 2.98090E-02
0.00000E+00-3.55207E-02
34 0.00000E+00-6.43222E+00 0.00000E+00 2.31877E-02
0.00000E+00-4.01551E-02
35 0.00000E+00-6.12123E+00 0.00000E+00 1.58549E-02
0.00000E+00-4.35777E-02
36 0.00000E+00-6.61048E+00 0.00000E+00 8.05500E-03
0.00000E+00-4.56646E-02
37 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
38 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
39 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
40 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
41 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
42 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
43 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
44 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
45 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
46 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
47 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
48 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
49 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00

50 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
51 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
52 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
53 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
54 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
55 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
56 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
57 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
58 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
59 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
60 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
61 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00

APPLIED JOINT EQUIVALENT LOADS
JOINT FORCE-X FORCE-Y FORCE-Z MOM-X MOM-
Y MOM-Z
62 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
63 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
64 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
65 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
66 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
67 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
68 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00

69 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
70 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
71 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
72 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
73 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
74 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
75 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
76 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
77 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
78 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
79 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
80 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
81 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
82 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
83 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
84 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
85 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
86 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
87 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
88 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
89 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00

90 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
91 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
92 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
93 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
94 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
95 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
96 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
97 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
98 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
99 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
100 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
101 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
102 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
103 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
104 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
105 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
106 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
107 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
108 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
109 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00
110 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00
0.00000E+00 0.00000E+00

111 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
112 0.00000E+00-2.05470E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
113 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
114 0.00000E+00-2.05469E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00

JOINT DISPLACEMENT (CM RADIANS) STRUCTURE TYPE = SPACE

JOINT	LOAD	X-TRANS	Y-TRANS	Z-TRANS	X-ROTAN	Y-ROTAN	Z-ROTAN
	18	2.2982	-0.5367	0.0039	-0.0006	0.0000	0.0001
	19	-2.2981	-0.5136	0.0040	-0.0006	0.0000	0.0002
	20	0.0003	-0.4944	-2.2939	-0.0007	0.0000	0.0002
	21	-0.0002	-0.5559	2.3017	-0.0005	0.0000	0.0001
	22	2.0820	-0.4510	0.0030	-0.0005	0.0000	0.0000
	23	-2.0821	-0.4259	0.0033	-0.0005	0.0000	0.0002
	24	-0.0003	-0.4718	2.0847	-0.0004	0.0000	0.0001
	25	0.0003	-0.4052	-2.0784	-0.0006	0.0000	0.0001
	26	1.8385	-0.4477	0.0031	-0.0005	0.0000	0.0000
	27	-1.8385	-0.4292	0.0032	-0.0005	0.0000	0.0002
	28	0.0002	-0.4138	-1.8351	-0.0006	0.0000	0.0001
	29	-0.0002	-0.4631	1.8414	-0.0004	0.0000	0.0001
13	6	1.7350	-0.0150	-0.0002	0.0000	0.0000	-0.0001
	7	-1.7350	0.0150	0.0002	0.0000	0.0000	0.0001
	8	-0.0003	-0.0257	1.7348	0.0001	0.0000	0.0000
	9	0.0003	0.0257	-1.7348	-0.0001	0.0000	0.0000
	1	-0.0001	-0.1682	0.0003	-0.0001	0.0000	0.0000
	2	0.0009	-0.1845	0.0022	-0.0003	0.0000	0.0002
	3	0.0000	-0.0154	0.0000	0.0000	0.0000	0.0000
	10	1.5321	-0.0111	-0.0001	0.0000	0.0000	-0.0001
	11	-1.5321	0.0111	0.0001	0.0000	0.0000	0.0001
	12	0.0002	0.0190	-1.5319	-0.0001	0.0000	0.0000
	13	-0.0002	-0.0190	1.5319	0.0001	0.0000	0.0000
	4	0.0008	-0.3681	0.0025	-0.0004	0.0000	0.0002
	5	0.0012	-0.5521	0.0037	-0.0006	0.0000	0.0003
	14	2.6037	-0.5516	0.0034	-0.0006	0.0000	0.0002
	15	-2.6013	-0.5065	0.0040	-0.0006	0.0000	0.0004

	16	0.0007	-0.5676	2.6059	-0.0005	0.0000	0.0003
	17	0.0017	-0.4905	-2.5985	-0.0007	0.0000	0.0003
	18	2.2993	-0.5457	0.0035	-0.0006	0.0000	0.0002
	19	-2.2969	-0.5123	0.0038	-0.0006	0.0000	0.0004
	20	0.0015	-0.5006	-2.2942	-0.0007	0.0000	0.0003
	21	0.0010	-0.5575	2.3016	-0.0005	0.0000	0.0003
	22	2.0830	-0.4598	0.0027	-0.0005	0.0000	0.0001
	23	-2.0811	-0.4237	0.0032	-0.0005	0.0000	0.0003
	24	0.0006	-0.4725	2.0847	-0.0004	0.0000	0.0002
	25	0.0013	-0.4109	-2.0788	-0.0006	0.0000	0.0002
	26	1.8394	-0.4550	0.0028	-0.0005	0.0000	0.0002
	27	-1.8375	-0.4283	0.0031	-0.0005	0.0000	0.0003
	28	0.0011	-0.4189	-1.8354	-0.0005	0.0000	0.0002
	29	0.0007	-0.4645	1.8413	-0.0004	0.0000	0.0002
14	6	1.7350	-0.0192	-0.0003	0.0000	0.0000	-0.0001
	7	-1.7350	0.0192	0.0003	0.0000	0.0000	0.0001
	8	-0.0003	-0.0228	1.7349	0.0001	0.0000	0.0000
	9	0.0003	0.0228	-1.7349	-0.0001	0.0000	0.0000
	1	0.0000	-0.1687	0.0002	0.0000	0.0000	0.0000
	2	0.0014	-0.1852	0.0019	-0.0003	0.0000	0.0003
	3	0.0000	-0.0154	0.0000	0.0000	0.0000	0.0000

JOINT DISPLACEMENT (CM RADIANS) STRUCTURE TYPE = SPACE

JOINT LOAD X-TRANS Y-TRANS Z-TRANS X-ROTAN Y-ROTAN Z-ROTAN

10	1.5320	-0.0142	-0.0001	0.0000	0.0000	-0.0001
11	-1.5320	0.0142	0.0001	0.0000	0.0000	0.0001
12	0.0001	0.0169	-1.5320	-0.0001	0.0000	0.0000
13	-0.0002	-0.0168	1.5320	0.0001	0.0000	0.0000
4	0.0015	-0.3693	0.0020	-0.0003	0.0000	0.0003
5	0.0022	-0.5539	0.0031	-0.0005	0.0000	0.0004
14	2.6047	-0.5596	0.0027	-0.0005	0.0000	0.0003
15	-2.6002	-0.5019	0.0035	-0.0005	0.0000	0.0005
16	0.0018	-0.5650	2.6054	-0.0004	0.0000	0.0004
17	0.0027	-0.4966	-2.5992	-0.0006	0.0000	0.0004
18	2.3003	-0.5520	0.0029	-0.0005	0.0000	0.0003
19	-2.2958	-0.5094	0.0033	-0.0005	0.0000	0.0005

	20	0.0025	-0.5055	-2.2949	-0.0006	0.0000	0.0004
	21	0.0020	-0.5560	2.3010	-0.0004	0.0000	0.0004
	22	2.0837	-0.4662	0.0021	-0.0004	0.0000	0.0002
	23	-2.0802	-0.4201	0.0028	-0.0004	0.0000	0.0004
	24	0.0014	-0.4705	2.0843	-0.0003	0.0000	0.0003
	25	0.0021	-0.4158	-2.0794	-0.0005	0.0000	0.0003
	26	1.8402	-0.4602	0.0023	-0.0004	0.0000	0.0003
	27	-1.8367	-0.4261	0.0026	-0.0004	0.0000	0.0004
	28	0.0019	-0.4229	-1.8359	-0.0005	0.0000	0.0003
	29	0.0016	-0.4633	1.8408	-0.0003	0.0000	0.0003
15	6	1.7349	-0.0228	-0.0003	0.0000	0.0000	-0.0001
	7	-1.7349	0.0228	0.0003	0.0000	0.0000	0.0001
	8	-0.0003	-0.0192	1.7350	0.0001	0.0000	0.0000
	9	0.0003	0.0192	-1.7350	-0.0001	0.0000	0.0000
	1	0.0002	-0.1687	0.0000	0.0000	0.0000	0.0000
	2	0.0019	-0.1852	0.0014	-0.0003	0.0000	0.0003
	3	0.0000	-0.0154	0.0000	0.0000	0.0000	0.0000
	10	1.5320	-0.0168	-0.0002	0.0000	0.0000	-0.0001
	11	-1.5320	0.0169	0.0001	0.0000	0.0000	0.0001
	12	0.0001	0.0142	-1.5320	-0.0001	0.0000	0.0000
	13	-0.0001	-0.0142	1.5320	0.0001	0.0000	0.0000
	4	0.0020	-0.3693	0.0015	-0.0003	0.0000	0.0003
	5	0.0031	-0.5539	0.0022	-0.0004	0.0000	0.0005
	14	2.6054	-0.5650	0.0018	-0.0004	0.0000	0.0004
	15	-2.5992	-0.4966	0.0027	-0.0004	0.0000	0.0006
	16	0.0027	-0.5596	2.6047	-0.0003	0.0000	0.0005
	17	0.0035	-0.5019	-2.6002	-0.0005	0.0000	0.0005
	18	2.3010	-0.5560	0.0020	-0.0004	0.0000	0.0004
	19	-2.2949	-0.5055	0.0025	-0.0004	0.0000	0.0006
	20	0.0033	-0.5094	-2.2958	-0.0005	0.0000	0.0005
	21	0.0029	-0.5520	2.3003	-0.0003	0.0000	0.0005
	22	2.0843	-0.4705	0.0014	-0.0003	0.0000	0.0003
	23	-2.0794	-0.4158	0.0021	-0.0003	0.0000	0.0005
	24	0.0021	-0.4662	2.0837	-0.0002	0.0000	0.0004
	25	0.0028	-0.4201	-2.0802	-0.0004	0.0000	0.0004
	26	1.8408	-0.4633	0.0016	-0.0003	0.0000	0.0003

Various softwares used rfor the design of tank

http://softwaretopic.informer.com/software-for-water-tank-design/::

TSOLexpress: Simulation program for design and calculation of solar thermal systems.

Daikin Altherma Simulator:A static calculation tool for dimensioning Daikin Altherma heat pump systems.

GeoDesigner :GeoDesigner is the most complete residential earth loop design.

RainTank2:RainTank 2 is an interactive software tool which assists rural communities.

Storage **Tank Design Software** :

www.techtarget.com/Data-Backup Expert Solutions & Latest Tools. For More Efficient Data Solutions.

Wadiso:Wadiso is a application built for the analysis of water distribution systems.

HYDROFLO:Hydro-flow is a powerful software tool that assists piping system designers.

TriTank650:TRI*TANK650 software for the design and rating of welded steel oil storage tanks.

CONCLUSIONS

Elevated Service Reservoir of 150 K.L. capacity with 12 m staging has been designed considering M30 concrete for the Container and M20 for staging. However, M25 concrete is used for staging.

Detailed structural drawings have been prepared.

Abstract estimate is prepared for the elevated service reservoir including pipe connections considering the current standard schedule of rates, issued by government of Andhra Pradesh. The estimate works out to Rs:27,17,550

REFERENCES

1 IS: 456-2000 Plain Reinforced concrete code of practice.

2 SP :16 Design aids.

3 IS:3370 -1965 code of practice for concrete structures for storage of liquids. Part I -General requirement, part II – Reinforced concrete structures part- IV - Design tables.

4 IS :875-1987

5 IS:1893 -2002

6 IS:13920 -1993

7 IS:11682 -1985

8 SP:34 Hand book for concreting & detailing of reinforcement.

9 Reinforced concreter design by Ashok Kumar Jain and Arun Kumar Jain.

10 Reinforced concrete design by N. Krishna Raju and R.N. Pranesh