**DESIGN OF OHSR 35000 LITRES CAPACITY F.S.L(22M) ,HOSHIARPUR**

**GIVEN DATA**

fck=25 N/mm2,fy=415 N/mm2,Ϭcbc=fck/3=8.5N/mm2

m=280/(3\* Ϭcbc)=280/(3\*8.5)=10.9

k=m\* Ϭcbc/(m\* Ϭcbc+Ϭst)=10.9\*8.5/(10.9\*8.5+150)=0.383

j=1-k/3=1-0.383/3=0.872

Q=0.5\* Ϭcbc\*j\*k=0.5\*10\*0.872\*0.383=1.623 N/mm2

Ϭcc=8 N/mm2,Ϭct=1.5 N/mm2,Ϭcbc=10 N/mm2,Ϭcbt=2 N/m

Height of tank wall in vertical(H)=1.97m

Freeboard(f)=0.6m

**DESIGN OF VERTICAL WALL(M25, 120MM THICK AT TOP)**

Height of water level in vertical wall=1.97-0.6=1.37m

Height under cantilever action=1m

Height under hoop tension =1.37-1=0.37m

Hoop pressure acting on walls(p)=10\*(1.37-1)=3.7 KN/m2

Cantilever moment in long wall=4.28 KNm

Fixed end moments in short wall=9.7\*(3.048)^2/12=7.50KNm

 Eff. Depth reqd for balanced section=(M/Q/b)^0.5=160mm

(d)p=160mm

Overall thickness of wall (D)p=200mm

 Eff clear cover=200-160=40mm

TL=10\*(1.97-1)\*3.048/2=14.63 KN

Ts=10(1.917-1)=9.7 KN

**IN LONG WALL(M25, 120MM THICK AT TOP)**

Cantilever moment=4.29KNm

Ast required=4.28\*10^6/150/0.85/140=239 mm2

Ast for direct tension=14.63\*1000/150=97.4 mm2

Ast min.=0.3% of 1000\*200=600mm^2

Provide 10φ@100mm c/c

**IN SHORT WALL(M25, 120MM THICK AT TOP)**

At corner

Design moment at corner of short wall=M-TBx

 =7.63-9.7\*7.5/1000=7.96 KNm

Ast at corner=7.96\*10^6/150/0.85/140=445.8.7 mm2

Ast for direct tension=9.7\*1000/150=64.66mm2

Total Ast=445.7+64.66=509.7 mm2

Ast min.=0.3% of 1000\*200=600mm^2

Provide 10φ@100mm c/c

At middle

B.M=10\*(3.048)^2/16=5.66 KNm

Design Moment=5.66-9.7\*7.5/1000=5.54 KNm

Since B.M is very small,therefore provide minimum steel

Ast =0.3 % of bD=0.3/100\*1000\*200=600mm2

Provide 10φ@100mm c/c at outer face of short wall

**REINFORCEMENT IN VERTICAL DIRECTION**

For cantilever action, cantilever moment=(10\*1^3)/6=1.66 KNm

Ast =1.66\*10^6/150/0.85/140=92.6 mm2

Provide minimum reinforcement

Provide 10φ@125 mm c/c @ both the faces as vertical st

**DESIGN OF BOTTOM SLAB(M25, 170MM THICK)**

Ly/Lx=3.048/(6.096/2)=1.0

Let the thickness of slab be 170 mm

Wt of vertical wall =101.43

Wt of water in vertical wall=10\*6.096\*3.048\*1.37=254.55 KN

Self wt of bottom slab=25\*.160\*6.31\*3.048=77.5 KN

Total w= 432.89KN

Wt / m2(wu)=816.75/6.096/3.048=23.3KN/m2

-ᶑx=0.058

+ᶑx=0.045

+ᶑy=0.043

-Mx=23.3\*2.91^2\*0.058=11.44 KNm

+Mx=23.3\*2.91^2\*0.045=8.878 KNm

+My=23.3\*2.91^2\*0.043=8.48 KNm

d=(11.48\*10^6/1.623/1000)^0.5=84mm

(d)p=160 mm

(D)p=200 mm

Reinforcement along short span at edge strip

Ast=11.44\*10^6/150/0.85/160=560 mm2

Provide 12φ@170mm c/c upto 0.3m at edge strip of short wall on upper face

Reinforcement along short span in middle

Ast=8.482\*10^6/150/0.85/160=443 mm2

Provide 12φ@200mm c/c from each 0.3m at middle of short wall on lower face

Reinforcement along long span in middle

Ast=16.64\*10^6/150/0.9/120=1027.3 mm2

Provide 12φ@100mm c/c from each 0.3m at middle of long wall on lower face

Reinforcement along long span at edge strip

Ast=0.24% of bD=0.24/100\*210\*1000=384 mm2

Provide 10φ@150mm c/c upto 0.3m at edge strip of long wall on upper face

Torsion reinforcement at discontinuous edges

M=11.45\*3/4=8.84KNm

Ast=3/4\*560.3=420mm2

Provide 12φ@125mm c/c as top and bottom reinforcement upto 0.5m x 0.5m area of slab at discontinuous edges and 12φ@250mm c/c as top and bottom reinforcement upto 0.5m x 0.5m area of the slab.

**DESIGN OF BEAM BELOW BOTTOM SLAB(B2)(M25,300X450)**

Load including self weight of beam=33.94KN/m

Bending moment=39.51

Ast=417.89mm^2

Provide 4-12φ & 2-12 φbars with the nominal shear reinforcement of 2-legged 8φ@125 mm c/c in the beam

Provide 300 mm x 450 mm section of the beam

**DESIGN OF BEAM BELOW THE INTERFACE OF BOTTOM SLABS(B1)(M25,300X450)**

From above,total

Load=50.71KN/m

Bending moment=58.8KNm

Ast=635 mm2

Provide 4-16φ & 2-12 φbars with the nominal shear reinforcement of 2-legged 8φ@125 mm c/c in the beam.

Provide 300 mm x 450 mm section of the beam

**DESIGN OF STAGING**

Wt of cylindrical wall =101.43 KNM

Load due to water retained in tank=10\*6.096\*3.048\*1.37=254.55 KN

Load due to bottom slab=25\*6.31\*3.048\*0.160=77.0KN

Load due to bottom beam=25\*0.3\*0.45\*9.144=31.86 KN

Total load=101.43+254.55+77.0+31.86=464.84 KN

Load carried by each column=464.84/6=77.43 KN

Self wt of each column=25\*0.3\*0.3\*6.3=14.18 KN

Self wt of each brace=25\*0.2\*0.45\*2.91=6.5 KN/col

Total load on each column=98.15KN

**SEISMIC DESIGN**

Wt of tank when full=464.84KN

Wt of staging=125.41 KN

Eff. Wt of tank when full=464.84+41.80=506.64 KN

Eff. Wt of tank when empty=506.64-254.4=252.24 KN

MOI of one column=300\*300^3/12=675893025 mm4

When tank is full

Natural time period=2\*pi()\*(464.84/9.81/6339)^0.5=0.68

Structural response factor=1.69/0.64=2.48

Zone factor=0.24

Importance factor=1.5

Response reduction factor=5

Horizontal seismic coeff=2.48\*0.24\*1.5/5/2=0.08

Horizontal seismic force=464.84\*0.08=41.5 KN

Acting at 8.2 m from the foundation top.

Overturning moment in Ist bay=41.5(8.2)=341.5 KNm

Seismic shear per column=41.5/6=6.9 KN

B.M.in col of Ist bay= 7.1\*1.05=7.45 KNm

When tank is empty

Natural time period=2\*pi()\*(252.4/9.81/6339)^0.5=0.7

Structural response factor=1.67/0.685=2.44

Zone factor=0.24

Importance factor=1.5

Response reduction factor=5

Horizontal seismic coeff=2.44\*0.24\*1.5/5/2=0.088

Horizontal seismic force=252.4\*0.088=20.6 KN

Acting at 6.3+1.5=8.2m from the foundation top.

Overturning moment in Ist bay=20.6\*(8.2)=168 KNm

Seismic shear per column=20/6=3.5 KN

B.M.in col of Ist bay= 5\*1.05=5.25 KN

**DESIGN OF COLUMN(M25,300X300)**

Col size=300 mm x 300 mm

 eccentricity=(2.7-0.6) x 1000/500+ 300/30=14.2 mm

Ag=300 x300=90000 mm2

Ast required=450mm^2

Therefore, provide 6-12φ in each column with 10φ@ 200mm c/c as the stirrups for lateral binding.

Ast provided=6x 113=678 mm2

Area of concrete=90000-678=89322 mm2

Area of stirrup bar=pi()\*10^2/4=78.5 mm2

Diameter of core Dc=(300-30\*2-10)=230 mm

Pitch(p)=200 mm

Provide 300mm x 300mm col size with 6-bars of 12-φ tied together with 10φ@200mm c/c

Check

Vol of helical reinforcement =pi()\*Dc\*Asp\*4/pi()/(Dc)^2/p > ( Ag/Ac-1)\*0.36\*30\*415

Vol of core

226885.8/33238050 >(90000/89322-1)\*0.36\*30/415

 0.006>0.0001

Hence safe in reinforcement

**DESIGN OF BRACE(M25, 200X450)**

Provided section of the brace=200mm x450 mm

Bending moment=20.11KNm

Shear in the brace=42.69/6=15.11KN

Mu=20\*1.5=30 KNm

Ast=0.5\*25/415\*200\*400\*(1-(1-4.6\*30\*10^6/25/200/400^2)^0.5)

 =335 mm2

Provide 4-12φ bar

Ast provided=113.1\*4=454.4 mm2

Shear reinforcement

Vu=1.5\*15.11=22.67 KN

Τv=22.67\*1000/200/400=0.28 N/mm2

%age reinforcement=452.4\*100/200/400=0.5

In M25 concrete,τc=0.49N/mm2 >τv

Hence safe in shear.

Provide nominal shear reinforcement of 2-legged-10φ@250 mm c/c throughout.

**DESIGN OF ISOLATED FOOTING SUPPORTING COLUMNS(M25,10MM THICK)**

Load acting on each col=226.46 KN

Add 10% wt of footing=22.6 KN

Total wt(P)=248.6

Area of footing=248.6/87.5=2.85 m2

Provided area of footing(A)=2\*2=4

Pressure intensity at base=226.4/4=56.6<87.5 ,Hence safe

B.M at the face of the column=56.6\*0.75^2/2=15.63 KNm

Using M25 concrete ,

 Depth of footing required from bending criteria=104mm

Depth of footing required from 1-way shear=170mm

Provided eff depth of footing=170 mm

Provided overall depth of footing=170+80=250mm

Ast =0.25% of 1000\*170=425mm^2

Provide 12φ@ 220mm c/c in bothways.

Distribution steel=0.12% of 1000\*250=300mm^2

Provide 12 φ @200mm c/c