Design and Analysis of Al Maslamani Building

Prepared By :

Ala'a Qaqa

Halaa Salhab

Tamra Abu-Omar

Submitted to : Dr. Mohammad Samaaneh

Outline:

- Introduction.
- 3D modeling .
- Seismic design.
- Design and Detailing .

INTRODUCTION

Project Description

- Al Maslamani Mall is a commercial building, which is located in Beit-Eba Street – Nablus.

- The aim of the establishment of this building is to be used as show rooms and factory of nuts and sweets.

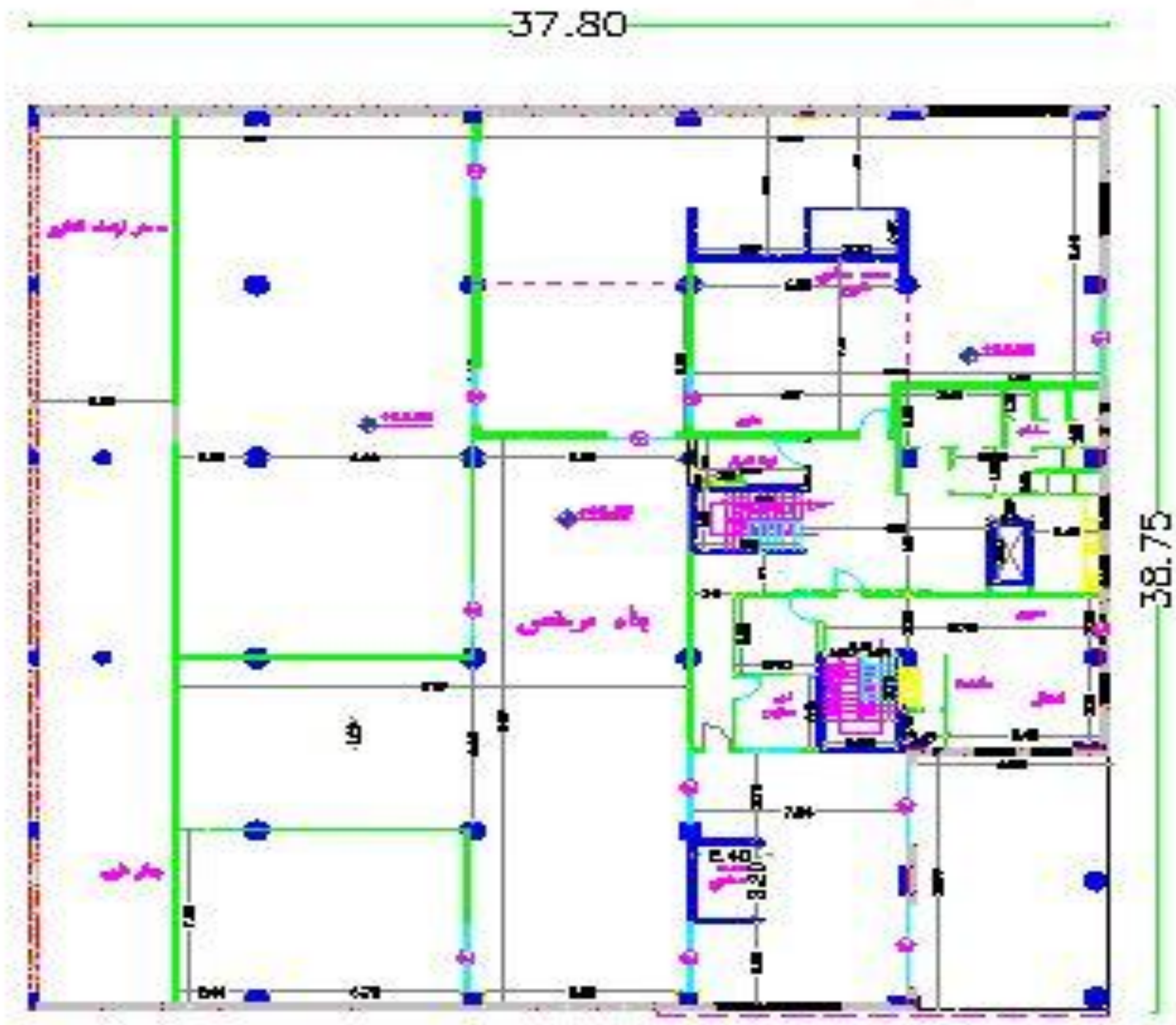
- The project consists of two basement floors, ground floor and top three floors.

Al Maslamani Building

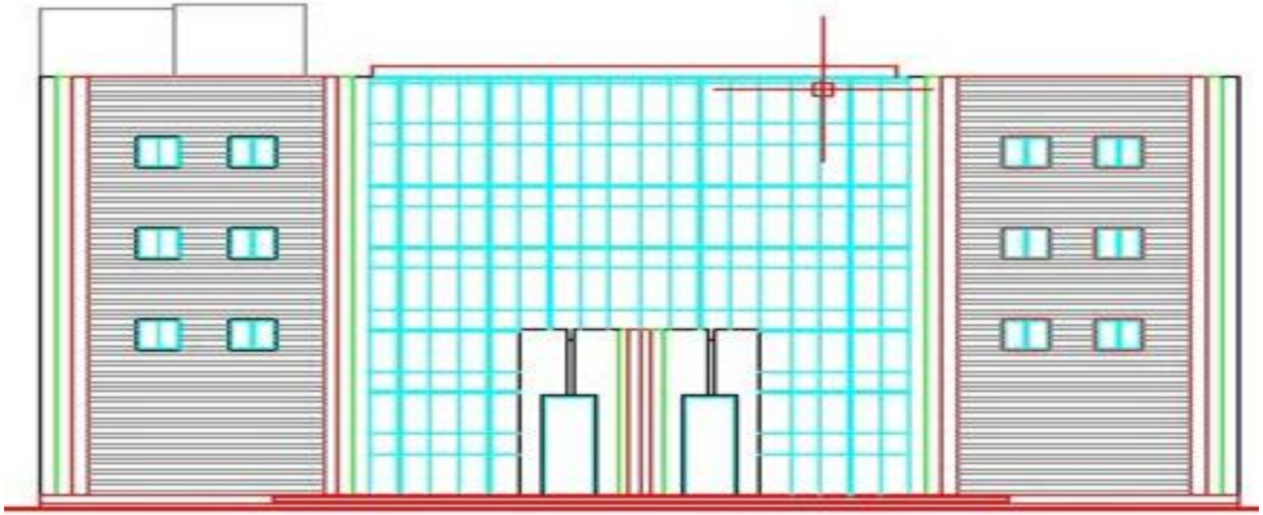
Floor	Area (m^2)	Height (m)	Use of floor
Second basement	1269.8	3.85	Offices and machins
First basement	1269.8	3.6	Offices and stores
Ground	1257.7	5.15	Offices and stores
First	1257.7	4.42	Stores
Second	1238.7	4.42	Stores
Third	1238.7	4.42	Stores
Total	7550	25.86	

Ground Floor consists:

Basement Floors consists:



Elevations



North elevation

South elevation.

East elevation

West elevation

Soil Properties

The type and the characteristics of soil is very important to be known for designing the footing by choosing the appropriate type and also for designing the retaining walls. The soil in the site area is mainly clay .

The bearing capacity of the soil

$q_{all} = 2.8 Kg/cm^2$ ($280 KN/m^2$)

Materials

1) Concrete :-

Property	value
Compressive strength of concrete(fc) for slabs and beams	25Mpa
Compressive strength of concrete(fc) for columns	30Mpa
Modulus of Elasticity (Ec)	$2.35 * 10^4$
Unit weight of reinforcing concrete(γ)	$25KN/m^3$

Materials

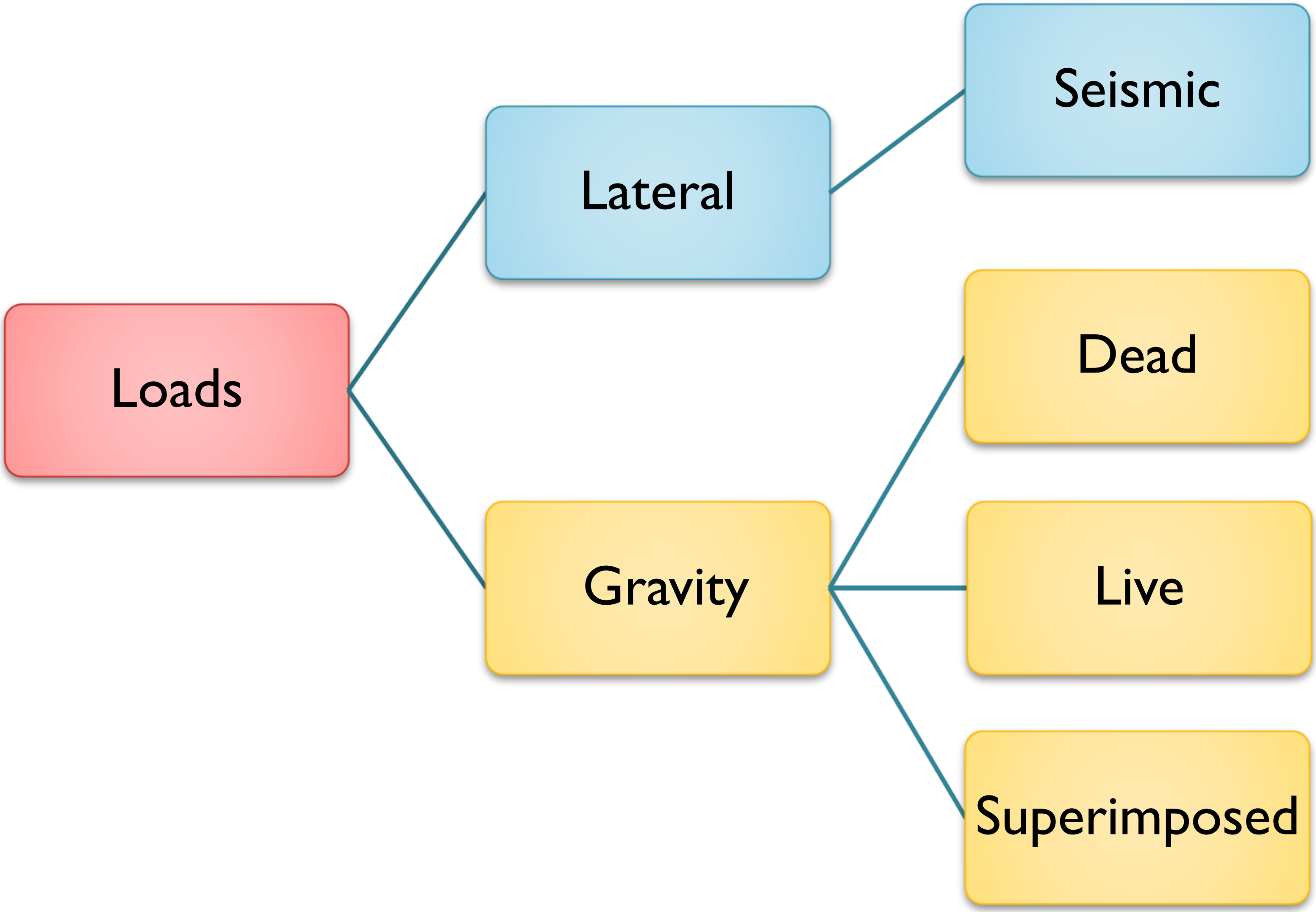
2) Reinforcing Steel :-

Property	Value
Yield strength(fy)	420Mpa
Modulus of elasticity (Es)	2.04*10^5Mpa

Codes

- ACI 318-08/IBC2009 (American Concrete Institute): building code requirements of structural concrete and commentary.
- UBC-97 (Uniform Building code).
- ASCE (American Society of Civil Engineers).

GRAVITY & LATERAL LOADS


Loads
Lateral
Gravity
Seismic
Dead
Live
Superimposed

Loads

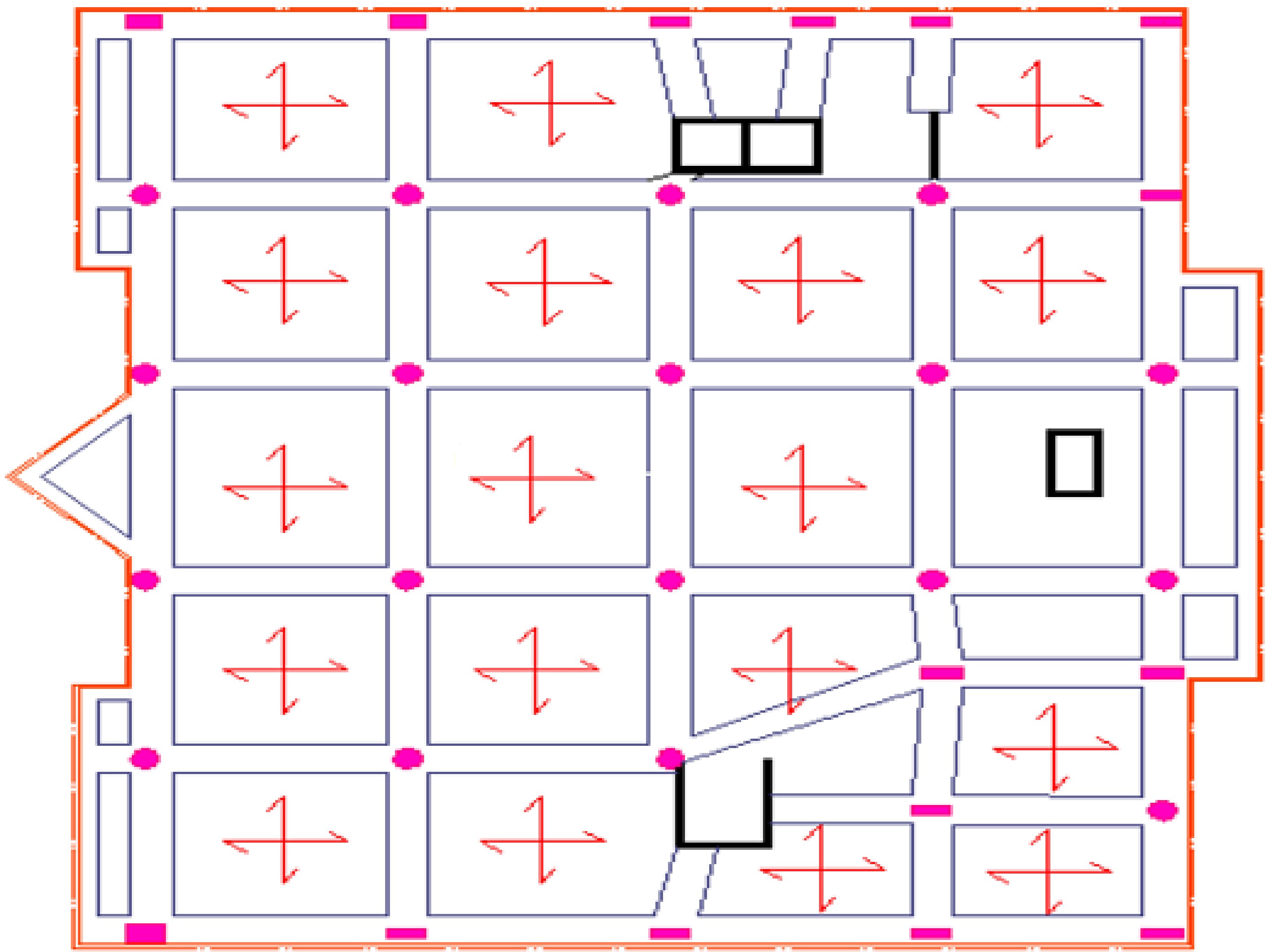
Floor	Live Load	Superimposed load
Second basement	5 kN /m^2	4.7 kN /m^2
First basement	5 kN /m^2	4.7 kN /m^2
Ground Floor	5 kN /m^2	4.7 kN /m^2
First Floor	5 kN /m^2	4.7 kN /m^2
Second Floor	5 kN /m^2	4.7 kN /m^2
Third Floor	5 kN /m^2	4.7 kN /m^2
Roof floor	10 kN /m^2	4.7 kN /m^2

Load combinations

According to ACI 318-09 code required strength U shall be at least equal to the effects of factored loads in Eq.

- U = 1.4D
- U = 1.2D + 1.6L +0.5(Lr or S or R)
- U = 1.2D + 1.6(Lr or S or R) + (1.0L OR 0.5W)
- U = 1.2D + 1.0W + 1.0L + 0.5(Lr or S or R)
- U = 1.2D + 1.0E + 1.0L + 0.2S
- U = 0.9D + 1.0W
- U = 0.9D +1.0E

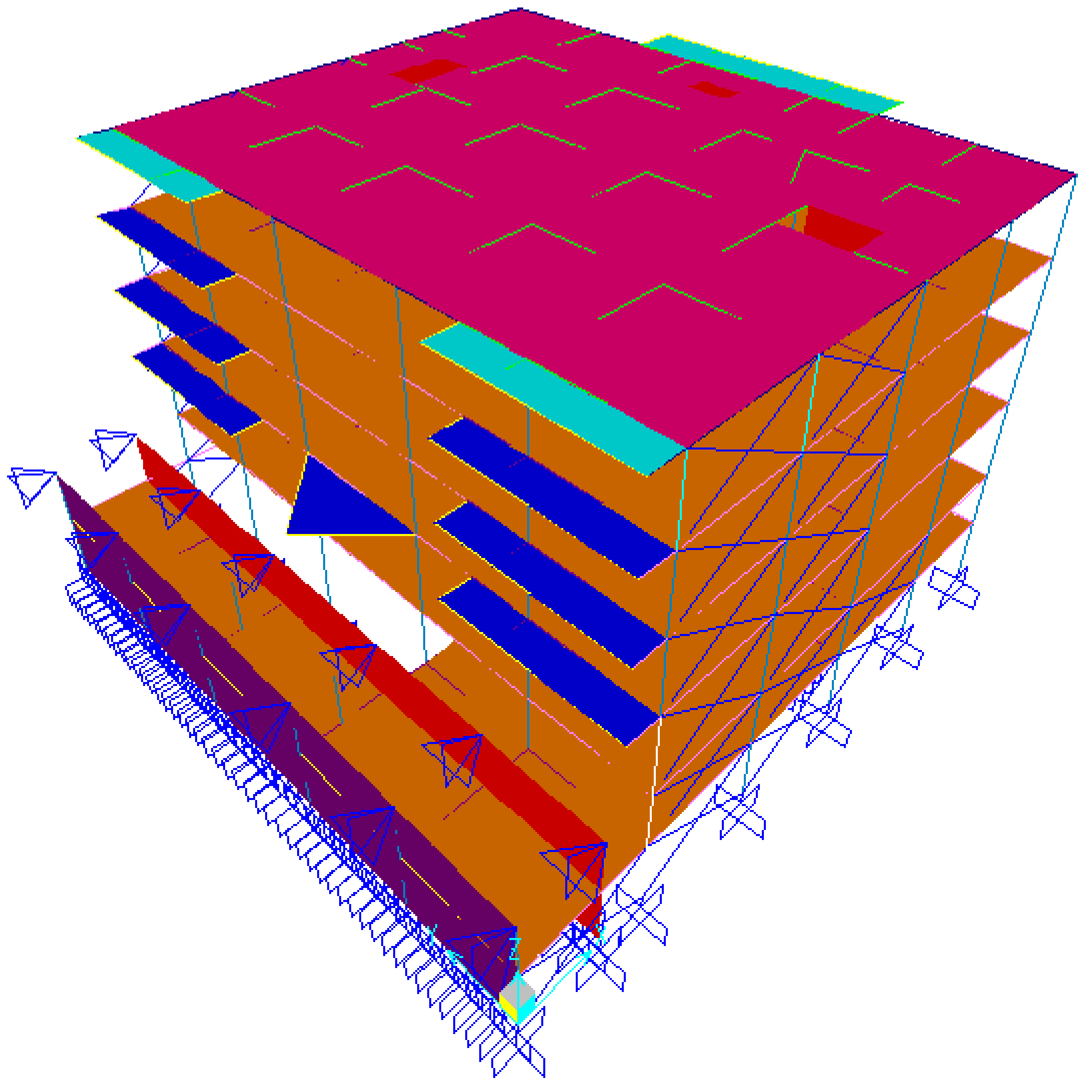
Two Way solid slab



THREE DIMENSIONAL STRUCTURAL ANALYSIS

3D

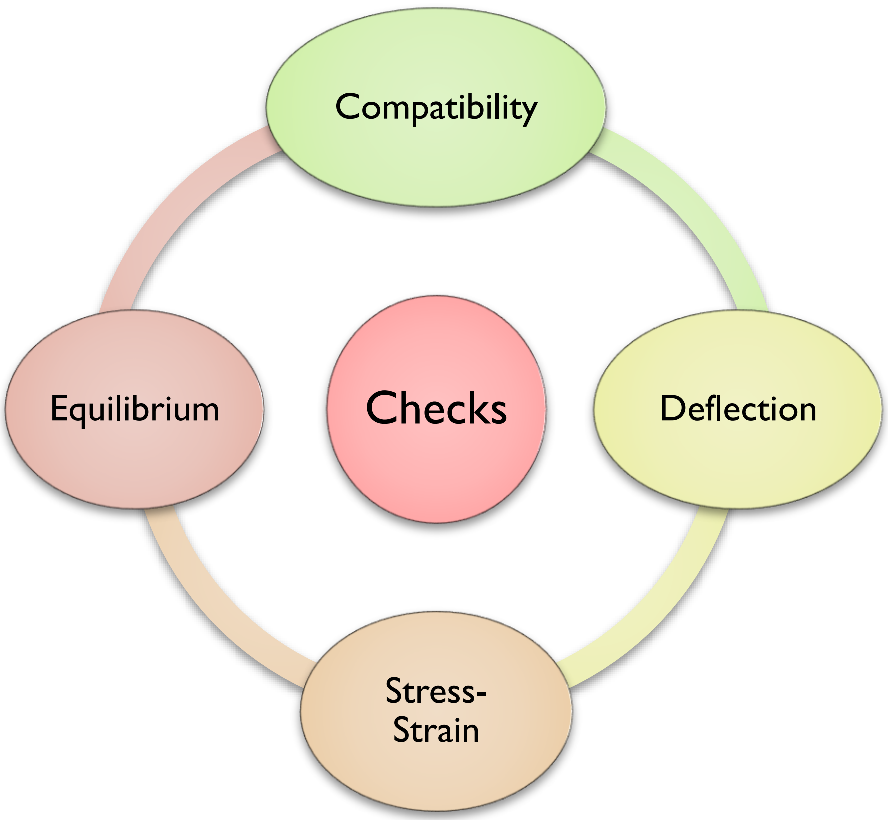
THREE DIMENSIONAL STRUCTURAL AL ANALYSIS



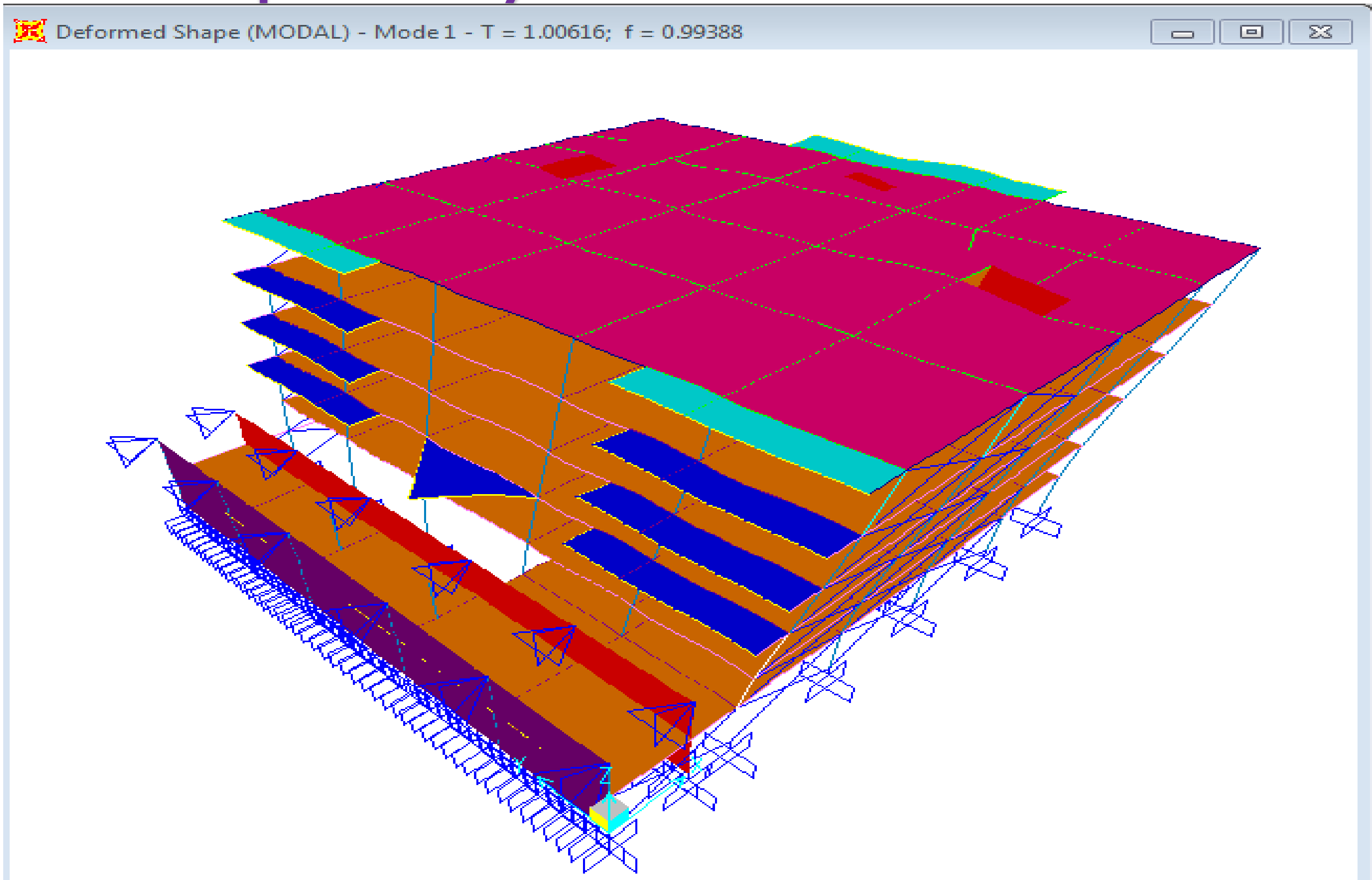
Modifiers for each element

Element	Modifier
Column	0.7
Beam	0.35
Slab	0.3
Shear wall	0.7

Verifications of structural analysis



Compatibility of structural model



Time Period =1.008 sec

Equilibrium

OutputCase Text	CaseType Text	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-m	GlobalMY KN-m	GlobalMZ KN-m
live	LinStatic	).0000001233	00000001025	39941.608	734474.1955	-883130.93	-0.000003185
SD	LinStatic	00000008249	00000006436	26494.036	481583.1169	-581466.31	-0.000002386
dead+wall	Combination	).0000003168	00000001543	93513.214	1782649.133	-2061381.61	-0.000007127

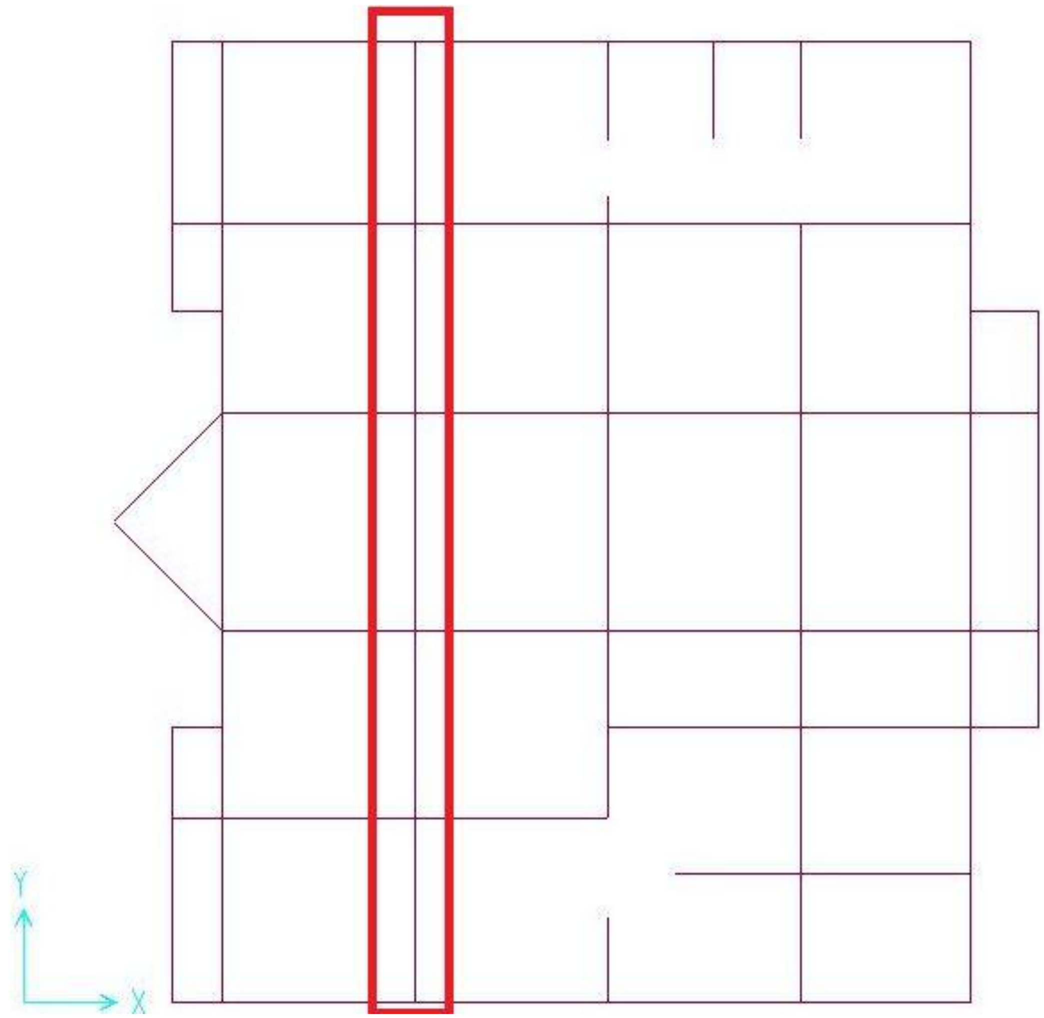
Load type	Hand results kN	SAP results kN	Differences %
Dead	94558	93513	1.1
SD	26455	26494	0.15
Live	39953	39941	0.03

The difference percentage is less than 5%, OK.

Stress Strain relationship (internal equilibrium)

Moments slab

Frame Y



1.Moments slab

Moments for frame Y from Sap in 3D

Take middle span
length of span =8.55m ,From sap M22

M+=371.49KN.m
M-=346.835KN.m
M-= 341.242 KN.m

Moments 3D Sap = $\frac{346.835+341.24}{2}$ **+ 371.49 = 715.52KN.m**

Moments slab for column strip

Moment Hand = $\frac{Wu * L^2}{8}$

Wu for column strip =1.2(Wd+ Wsd)+1.2(Wd beam) + 1.6(WL)

width of column strip =3.7

Wu = 1.2((5+4.7)3.7) +(1.2*6) + 1.6(5*3.7)

Wu=79.87 KN/m

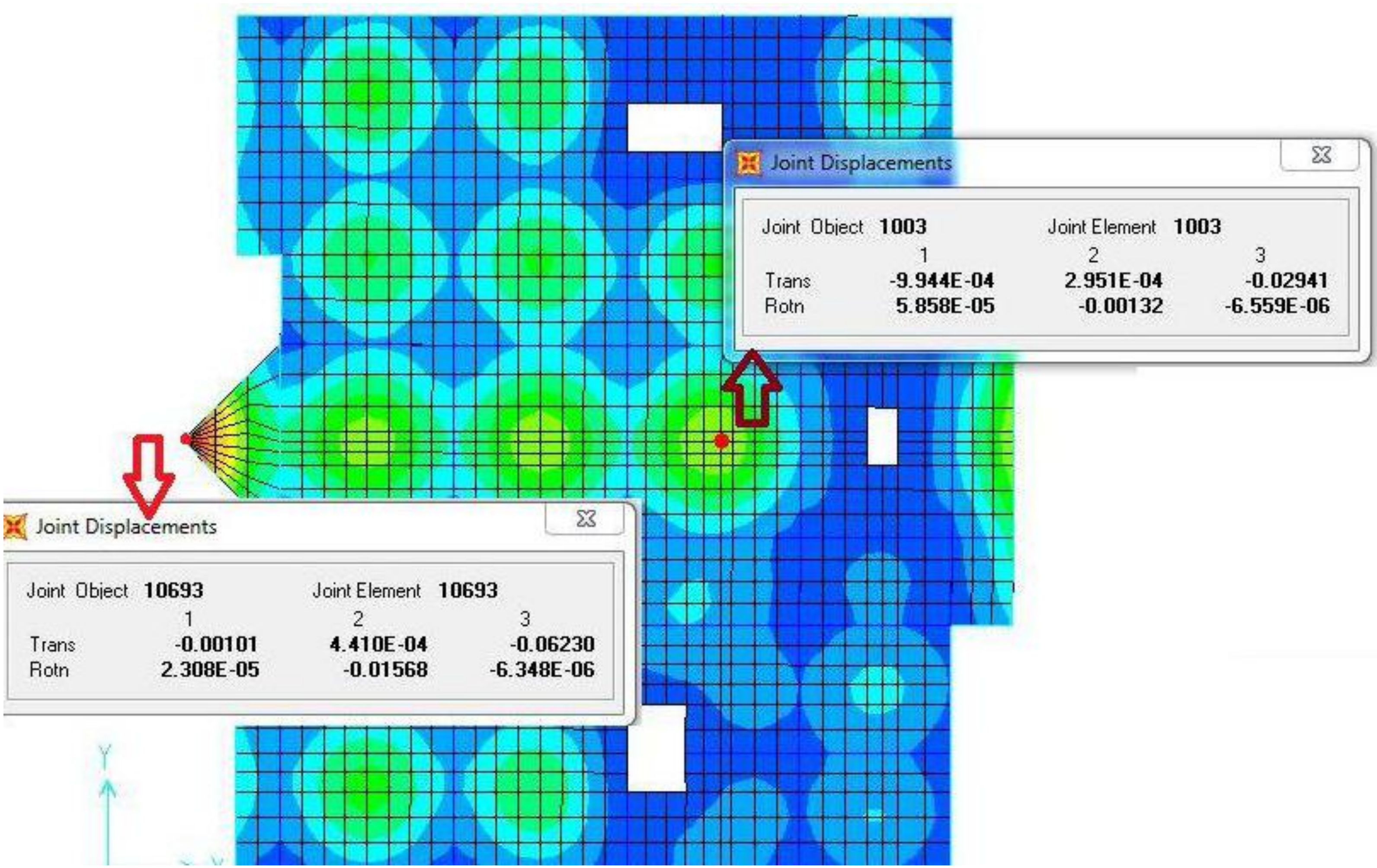
Moment hand=$\frac{79.87 * 8.55^2}{8}$ = 729.83 KN.m

%error = $\frac{729.83-715.52}{729.83}$ = 2%

The difference percentage is 2 %, which is less than 10%, OK.

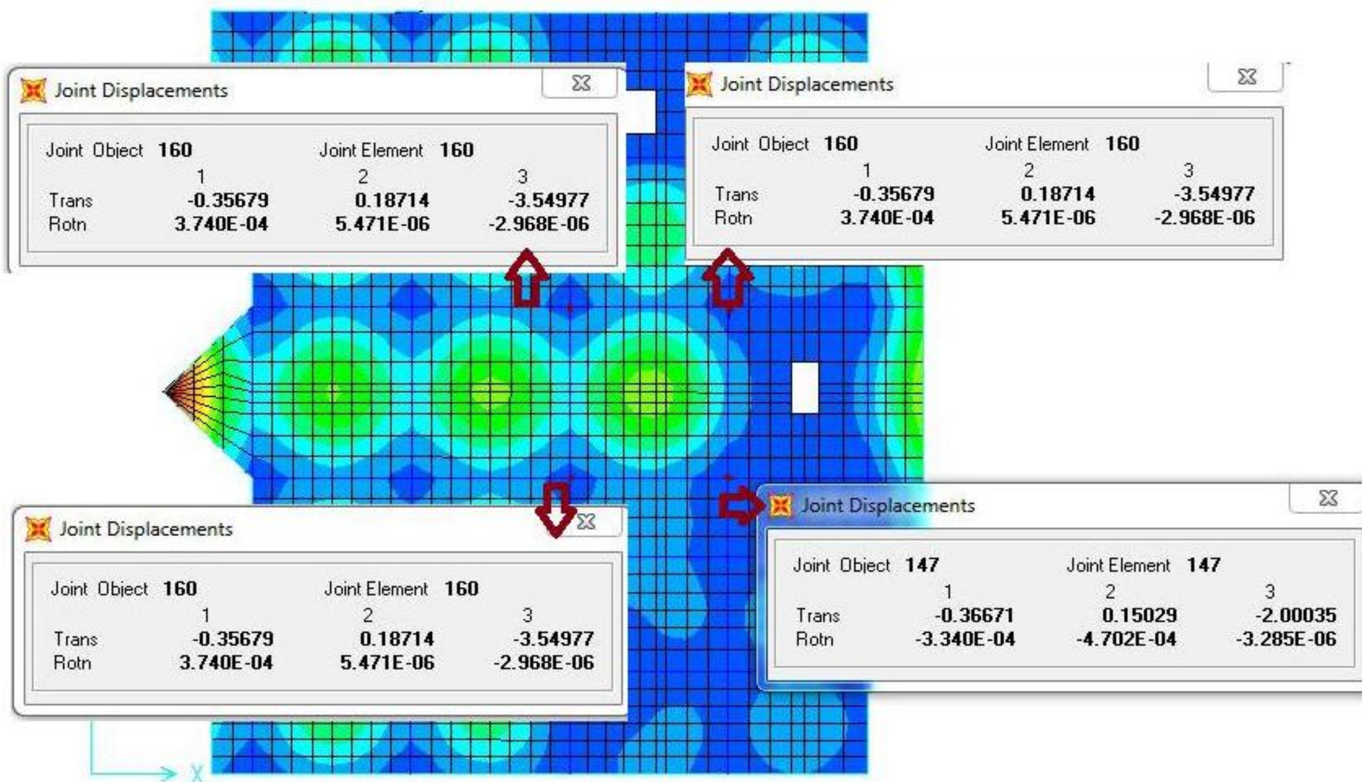
Check deflection for slab

Max deflection in floor



Deflection in slab

Max deflection in critical panel for column



Check deflection for slab

Long-term deflection:

Assume 50% sustained live load.

The long-term deflection is given by the following equation:

$$\Delta \text{ Long term} = \Delta L + \lambda\infty .\ \Delta D + \lambda t\ \Delta SL$$

Δslab= max deflection–(average deflection column+ average deflection beam)

$$\Delta \text{Dead} = 10.48 - \left(\frac{1.38+1.59+1.62+0.97}{4} + \frac{3.73+3.8+3.34+5.33}{4}\right) = 5.04 \text{ mm}$$

$$\Delta \text{ SD} = 8.427 - \left(\frac{0.587+0.37+0.69+0.707}{4} + \frac{2.28+2.37+1.97+3.47}{4}\right) = 5.316 \text{ mm}$$

$$\Delta \text{ Live} = 9 - \left(\frac{1.249+1.226+0.66+1.032}{4} + \frac{2.81+2.39+2.74+4.09}{4}\right) = 4.95 \text{mm}$$

Δ (Total dead) = 5.04+5.316= 10.356mm.

Δ (Live) = 4.95 mm

Δ Long term = $\Delta L + \lambda_\infty . \Delta D + \lambda_t \Delta SL$

Δ (Total dead) = 5.04+5.316= 10.356mm.

Δ (Live) = 4.95 mm.

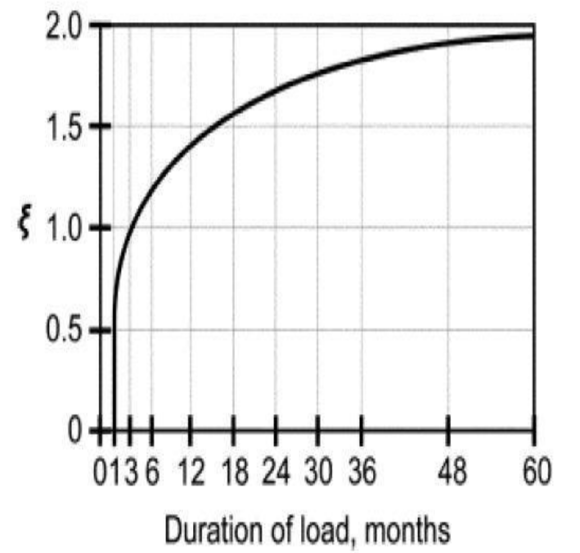
$\lambda_\infty . = \lambda_t = 2$

Δ Long term = $\Delta L + \lambda_\infty . \Delta D + \lambda_t \Delta SL$

Δ Long term $=4.95+2(10.356)+2\frac{4.95}{2}=$ 30.612mm

Δ allowable$= \frac{L}{240} = \frac{8.55}{240} =$0.0356m = 35.62 mm

Δ Long term 30.612mm < Δ allowable ok



Seismic Design

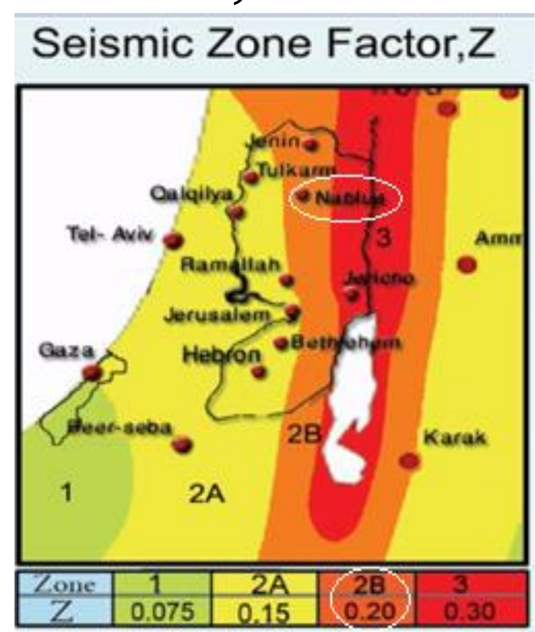
Seismic Design

Parameters

- **<u>Design according to UBC-97 code.</u>**

- Soil profile type: Stiff soil profile $\mathbf{S_D}$
- Zone factor: By using Palestine seismic map the zone factor Z for Nablus city is 2B thus, Z=0.2
- Seismic coefficients: C_a and C_v

- $\mathbf{C_a}$ **=0.28** Table 16-Q in UBC
- $\mathbf{C_v}$ **= 0.4** Table 16-R in UBC



Seismic Design

Parameters

- Importance factor [I]: I=1

TABLE 16-K—OCCUPANCY CATEGORY

OCCUPANCY CATEGORY	OCCUPANCY OR FUNCTIONS OF STRUCTURE	SEISMIC IMPORTANCE FACTOR, I	SEISMIC IMPORTANCE[1] FACTOR, I_p	WIND IMPORTANCE FACTOR, I_w
1. Essential facilities[2]	Group I, Division 1 Occupancies having surgery and emergency treatment areas Fire and police stations Garages and shelters for emergency vehicles and emergency aircraft Structures and shelters in emergency-preparedness centers Aviation control towers Structures and equipment in government communication centers and other facilities required for emergency response Standby power-generating equipment for Category 1 facilities Tanks or other structures containing housing or supporting water or other fire-suppression material or equipment required for the protection of Category 1, 2 or 3 structures	1.25	1.50	1.15
2. Hazardous facilities	Group H, Divisions 1, 2, 6 and 7 Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances Nonbuilding structures housing, supporting or containing quantities of toxic or explosive substances that, if contained within a building, would cause that building to be classified as a Group H, Division 1, 2 or 7 Occupancy	1.25	1.50	1.15
3. Special occupancy structures[3]	Group A, Divisions 1, 2 and 2.1 Occupancies Buildings housing Group E, Divisions 1 and 3 Occupancies with a capacity greater than 300 students Buildings housing Group B Occupancies used for college or adult education with a capacity greater than 500 students Group I, Divisions 1 and 2 Occupancies with 50 or more resident incapacitated patients, but not included in Category 1 Group I, Division 3 Occupancies All structures with an occupancy greater than 5,000 persons Structures and equipment in power-generating stations, and other public utility facilities not included in Category 1 or Category 2 above, and required for continued operation	1.00	1.00	1.00
4. Standard occupancy structures[3]	All structures housing occupancies or having functions not listed in Category 1, 2 or 3 and Group U Occupancy towers	1.00	1.00	1.00
5. Miscellaneous structures	Group U Occupancies except for towers	1.00	1.00	1.00

Seismic Design

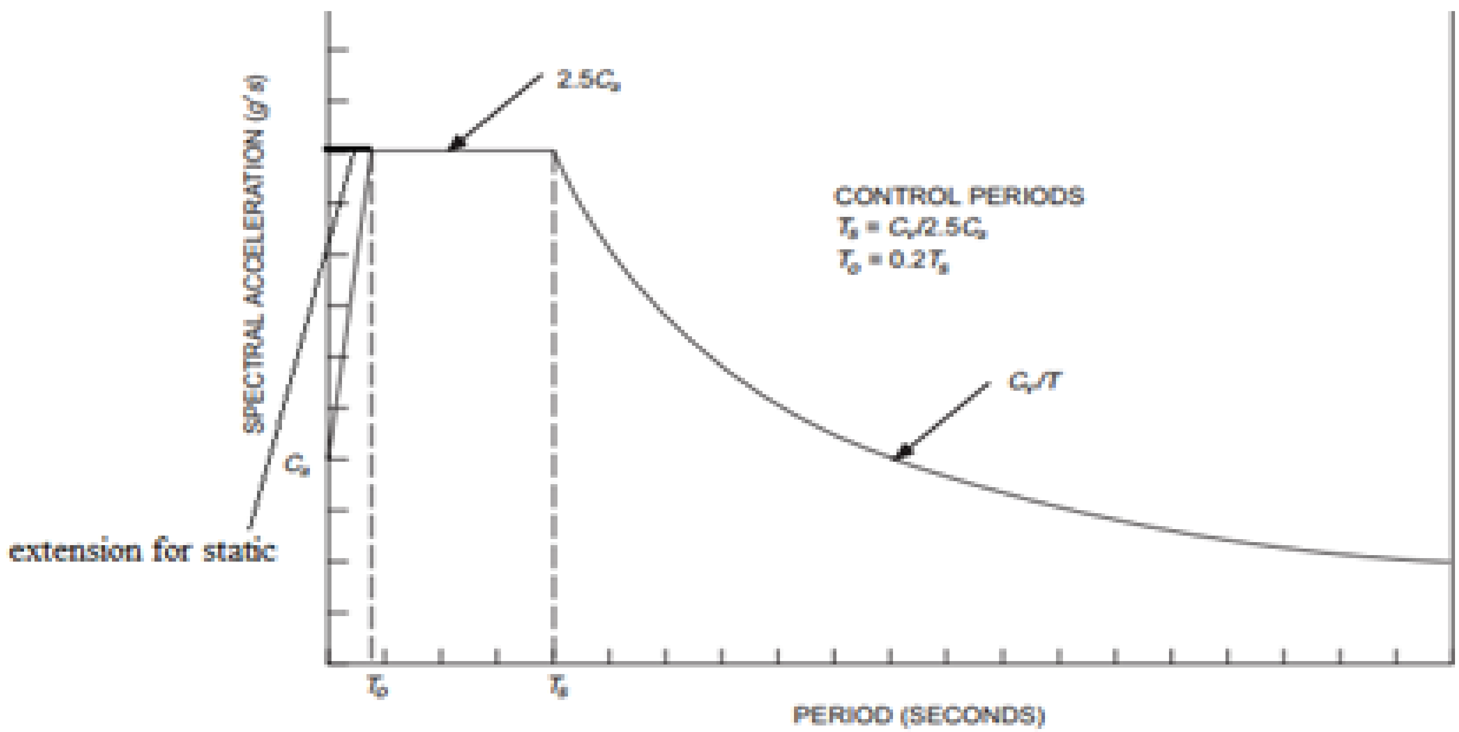
Parameters

- Response modification factor R=5.5

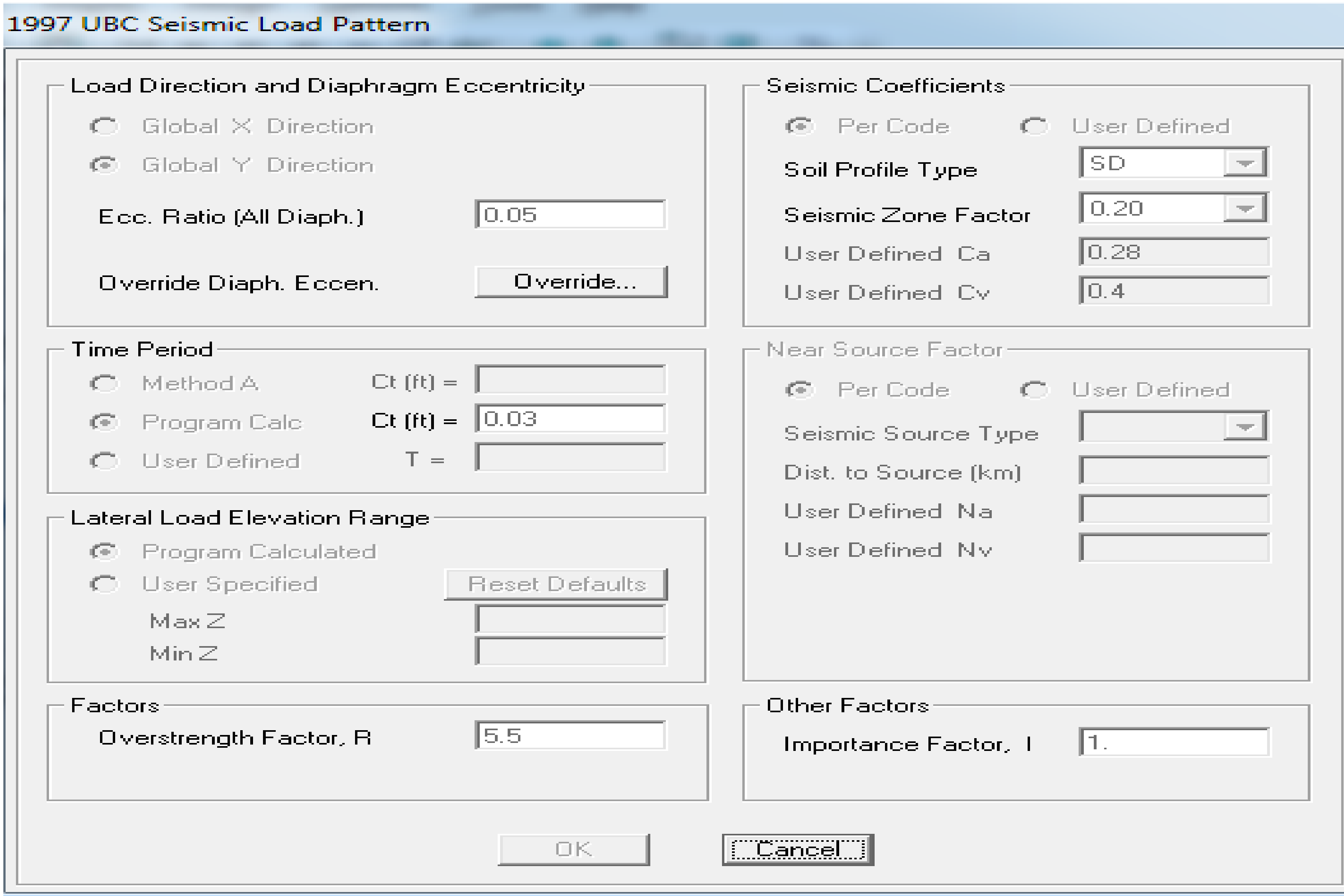
TABLE 16-N—STRUCTURAL SYSTEMS[1]

BASIC STRUCTURAL SYSTEM[2]	LATERAL-FORCE-RESISTING SYSTEM DESCRIPTION	R	Ω_0	HEIGHT LIMIT FOR SEISMIC ZONES 3 AND 4 (feet) × 304.8 for mm
1. Bearing wall system	1. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	5.5	2.8	65
	b. All other light-framed walls	4.5	2.8	65
	2. Shear walls			
	a. Concrete	4.5	2.8	160
	b. Masonry	4.5	2.8	160
	3. Light steel-framed bearing walls with tension-only bracing	2.8	2.2	65
	4. Braced frames where bracing carries gravity load			
	a. Steel	4.4	2.2	160
	b. Concrete[3]	2.8	2.2	—
	c. Heavy timber	2.8	2.2	65
2. Building frame system	1. Steel eccentrically braced frame (EBF)	7.0	2.8	240
	2. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	6.5	2.8	65
	b. All other light-framed walls	5.0	2.8	65
	3. Shear walls			
	a. Concrete	5.5	2.8	240
	b. Masonry	5.5	2.8	160
	4. Ordinary braced frames			
	a. Steel	5.6	2.2	160
	b. Concrete[3]	5.6	2.2	—
	c. Heavy timber	5.6	2.2	65
	5. Special concentrically braced frames			
	a. Steel	6.4	2.2	240
3. Moment-resisting frame system	1. Special moment-resisting frame (SMRF)			
	a. Steel	8.5	2.8	N.L.
	b. Concrete[4]	8.5	2.8	N.L.
	2. Masonry moment-resisting wall frame (MMRWF)	6.5	2.8	160
	3. Concrete intermediate moment-resisting frame (IMRF)[5]	5.5	2.8	—
	4. Ordinary moment-resisting frame (OMRF)			
	a. Steel[6]	4.5	2.8	160
	b. Concrete[7]	3.5	2.8	—
	5. Special truss moment frames of steel (STMF)	6.5	2.8	240

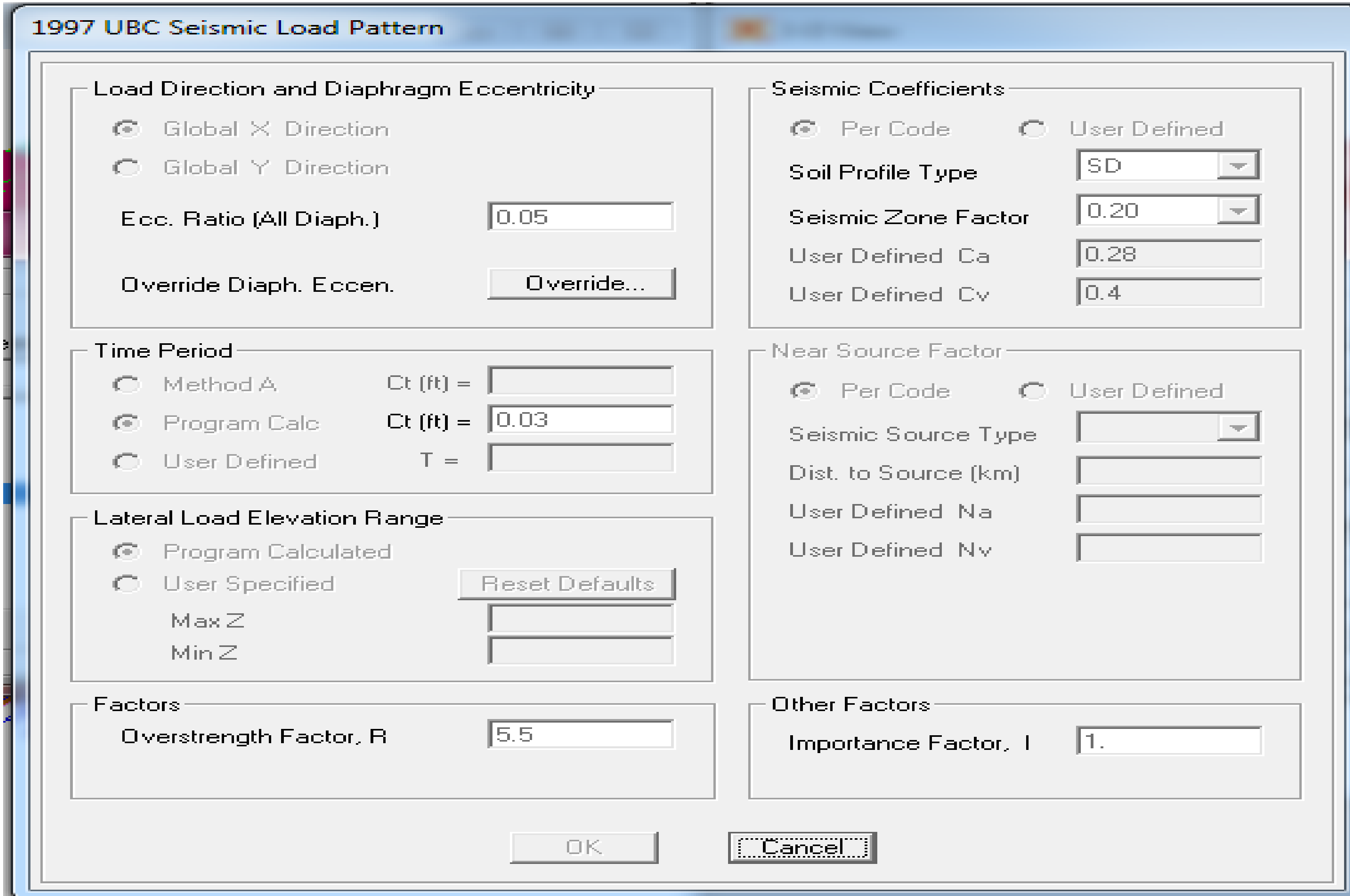
Using response spectrum to determine the design base shear



Define equivalent static in Y-direction

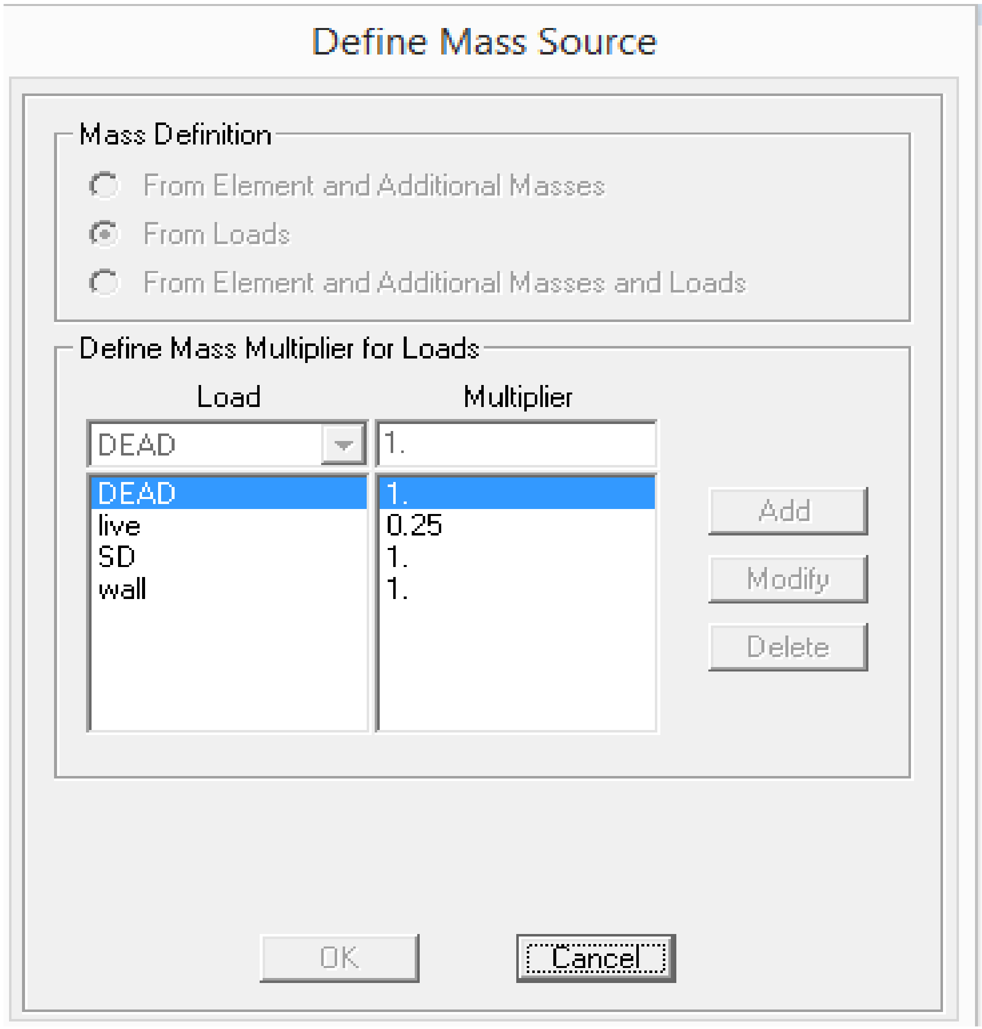


Define equivalent static in x-direction



Seismic Design

- Define mass source(super imposed load).



Seismic Design

Verification for Earth Quake

1. Check Period

- ✓ check period by using Method A formula:

$T = C_t * H^{3/4}$

Where: C_t =0.03(0.0731) for moment resistant concrete frames

$T = 0.0731 * (25.87)^{3/4}$

$T = 0.83 sec$

Verification for Earth Quake

Period from SAP

Modal Participating Mass Ratios

File View Format-Filter-Sort Select Options

Units: As Noted

Modal Participating Mass Ratios

	OutputCase Text	StepType Text	StepNum Unitless	Period Sec	UX Unitless	UY Unitless	UZ Unitless
	MODAL	Mode	1	1.008848	0.00012	0.66973	0.000004365
	MODAL	Mode	2	0.951035	0.000001027	0.000002977	0.00216
	MODAL	Mode	3	0.502518	0.00092	0.00000251	0.00061
	MODAL	Mode	4	0.48736	0.5095	0.00049	0.000003256
	MODAL	Mode	5	0.481737	0.00001785	0.0000009025	0.000009888
	MODAL	Mode	6	0.480346	0.01133	0.00011	0.00104
	MODAL	Mode	7	0.456994	0.00041	0.00002233	0.00051
	MODAL	Mode	8	0.432671	0.00007645	0.000000452	0.0000008571
	MODAL	Mode	9	0.430628	0.00037	0.000007938	0.00000919
	MODAL	Mode	10	0.430134	0.0000003789	0.0000003998	0.000005107
	MODAL	Mode	11	0.429555	0.0014	0.0000143	0.00002585
	MODAL	Mode	12	0.428449	0.0000001424	0.0000006337	0.00000008435
	MODAL	Mode	13	0.427468	0.0000002243	0.000008602	0.00004524
	MODAL	Mode	14	0.380277	0.00192	0.000005168	0.00395
	MODAL	Mode	15	0.379384	0.00054	0.000001756	0.001
	MODAL	Mode	16	0.378059	0.00026	0.000000623	0.00038
	MODAL	Mode	17	0.377255	0.00044	0.00001916	0.00512

Record: 23 of 200 Add Tables... Done

Seismic Design

Verification for Earth Quake

✓ Results:

period from SAP should be ≤ 1.3T(method A)

1.3T(method A) =1.3*(0.83) =1.079 sec

From SAP	Period (Tn sec) In x-direction	Period (Tn sec) In Y-direction
	0.487	1.008

Verification for Earth Quake

- 2.Modal participation mass ratio in X and Y > 90%

OutputCase Text	StepType Text	StepNum Unitless	Period Sec	UX Unitless	UY Unitless	UZ Unitless	SumUX Unitless	SumUY Unitless	SumUZ Unitless
MODAL	Mode	136	0.121221	0.00028	0.00022	0.00014	0.84041	0.86998	0.45914
MODAL	Mode	137	0.120867	0.0007	0.00085	0.02115	0.84111	0.87083	0.48028
MODAL	Mode	138	0.118669	0.01437	0.00304	0.00054	0.85548	0.87386	0.48082
MODAL	Mode	139	0.11698	0.00096	0.00037	0.00189	0.85644	0.87424	0.48271
MODAL	Mode	140	0.115354	0.0000009171	0.00066	0.00018	0.85644	0.8749	0.48288
MODAL	Mode	141	0.112841	0.00076	0.00109	0.00078	0.8572	0.87599	0.48367
MODAL	Mode	142	0.112047	0.00444	0.00000006493	0.00241	0.86164	0.87599	0.48608
MODAL	Mode	143	0.109629	0.00055	0.00079	0.00311	0.86219	0.87678	0.48919
MODAL	Mode	144	0.109139	0.00495	0.00003381	0.00016	0.86713	0.87681	0.48935
MODAL	Mode	145	0.106769	0.00591	0.00036	0.00026	0.87304	0.87717	0.4896
MODAL	Mode	146	0.106526	0.00024	0.00071	0.00002674	0.87328	0.87787	0.48963
MODAL	Mode	147	0.103315	0.04034	0.00043	0.00014	0.91361	0.8783	0.48976
MODAL	Mode	148	0.102334	0.00083	0.0007	0.00002565	0.91444	0.879	0.48979
MODAL	Mode	149	0.101094	0.01263	0.00025	0.00139	0.92707	0.87925	0.49118
MODAL	Mode	150	0.098635	0.00005339	0.00075	0.00059	0.92712	0.88	0.49177
MODAL	Mode	151	0.09696	0.00061	0.000008912	0.00036	0.92773	0.88001	0.49213
MODAL	Mode	152	0.095232	0.00026	0.00267	0.00003296	0.92799	0.88268	0.49217
MODAL	Mode	153	0.093453	0.00298	0.00583	0.000002787	0.93097	0.88851	0.49217
MODAL	Mode	154	0.092337	0.00069	0.00323	0.00025	0.93166	0.89174	0.49242
MODAL	Mode	155	0.089911	0.00431	0.00024	0.00851	0.93596	0.89199	0.50093
MODAL	Mode	156	0.08943	0.00184	0.00133	0.00419	0.9378	0.89331	0.50512
MODAL	Mode	157	0.085962	0.00552	0.00032	0.00038	0.94332	0.89364	0.5055
MODAL	Mode	158	0.084568	0.00019	0.00042	0.0003	0.94352	0.89405	0.50581
MODAL	Mode	159	0.082244	0.00972	0.00028	0.0015	0.95324	0.89434	0.50731
MODAL	Mode	160	0.081356	0.00016	0.00341	0.00028	0.9534	0.89775	0.50759
MODAL	Mode	161	0.078968	0.00092	0.000003747	0.00595	0.95432	0.89775	0.51354
MODAL	Mode	162	0.076317	0.00045	0.00083	0.00024	0.95478	0.89859	0.51378
MODAL	Mode	163	0.074393	0.00153	0.00004455	0.00035	0.95631	0.89863	0.51413
MODAL	Mode	164	0.073978	0.00399	0.00145	0.0003	0.96029	0.90008	0.51443
MODAL	Mode	165	0.070333	0.00068	0.00002704	0.00025	0.96097	0.9001	0.51468
MODAL	Mode	166	0.069666	0.00015	0.00034	0.0006	0.96112	0.90044	0.51528
MODAL	Mode	167	0.067712	0.00039	0.0000001268	0.00063	0.96151	0.90044	0.51591
MODAL	Mode	168	0.064231	0.000007438	0.00202	0.000003348	0.96152	0.90247	0.51592
MODAL	Mode	169	0.062541	0.00004403	0.00127	0.00001166	0.96156	0.90374	0.51593
MODAL	Mode	170	0.061956	0.00049	0.00152	0.00004054	0.96205	0.90526	0.51597
MODAL	Mode	171	0.059215	0.00776	0.00411	0.0000003589	0.96981	0.90937	0.51597

Verification for Earth Quake

3.Check drift, P– Δ effect,

- **The time of structure is greater than 0.7 sec, the calculated story drift shall not exceed 0.020 times the story height.**

- Δ allowable = $\frac{L}{50} = \frac{4.42}{50} * 1000$ =88.4mm

In X direction

From SAP >> ΔS = 2.3mm

$\Delta M = 0.7 * R * \Delta S$

$\Delta M = 0.7*5.5*2.3 = 8.85$ mm

$\Delta M < \Delta$allowable

In Y direction

From SAP >> ΔS = 25.1mm

$\Delta M = 0.7 * R * \Delta S$

$\Delta M = 0.7*5.5*5.1 = 19.6$ mm

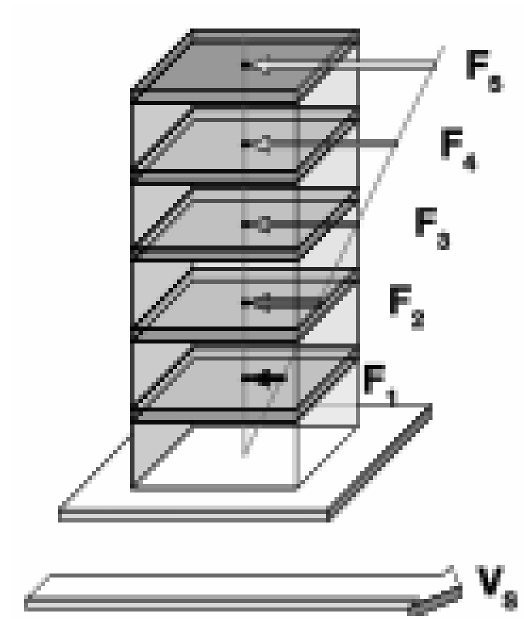
$\Delta M < \Delta$allowable

Seismic Design

Verification for Earth Quake

Determine of Base Shear

- V = $\frac{CvI}{RT}w$, this value must be between:
  - Max: V = $\frac{2.5\ CaI}{R}w$
  - Min: V = 0.11 Ca I W



Seismic Design

Base shear Calculations

<u>In X direction</u>

Cs=0.15

Cs max =0.1272

Cs min =0.0308

Cs min< Cs >Cs max

Base shear (V) = 0.1272 *122214.285 = 15545.65kN. `

<u>In Y direction</u>

Cs=0.072

Cs max =0.1272

Cs min =0.0308

Cs min < Cs < Cs max ☐OK.

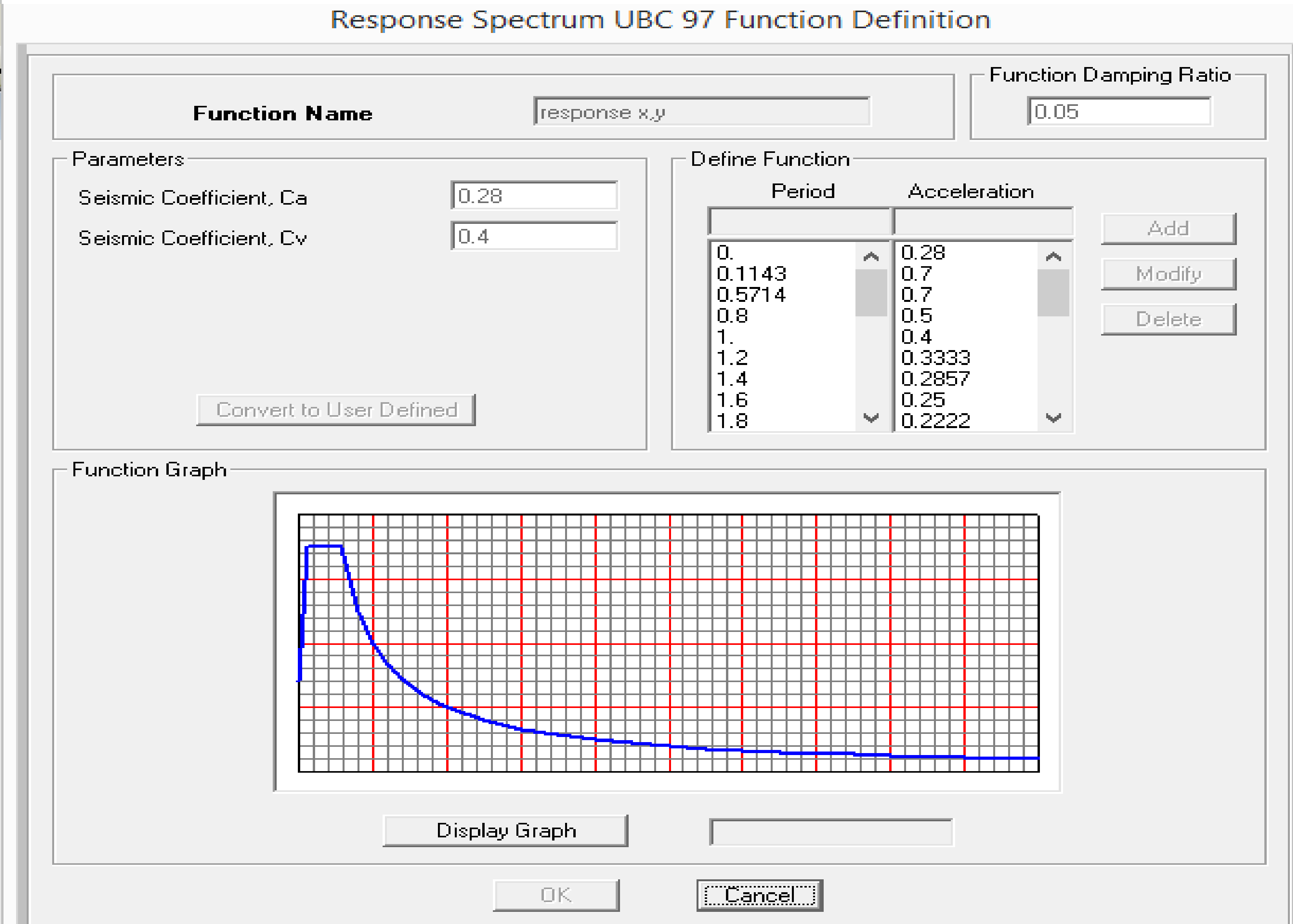
Base shear (V)= 0.072 *122214.285 =8799.4kN.

Seismic Design

Base shear Results From SAP

From SAP	Base shear in x-direction (kN)	Base shear in y-direction (kN)
	15554.455	8810.362

Definition of Response Spectrum Function



Definition of Response Spectrum Function

- Scale factor: $\frac{I * g}{R}$

I: Importance factor = 1

g: Gravity acceleration = 9.81 m/s^2

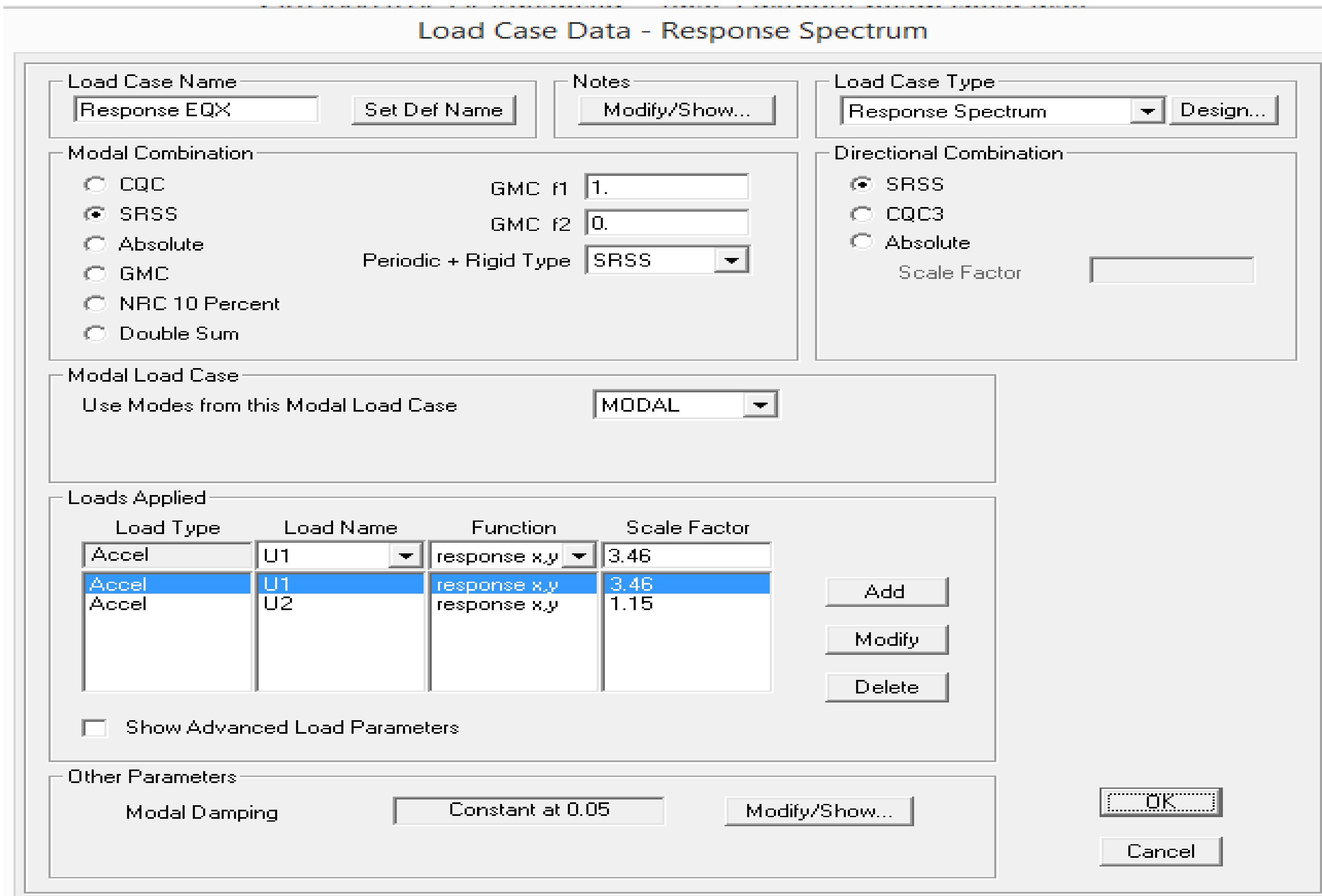
R: Response Modification Coefficient.

Note :

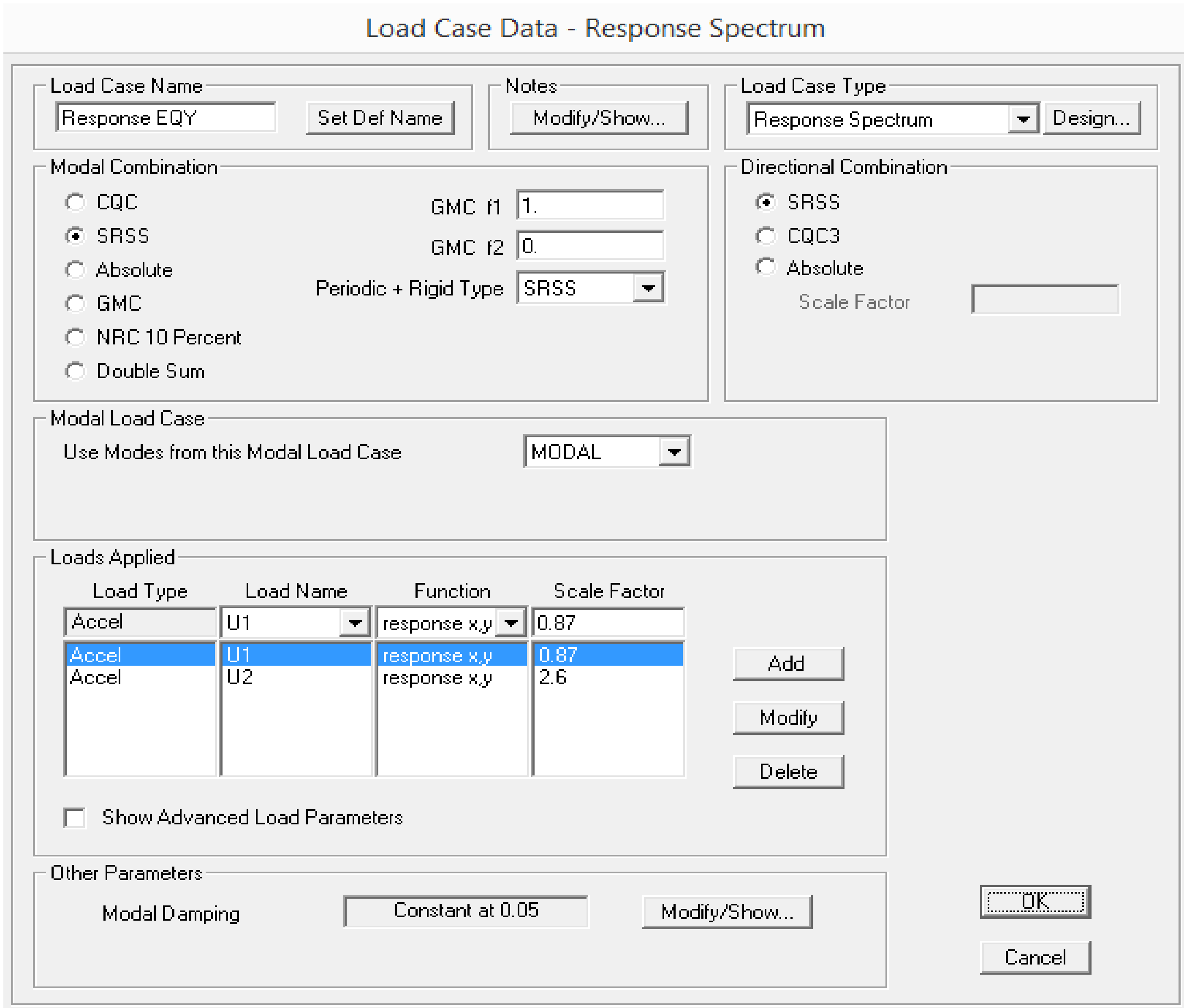
for each direction there must be
a component of 30% from the perpendicular direction.

As a requirement from UBC-97 :
response spectrum base shear is (85- 100) % of the base shear determined in equivalent static method. So modify scale factor:

Scale Factor



Scale Factor



Seismic Design

Base shear Static in X direction = 15545.65kN.
Base shear Static in Y direction = 8799.4kN.

Base shear Results From SAP

From SAP	Base shear in x-direction (kN)	Base shear in y-direction (kN)
	15966.27	8921.362

Note :

After modifications the value of base shear from response analysis is greater than the value from static calculations.

Design and detailing

Structural elements:

- Slab
- Beams
- Shear wall
- Columns
- Footing

Detailing & Design

Slab design & detailing

Check Slab thickness

$$\emptyset V_c = \frac{0.75 * \sqrt{25} * 1000 * 160}{6} = 100 \text{ kN}$$

V_{u23}, max from sap = 34.268kN

V_{u13}, max from sap= 40.322kN

$\Phi V_c > V_u$ Then the thickness is . OK .

Slab design & detailing

Reinforcement:

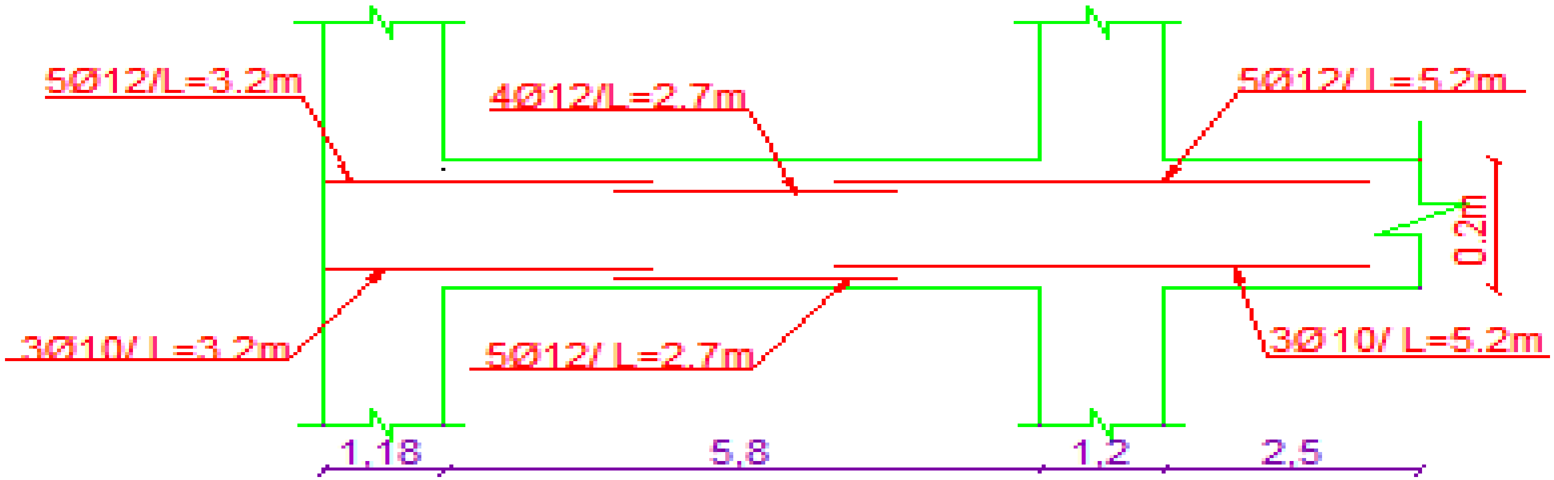
$$A_{s,min} = 0.0018 * b * d = 0.0018 * 1000 * 160 = 288 \text{ mm}^2$$

$\Longrightarrow use$ 4ø12/m

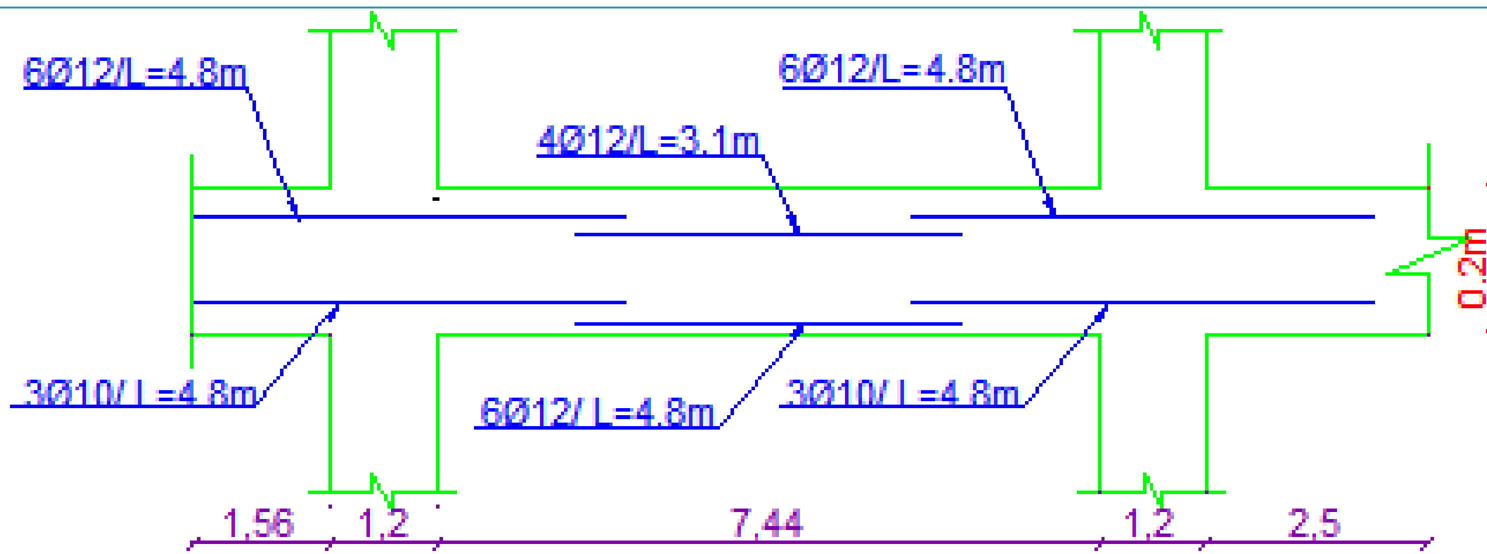
Note:

4ø12/m is used in regions with moment 26.6kN.mwhenever the moment is greater than this additional steel is used .

Slab Detailing :



Section in Y-direction



Section in x-direction

Columns design & detailing

Check slenderness:

Need to find Moments of inertia for sections are:

For interior column in group 2:

Diameter of column = 800 mm

For Beam T (0.8*0.4)Ig=0.0272m4

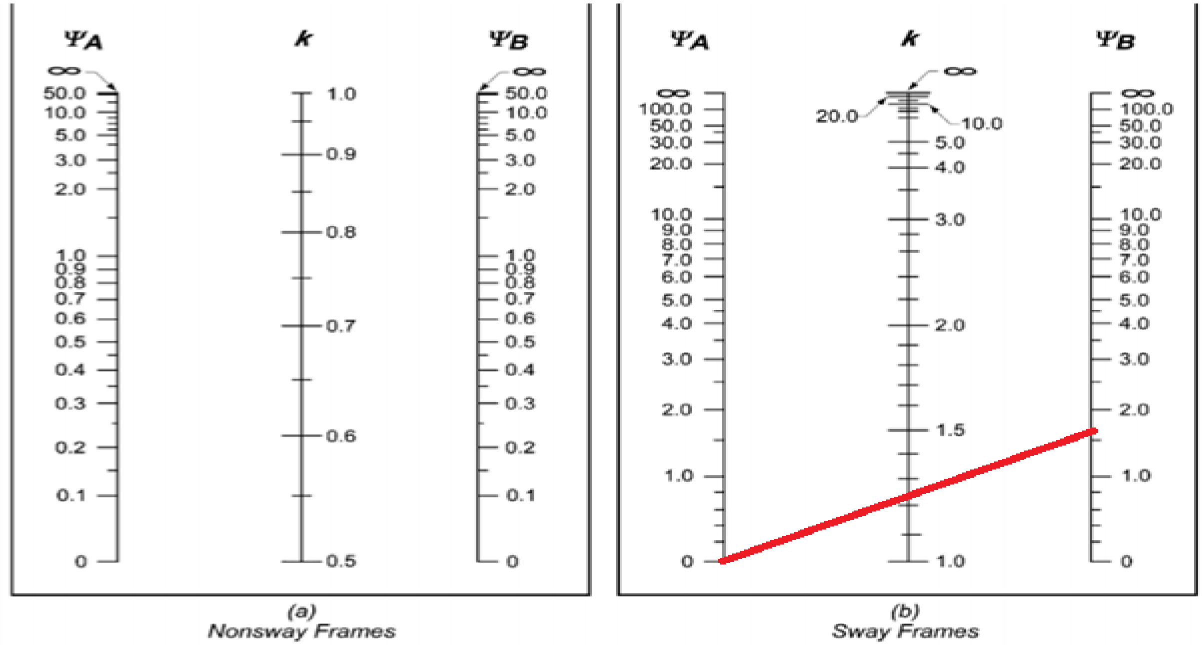
For column (D=0.8) Ig=0.0201m4

E for column=$4700\sqrt{30} = 25742.96$ Mpa

E for Beam=$4700\sqrt{25} = 23500$ Mpa

φA =0 Because support of column is Fixed

φB =1.654



Ψ = ratio of Σ(EI/ℓc) of compression members to Σ(EI/ℓ) of flexural members in a plane at one end of a compression member

ℓ = span length of flexural member measured center to center of joints

For Sway Frame

K=1.22

Neglect slenderness if $\left(\frac{\mathrm{kLu}}{\mathrm{r}} \leq 22\right)$

Lu= (3.88-($\frac{0.8}{2}$)) =3.48 m

$\frac{\mathrm{KLu}}{\mathrm{r}} = \frac{1.22*3.48}{0.25(0.8)}$= 21.2

Then the column is non slender

Columns design & detailing

Reinforcement

The value of longitudinal reinforcement from SAP: 17Φ22

- Spiral spaces :

$S=\frac{4\ Asp}{\rho s\ Dc}$ =< 75 mm

We use Φ=10mm for spiral s

$Asp = 78.5\ mm^2$

Dc = 800-120 = 680mm

$\rho s= 0.45\ (\frac{Ag}{Ach} -1)\ \frac{fc}{fy}$

$Ag = 502654.8\ mm^2$

$Ach = \frac{\pi}{4} D_C{}^2 = 363168\ mm^2$

$\rho s = 0.0123$

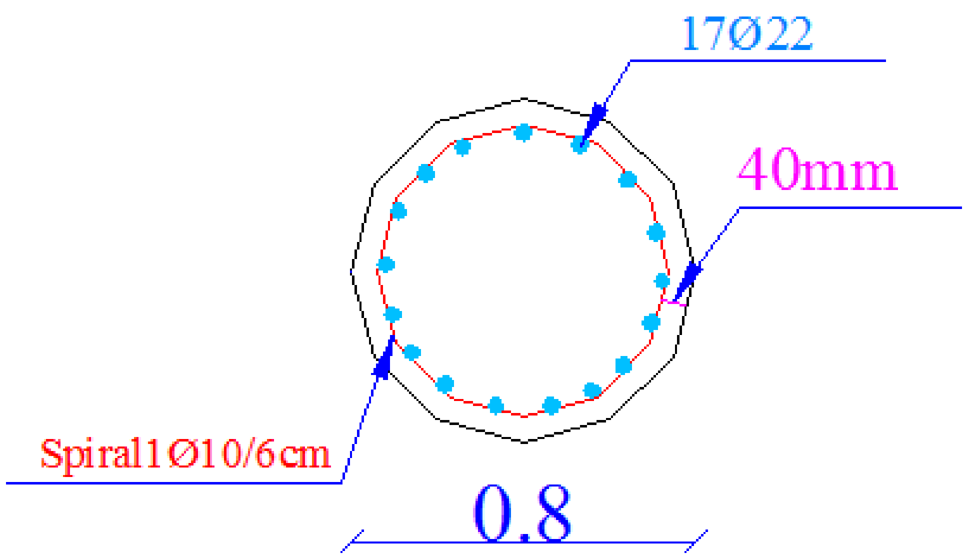
S = 37.5 mm < 75mm

∴ **Use 1Φ10 / 60 mm for spiral**

Columns design & detailing

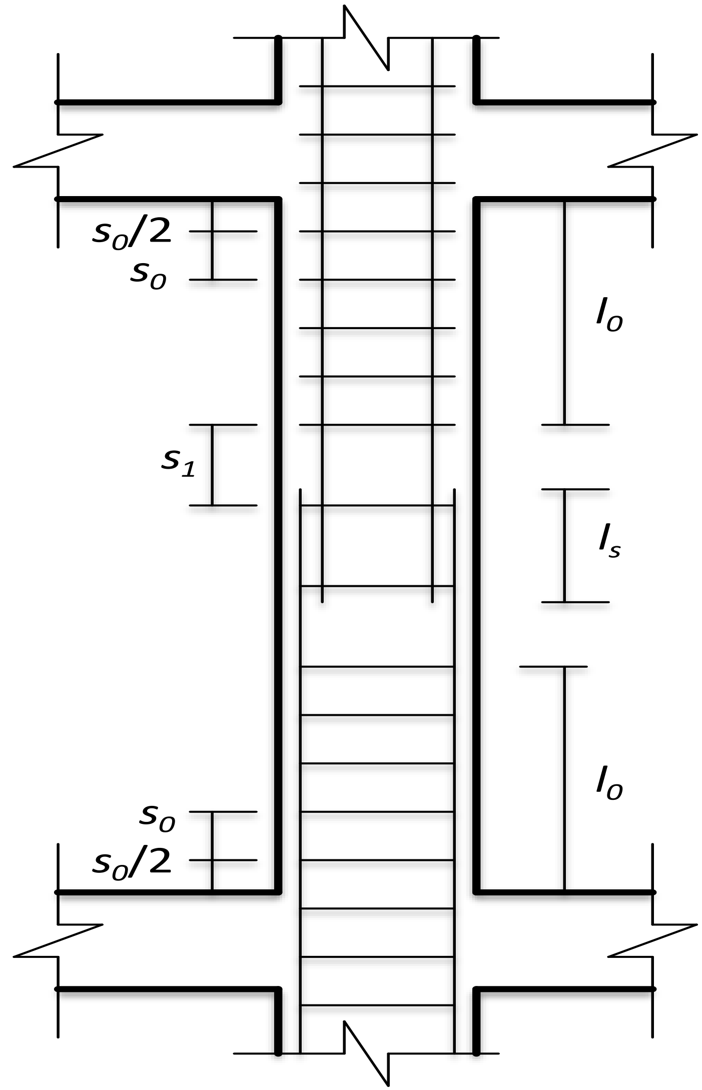
Column detail:

Column Name	Column Dimension	Number of Bars	Ls=1.3Ld	Spacing between Spiral
C2	D=80 mm	17Ø22	1.2 m	6 cm



General Detailing and design according code UBC97

Column No	Column width (m)	column depth (m)	Reinforcement
C1	0.65	0.3	12Ø16
C2	D=0.8	D=0.8	17Ø22
C2.1	D=0.8	D=0.8	20Ø25
C2.2	D=0.8	D=0.8	17Ø32
C3	0.4	1.1	18Ø18
C3.1	0.4	1.1	22Ø22
C3.2	0.4	1.1	18Ø32
C4	0.8	1.1	24Ø32
C5	0.5	1.0	18Ø20



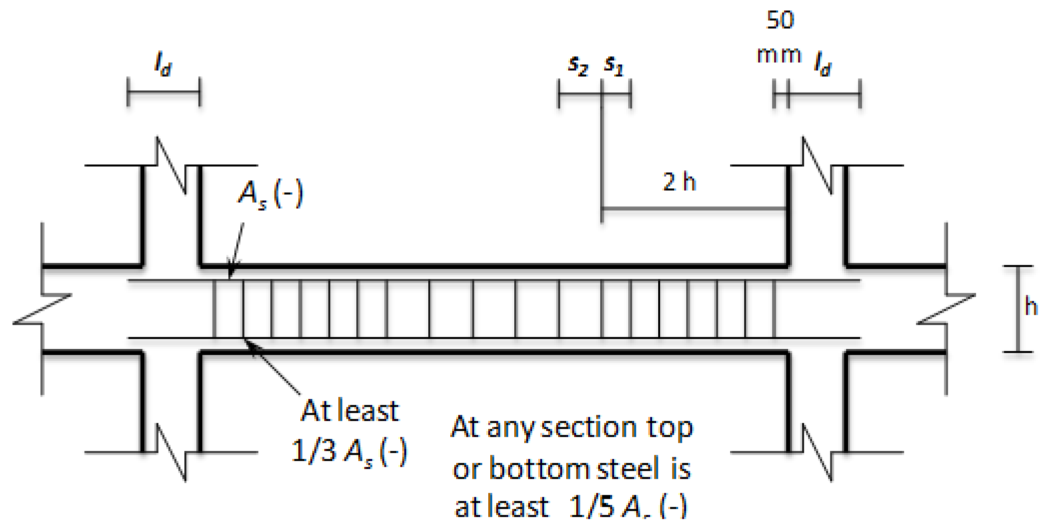
Beams design & detailing

Beam design:

Check Slab thickness

Vu= 313.207 KN.

$ØV_c$ = 190 KN.



Vu > ØVc So need Shear reinforcement

Vs= 164.6 kN

$\frac{Av}{s}$ = 0.514

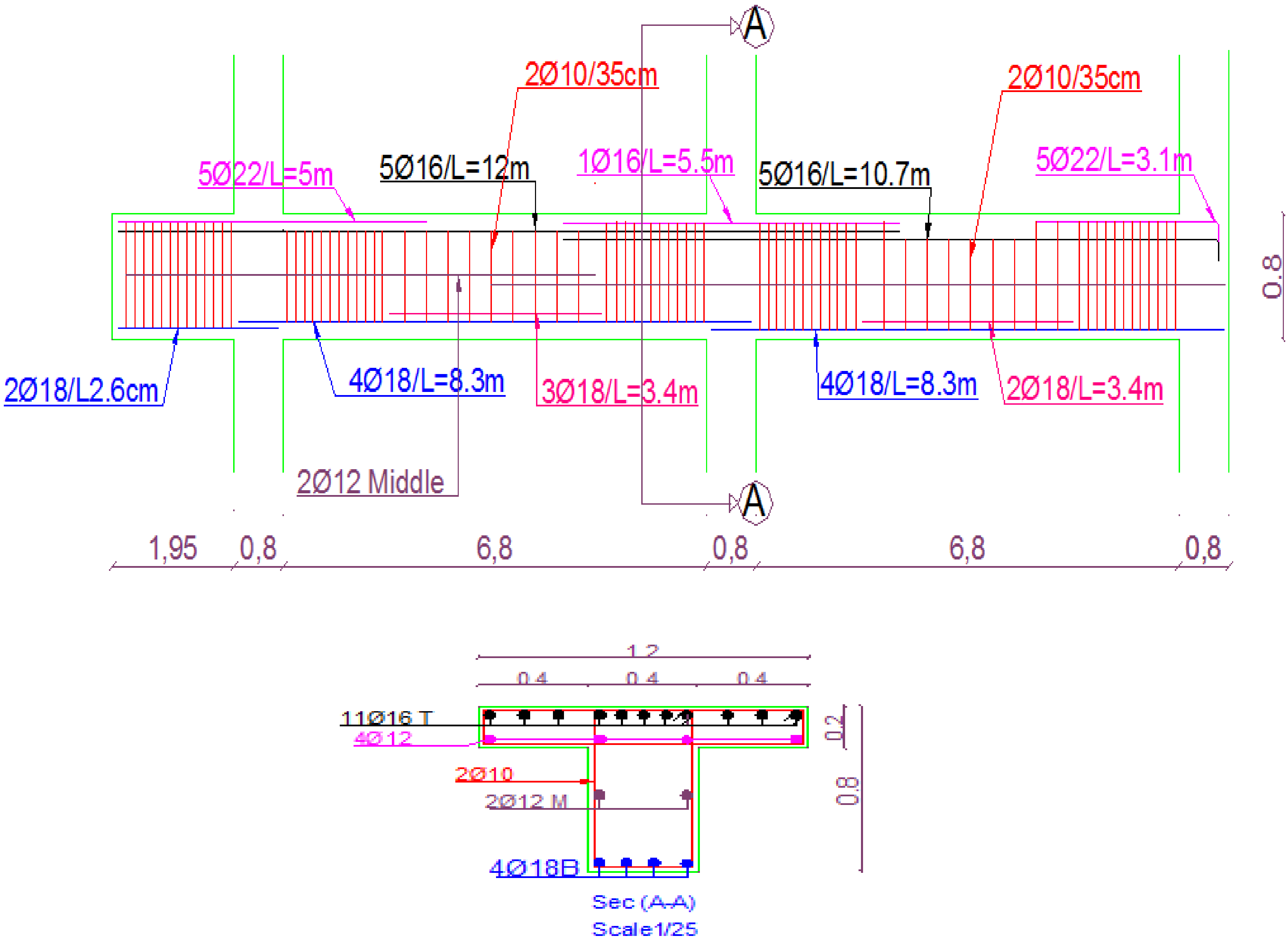
$S = 31cm$

$$s_1 = Min\begin{Bmatrix} d/4 \\ 8d_b \\ 24d_s \\ 300\ mm \end{Bmatrix}$$

$S1 = 1\ 4cm$

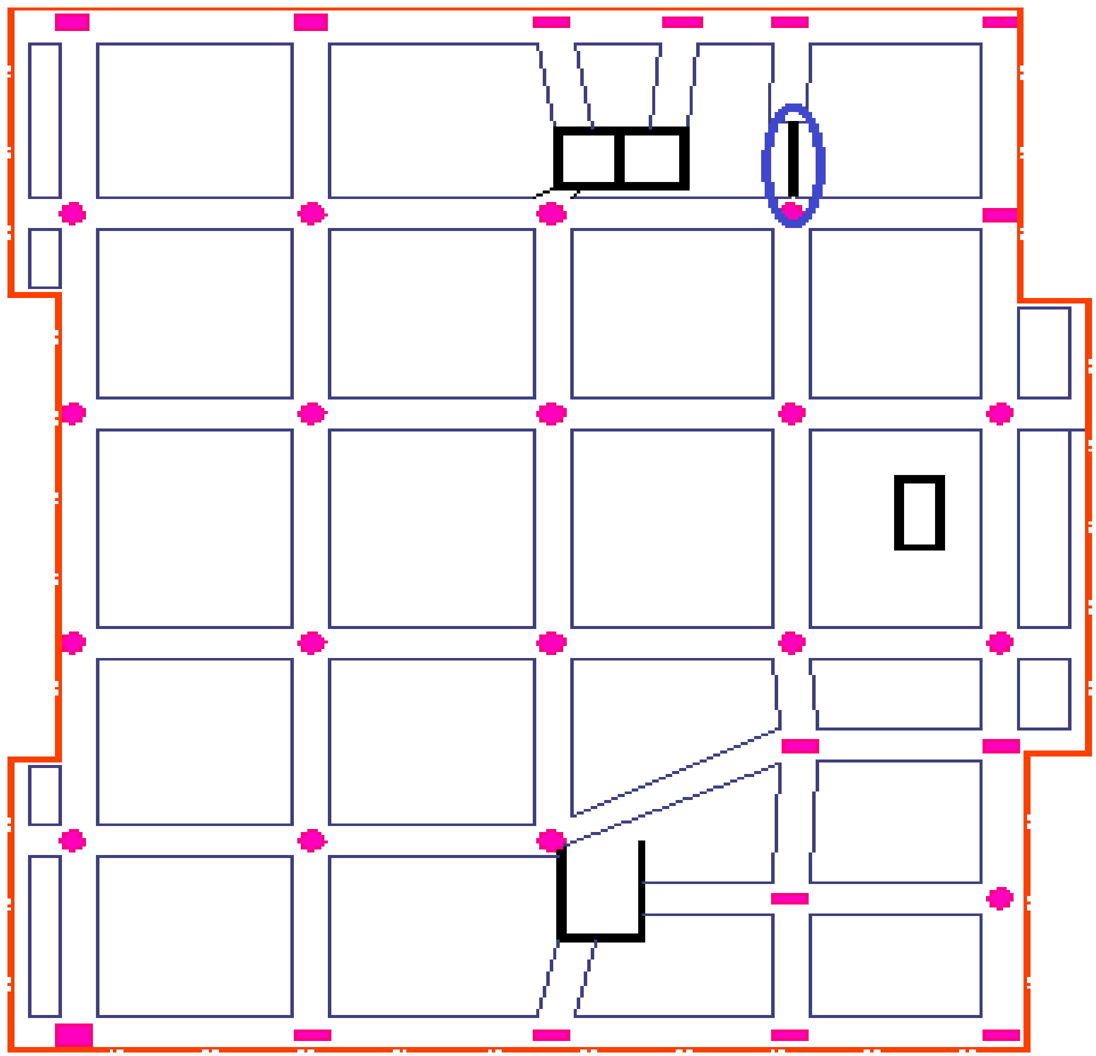
$S2 = 35cm$

s2 = d/2



2Ø10/35cm
2Ø10/35cm
5Ø22/L=5m
5Ø16/L=12m
1Ø16/L=5.5m
5Ø16/L=10.7m
5Ø22/L=3.1m
0.8
2Ø18/L2.6cm
4Ø18/L=8.3m
3Ø18/L=3.4m
4Ø18/L=8.3m
2Ø18/L=3.4m
2Ø12 Middle
A
A
1,95
0,8
6,8
0,8
6,8
0,8
1.2
0.4
0.4
0.4
11Ø16 T
4Ø12
2Ø10
2Ø12 M
4Ø18B
0.2
0.8
Sec (A-A)
Scale1/25

Shear wall design & detailing

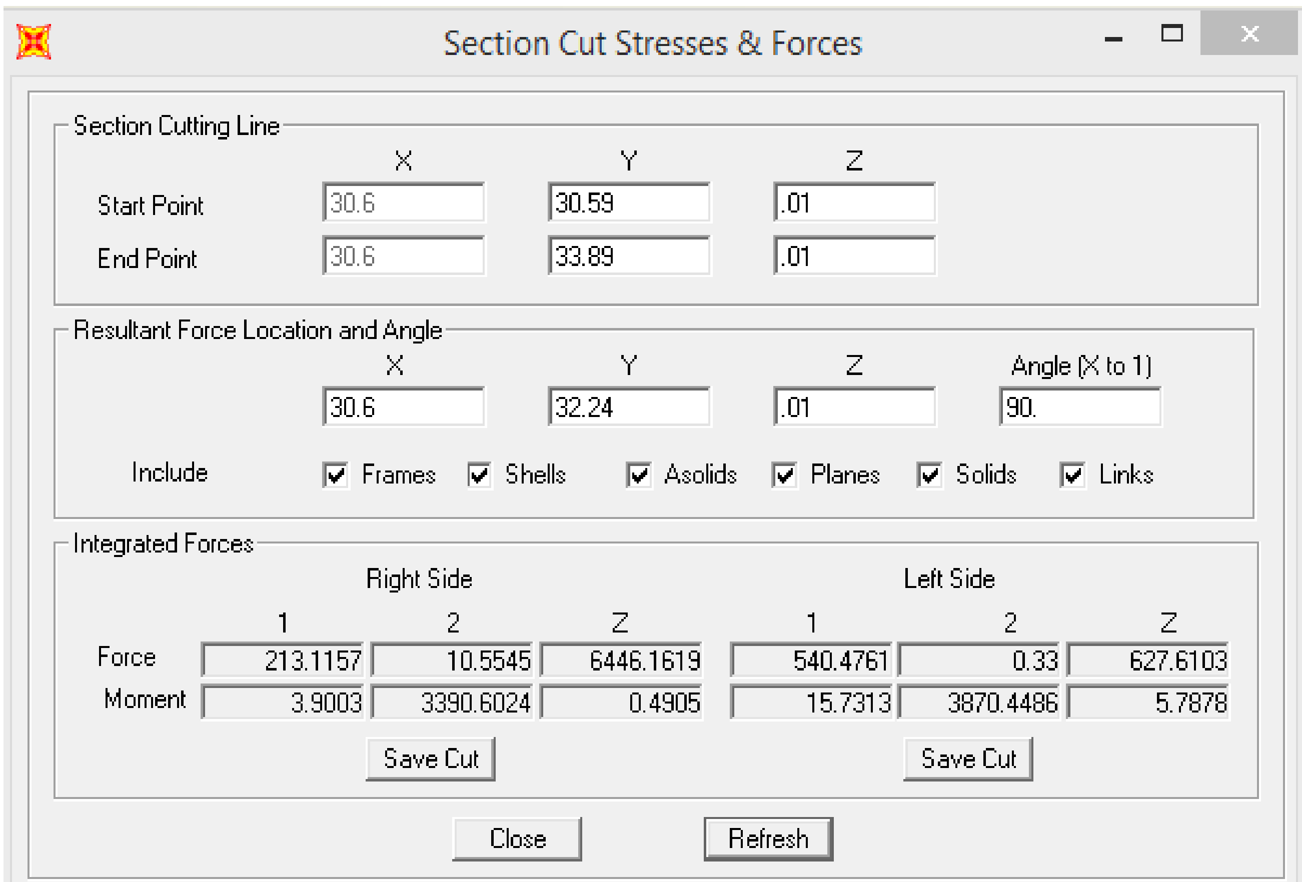


Shear wall design & detailing

Shear wall design:

Thickness= 200mm

Internal forces:



Shear wall design & detailing

Shear wall detailing:

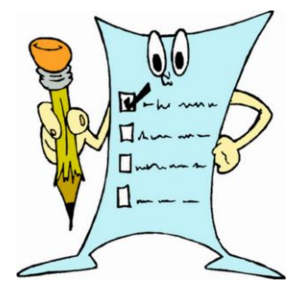
Total longitudinal reinforcement =As from My+ As from Mx

Total longitudinal reinforcement=$346*2+1650=2342\ mm^2$

For horizontal steel from Vuy =540.5kN

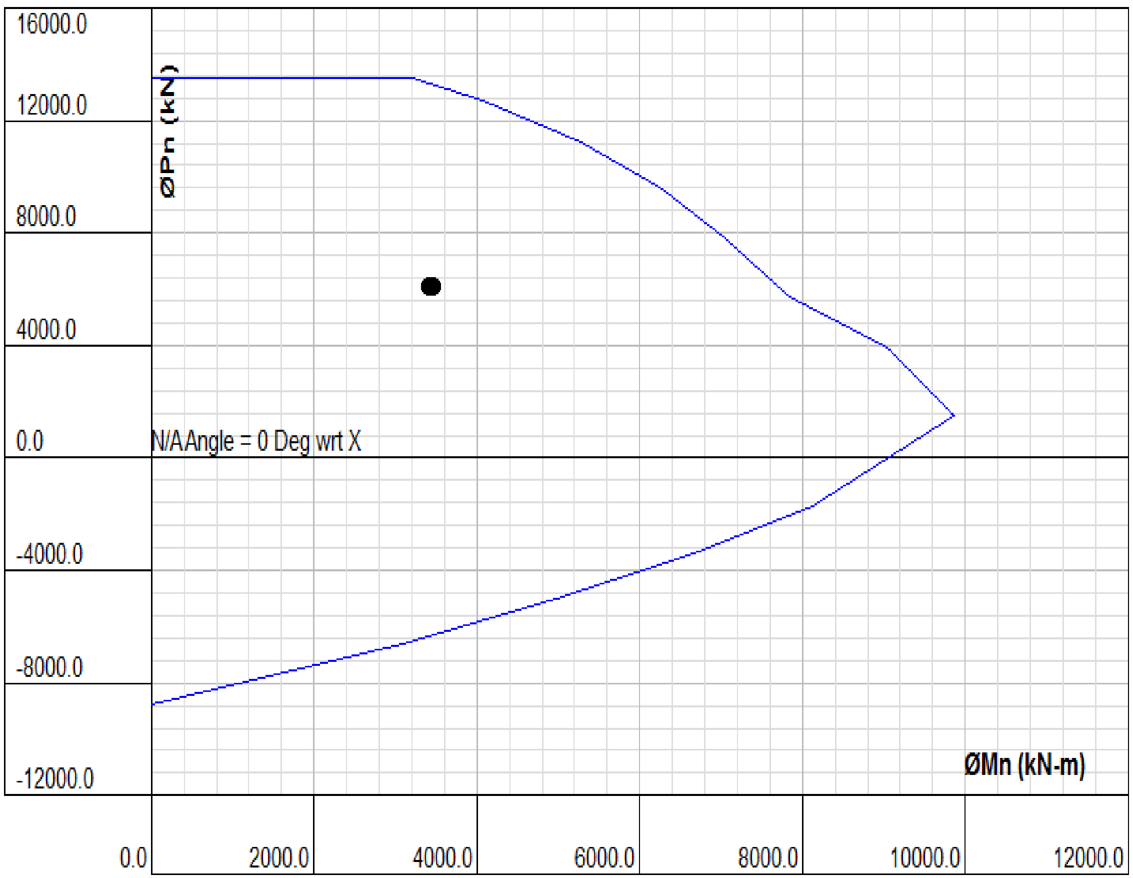
Use longitudinal reinforcement 4Ø12/m on each side

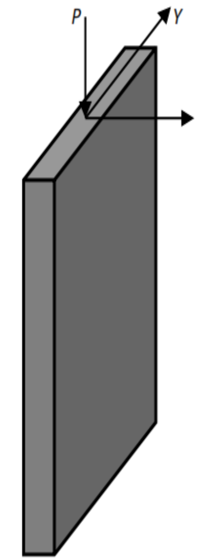
Use horizontal steel use 2ø12/350mm



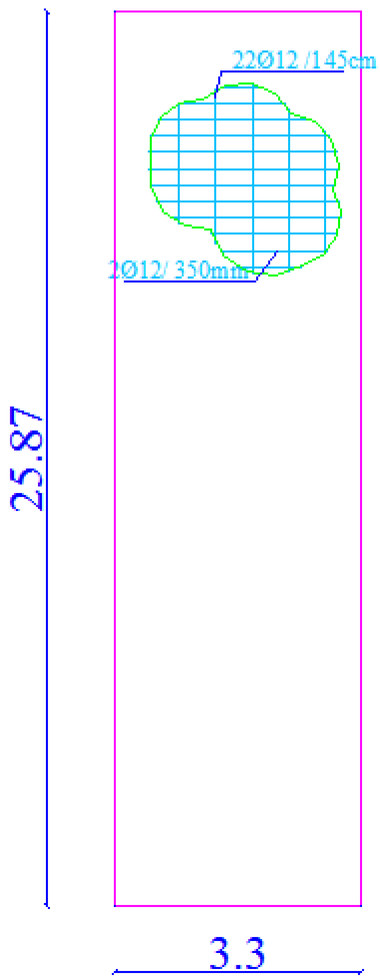
Shear wall design & detailing

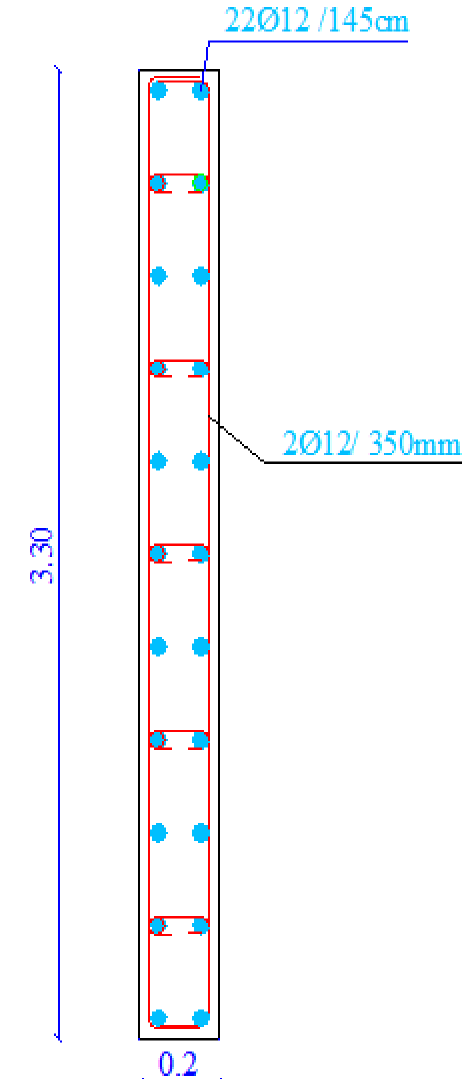
Axial and Flexural: interaction diagram





Shear wall detailing:



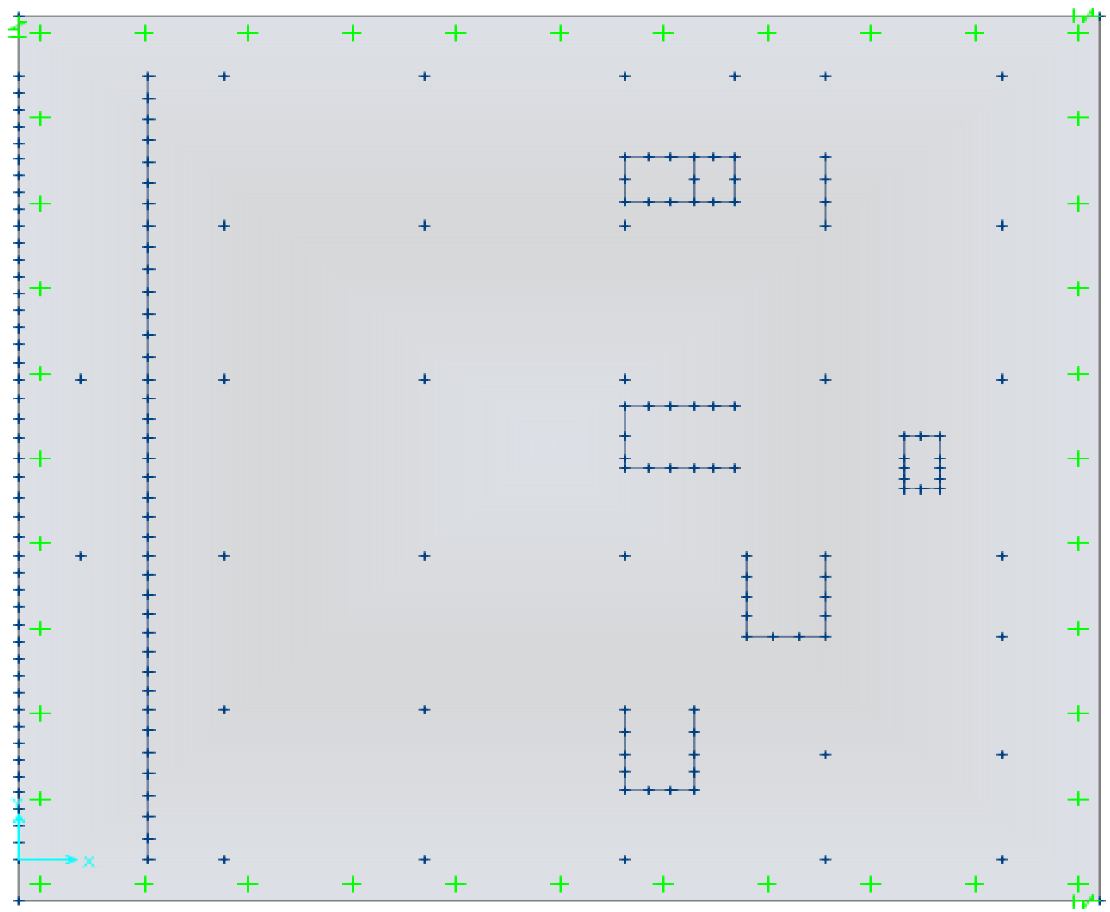


Mat foundation design & detailing

Thickness assumed :700mm

The dimension in X-direction =41m

The dimension in Y-direction= 42m

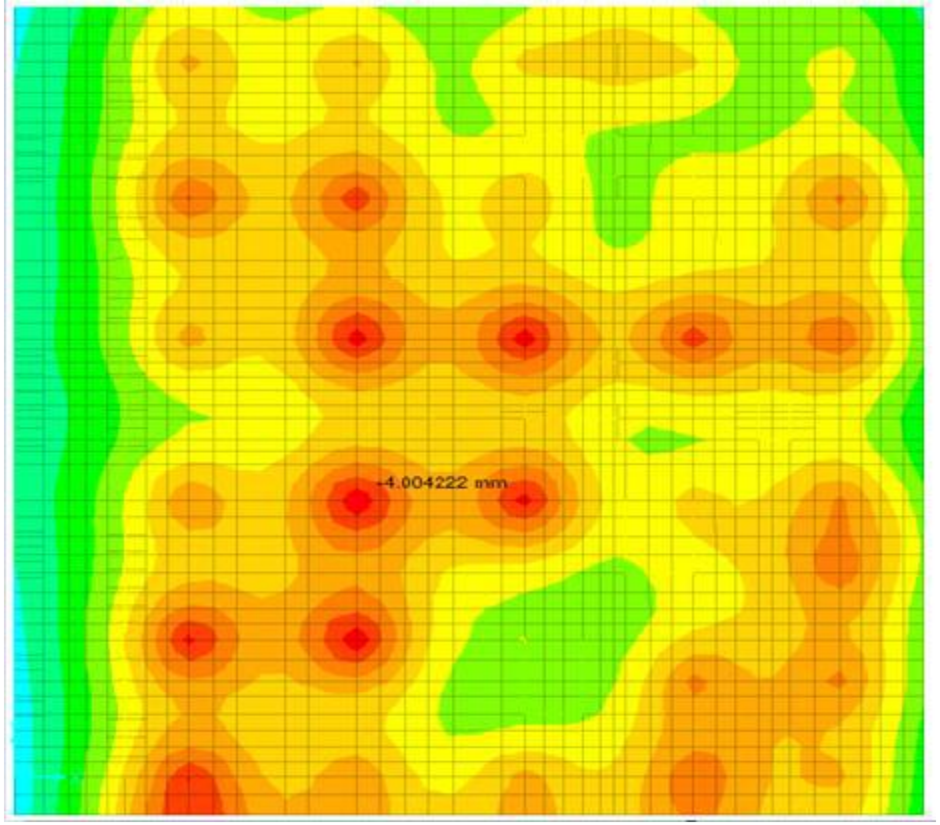


Verifications

1-Check deflection

max deflection =4mm < ∆ allowable 10mm

No need to increase dimensions.

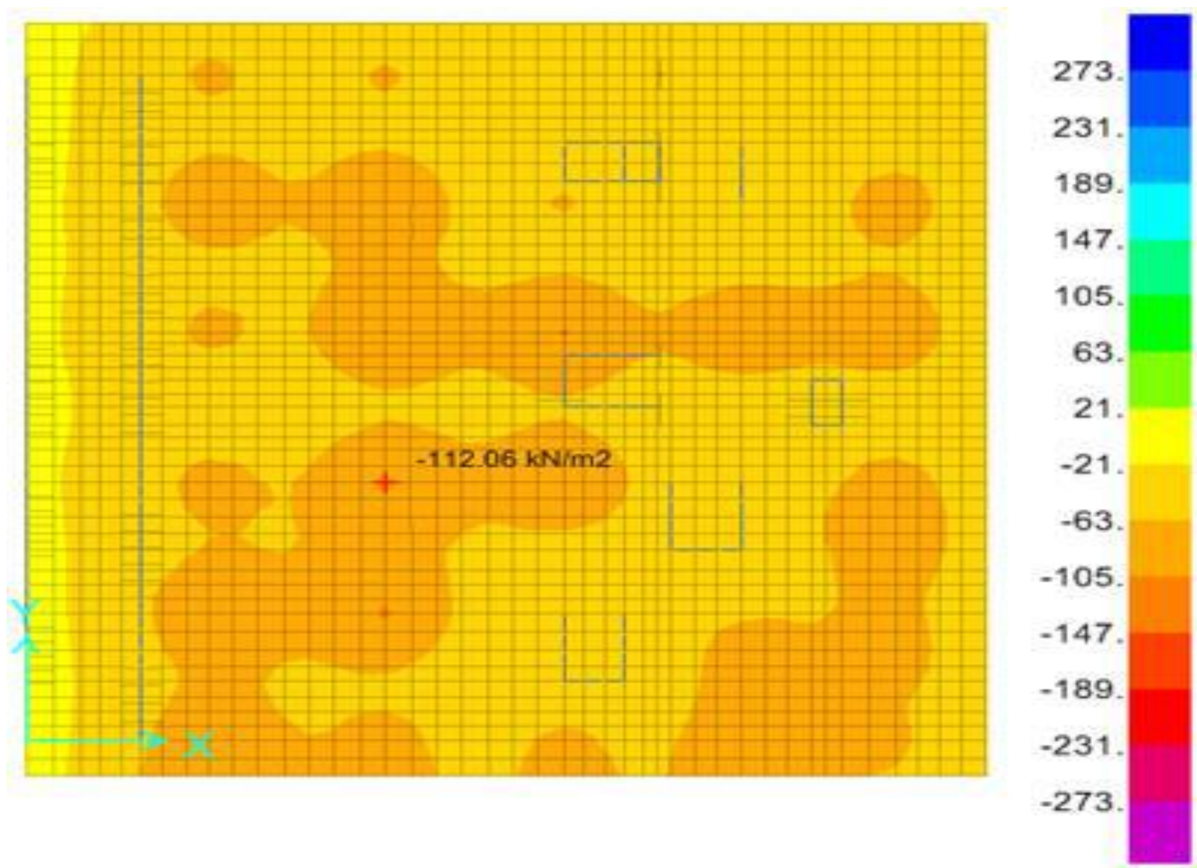


Verifications

2-Check bearing capacity of soil

Maximum bearing capacity for mat foundation =112 kN/m2< qall=280kN/m^2

So no need to increase dimension of mat foundation.

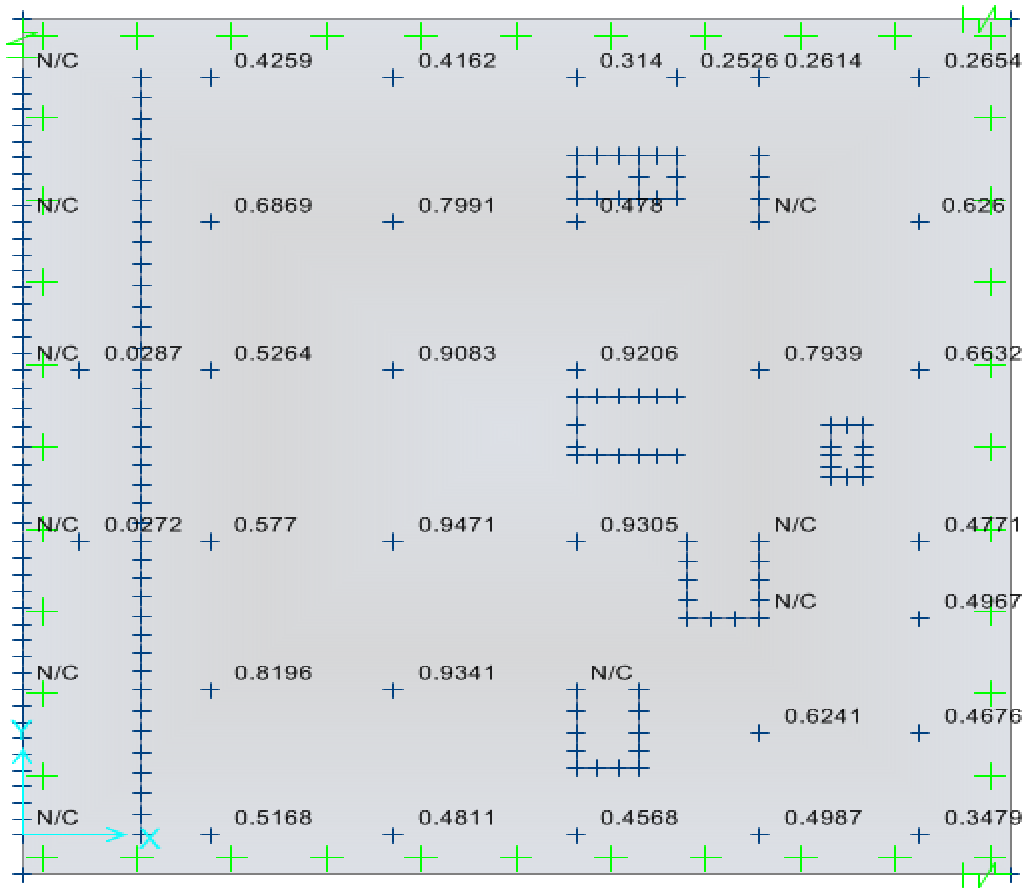


Verifications

3- Check Punching shear:

All values of $\frac{Vu}{\emptyset vc} < 1$

So the punching shear is ok & no need to increase the dimension of the mat foundation.



Verifications

4-Check wide beam shear:

$$\text{ØVc} = \frac{0.75*\sqrt{25}*1000*640}{6} = 400 \text{ kN}$$

From SAP maximum pressure= 157.7 kN/m2

$$\text{Vu} = \frac{wu*L}{2} = \frac{157.7*3}{2} = 236.55 \text{ kN}$$

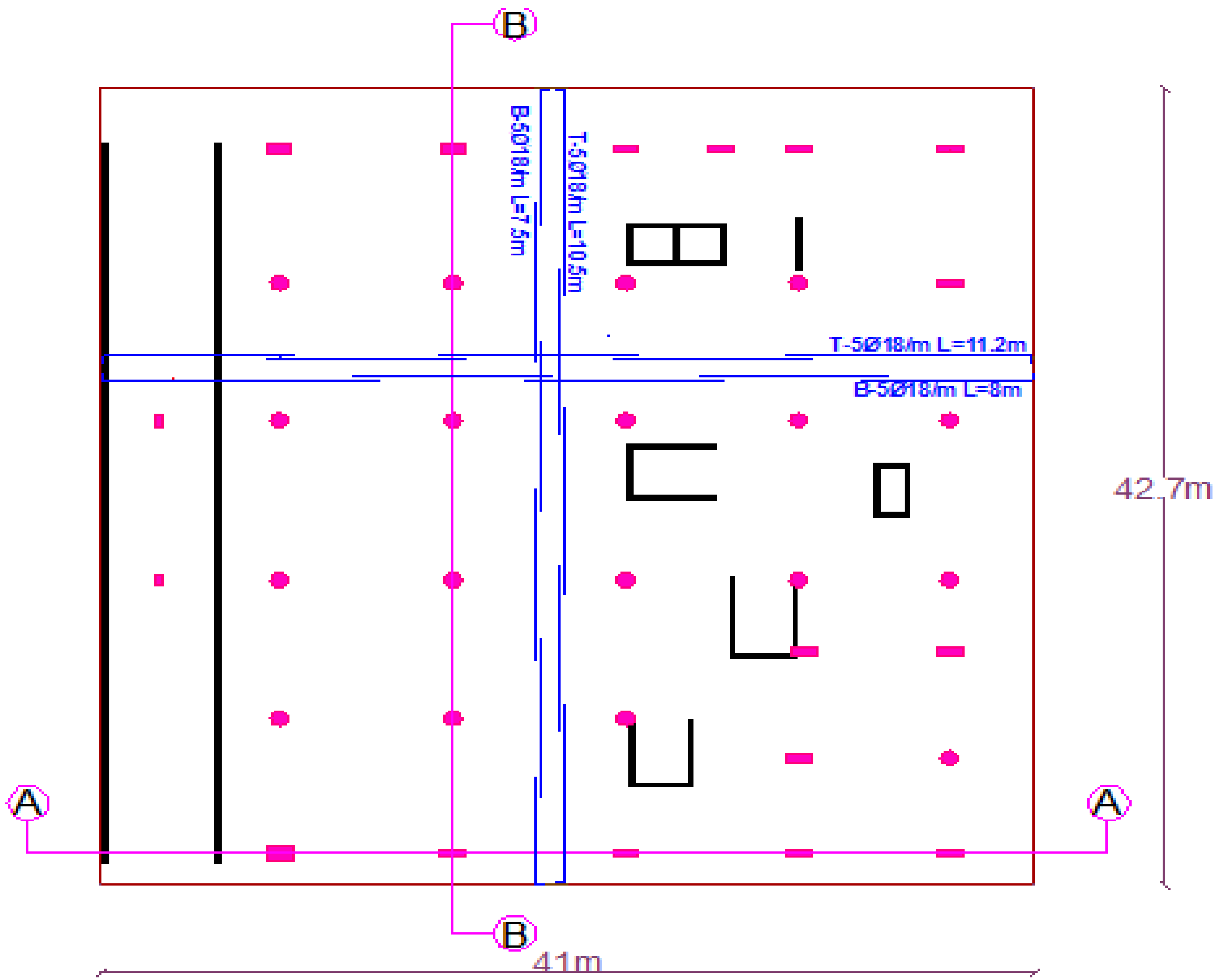
Vu < ØVc, so the check of wide beam shear is OK.

Note :

After verification the dimensions founded to be adequate:

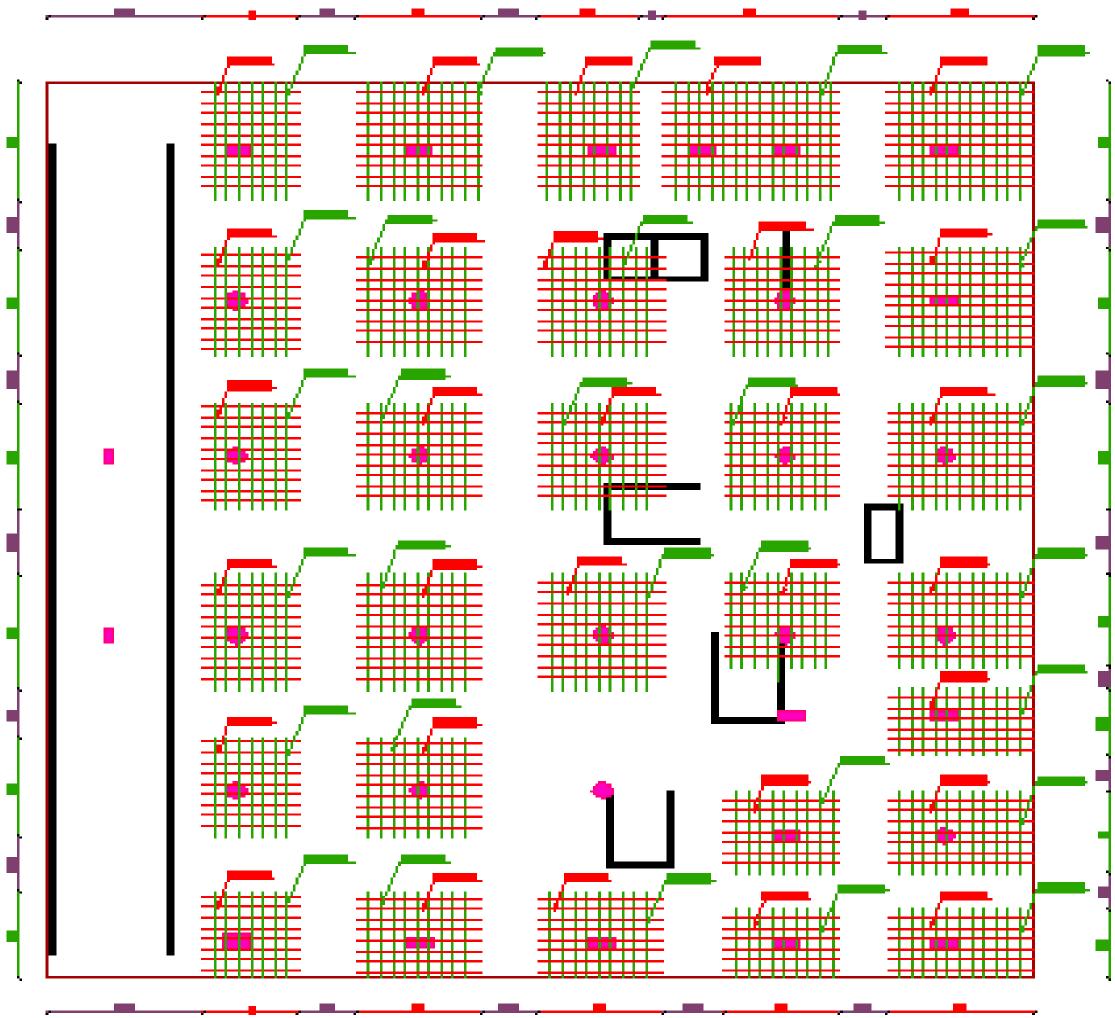
Mat design & detailing

As min = $0.0018 \times 630 \times 1000 = 1134\ mm^2$ $\Longrightarrow$ ***use* 5ø18/m**



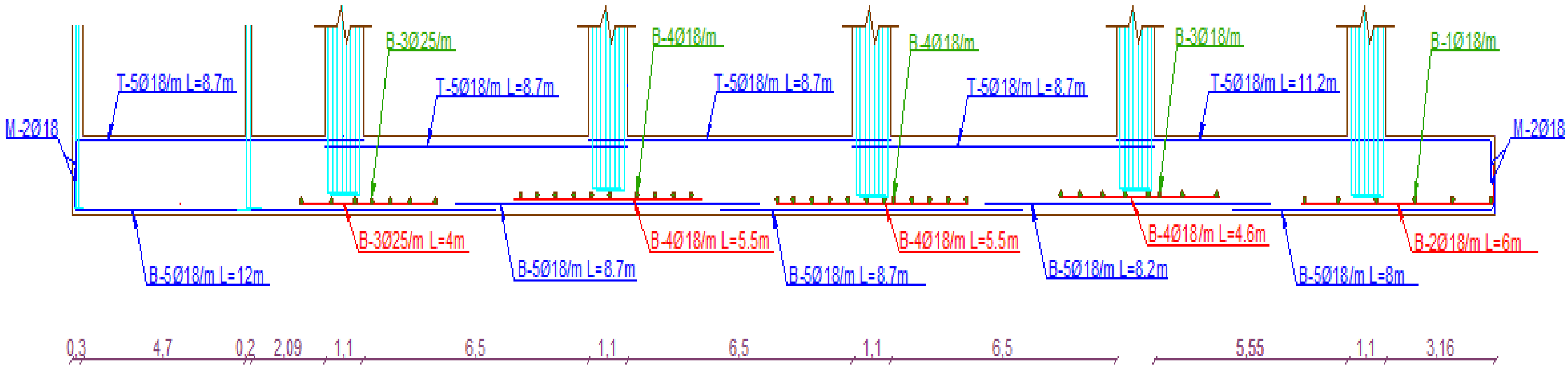
Mat design & detailing

Additional Steel under Columns

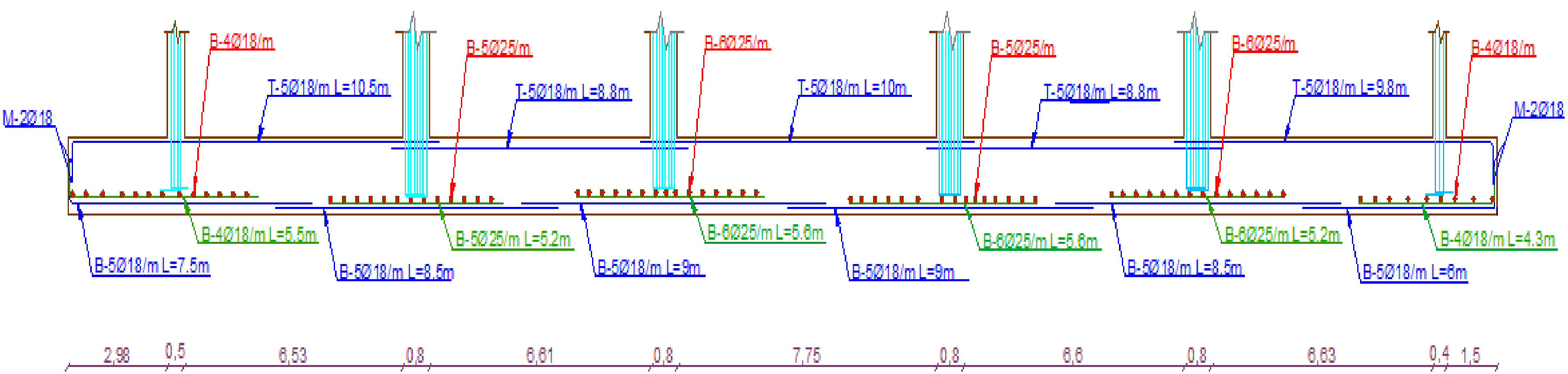


Mat design & detailing

Sections in mat foundation

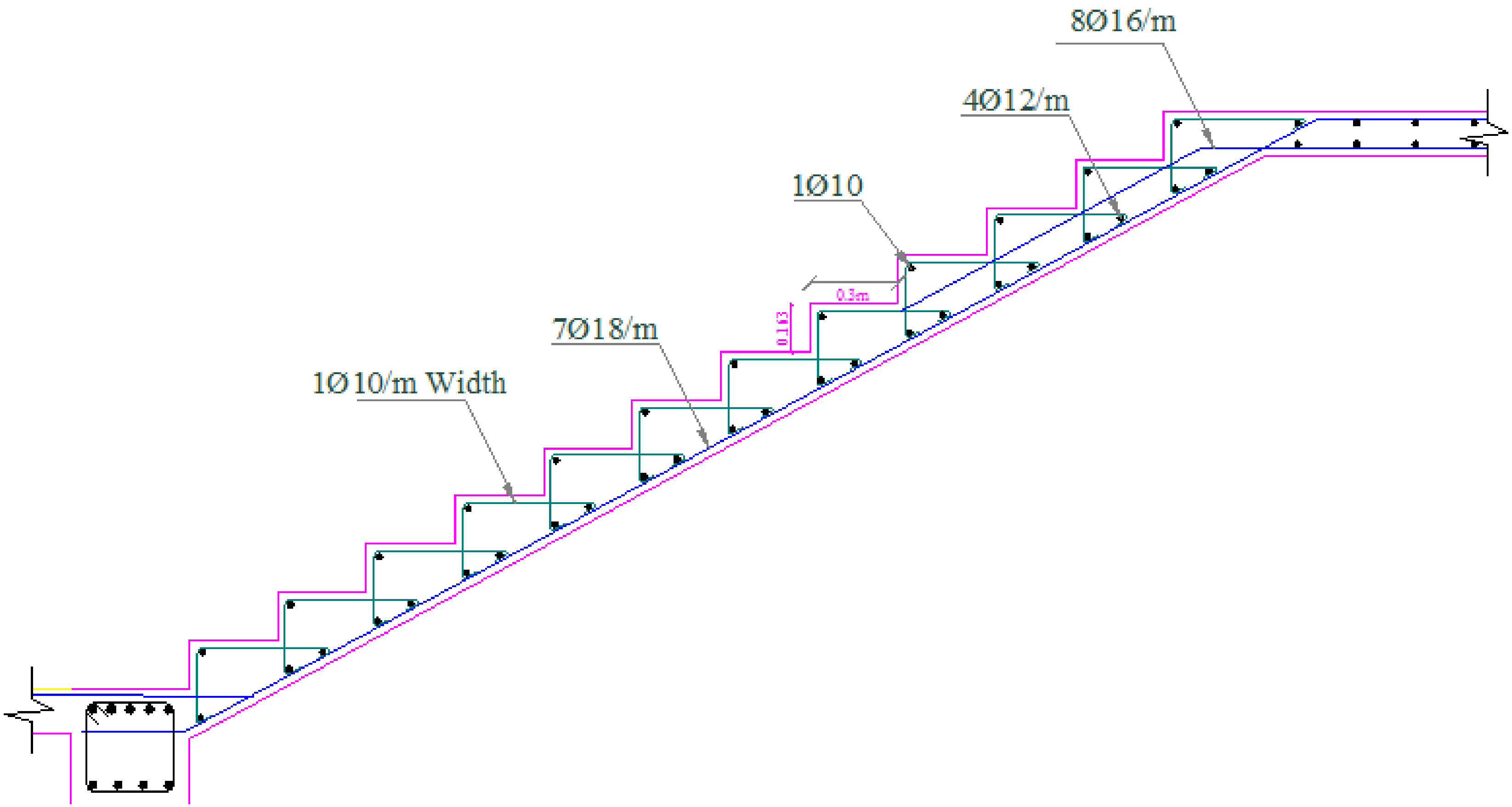


sec A-A



sec B-B

Detailing for stairs




Thank you