



## Structural & Geotechnical Design of 50 Storey Tower (Chamber of Commerce) in Dammam City.

### Final-Exam Presentation

Supervisor's:

Engr. Danish Ahmed

Dr. Tahar Ayadat

Coordinator:

Dr. Andi Asiz

### PRESENTED BY:

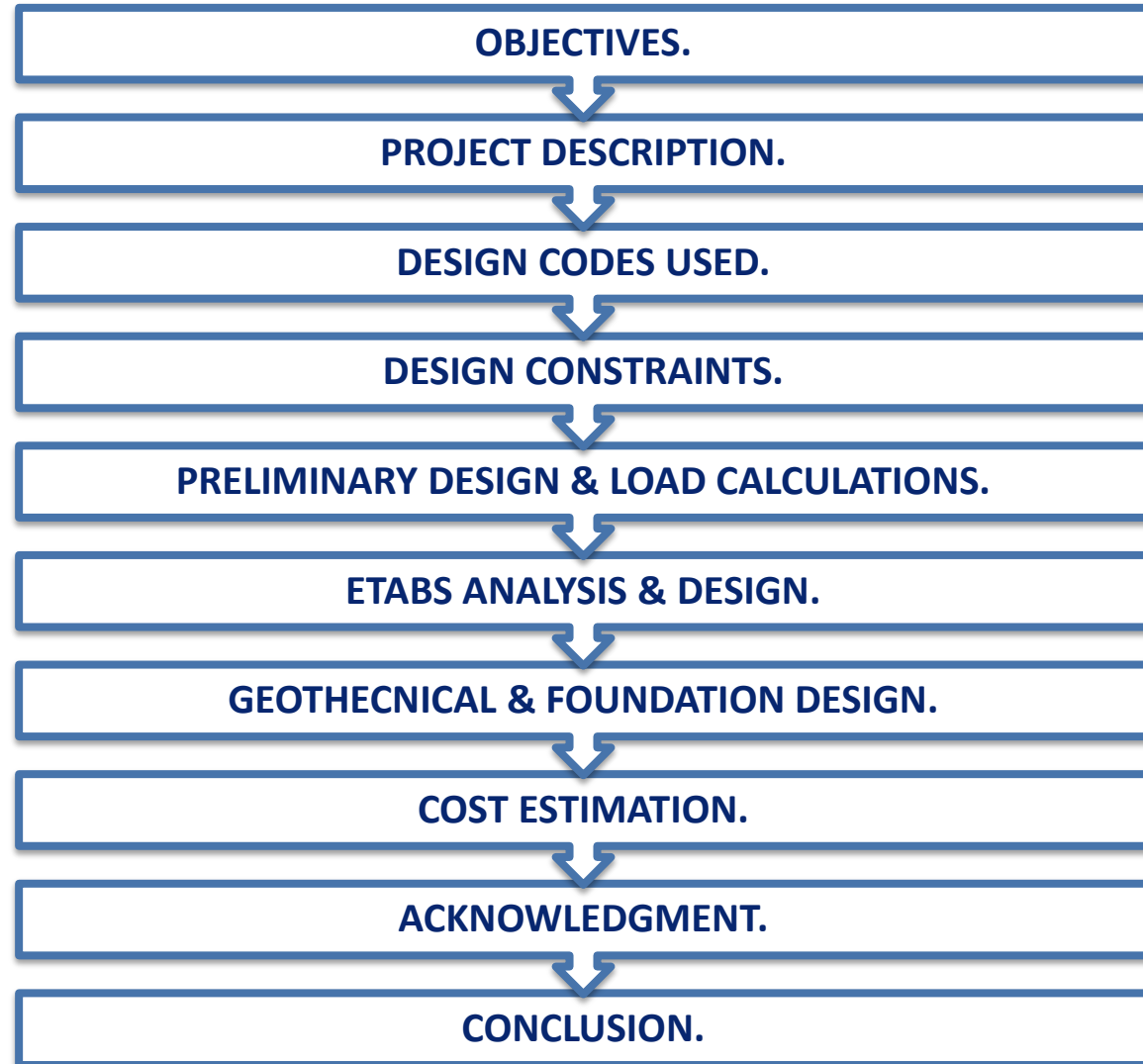
MOHANAD AL-OTAISHAN : 201300456

ABDULRAHMAN AL-AMER : 201300351



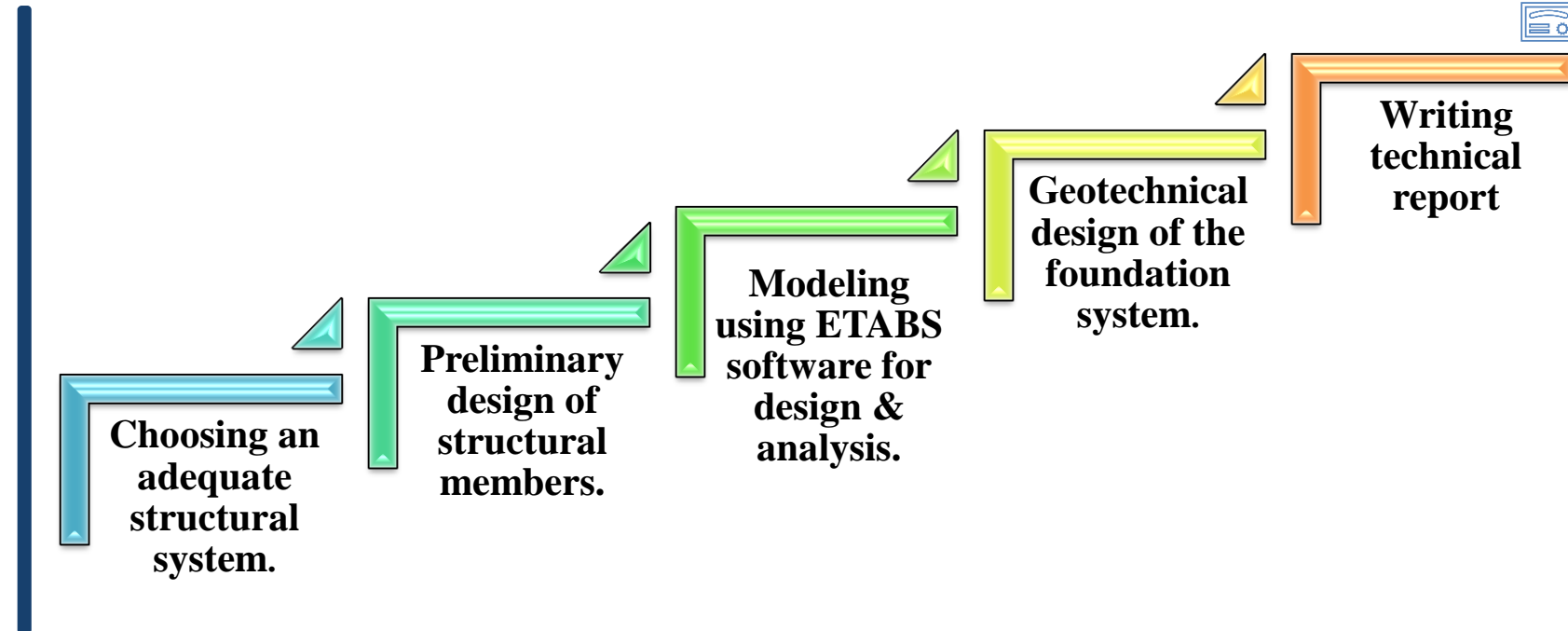


# Presentation Outlines





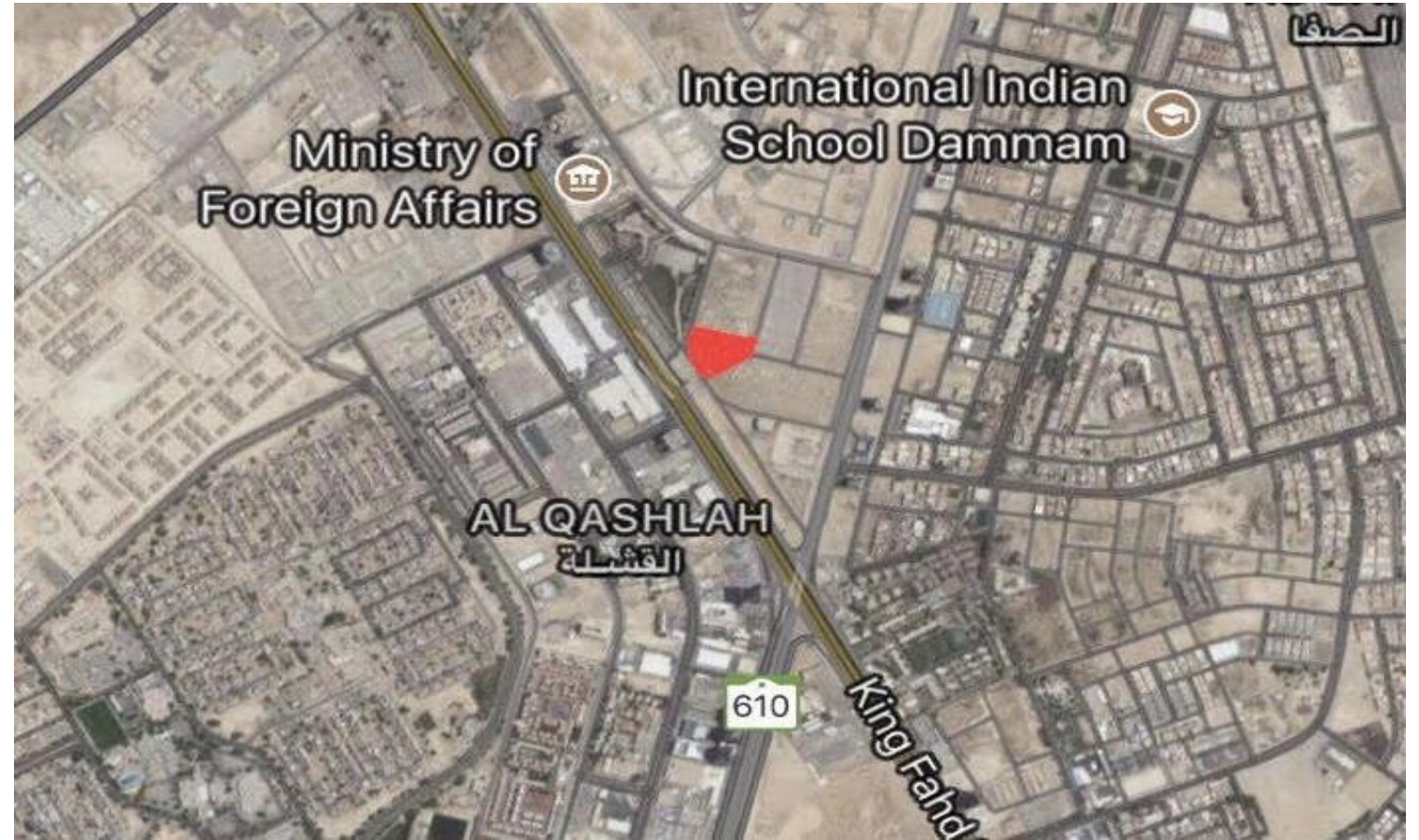
## Project Objectives





## Project Description

- **Location:**  
Dammam City
- **Commercial Tower**
- **50 Floors**



❖ Google maps





## Project Description

(Continues)

- Floors Area.

S.No	Floor	Area m <sup>2</sup>
1	Sub-Basement	3717.441
2	Basement	3717.441
3	Ground Floor	3717.441
4	Mezzanine	3717.441
5	Podiums	3717.441
6	First Group	1663.677
7	Second Group	1663.677
8	Third Group	1663.677
9	Fourth Group	1663.677
10	Fifth Group	1663.677
11	Sixth Group	1663.677
12	Seventh Group	1663.677
13	Eighth Group	1663.677
14	Roof Deck	1663.677





## Project Description

(Continues)

- Tower 3D model



❖ Reference: Arabtech Jardaneh





## CODES

- **Structural Design and Analysis codes:**
  - **ACI 318-11 Code : American Concrete Institute**
  - **SBC (301) : Saudi Building Code**
  
- **Geotechnical Design and Analysis:**
  - **SBC(303): Saudi Building Code**
  - **International Building Code (2009)**





# DESIGN CONSTRAINTS

Design Constraints	Project Application
Performance	Several performance requirements were established
Serviceability	Several factors considered such as durability, overall stability and deflection limitations.
Economic	Economical limitations were established
Environmental	Did not affect our design
Environmental Sustainability	Did not affect our design
Manufacturability	Being able to design a manufacturable building.
Ethical	We did not violate any ethical rule as far as we are aware of.
Health and safety	Several safety factors and precautions were taken into account in designing process.
Social	Did not affect our design
Political	Did not affect our design





# PRELIMINARY DESIGN & LOAD CALCULATION



# PRELIMINARY DESIGN

- Slab design

- Slab

Type : Two Way Solid Slab – Flat Plate  
Thickness : 37 cm

- Control deflection values.
- Satisfy shear requirements to prevent punching shear.





# PRELIMINARY DESIGN (CONTINUOUS)

- Dead Load

Dead Load	Unit weight (kN/m <sup>3</sup> )	Thickness (m)	W (kN/m <sup>2</sup> )
Sand	14	0.01	0.14
Mortar	20.5	0.01	0.205
Tile	23.5	0.01	0.235
Concrete Slab	24	0.37	8.88
Total service load per unit area W (kN/m <sup>2</sup> )			9.46



# PRELIMINARY DESIGN (CONTINUOUS)

- Live Load

Floor	Live Load (kN/m <sup>2</sup> )
Sub Basement	2
Basment	2
Ground Floor	5
Mezzanine	5
Podiums	2
First Group	2.5
Second Group	2.5
Third Group	2.5
Fourth Group	2.5
Fifth Group	2.5
Sixth Group	2.5
Seventh Group	2.5
Eighth Group	2.5
Roof Deck Floor	2.5



# PRELIMINARY DESIGN (CONTINUOUS)




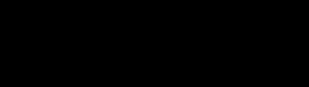
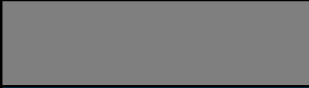


○ Ultimate Floor Load

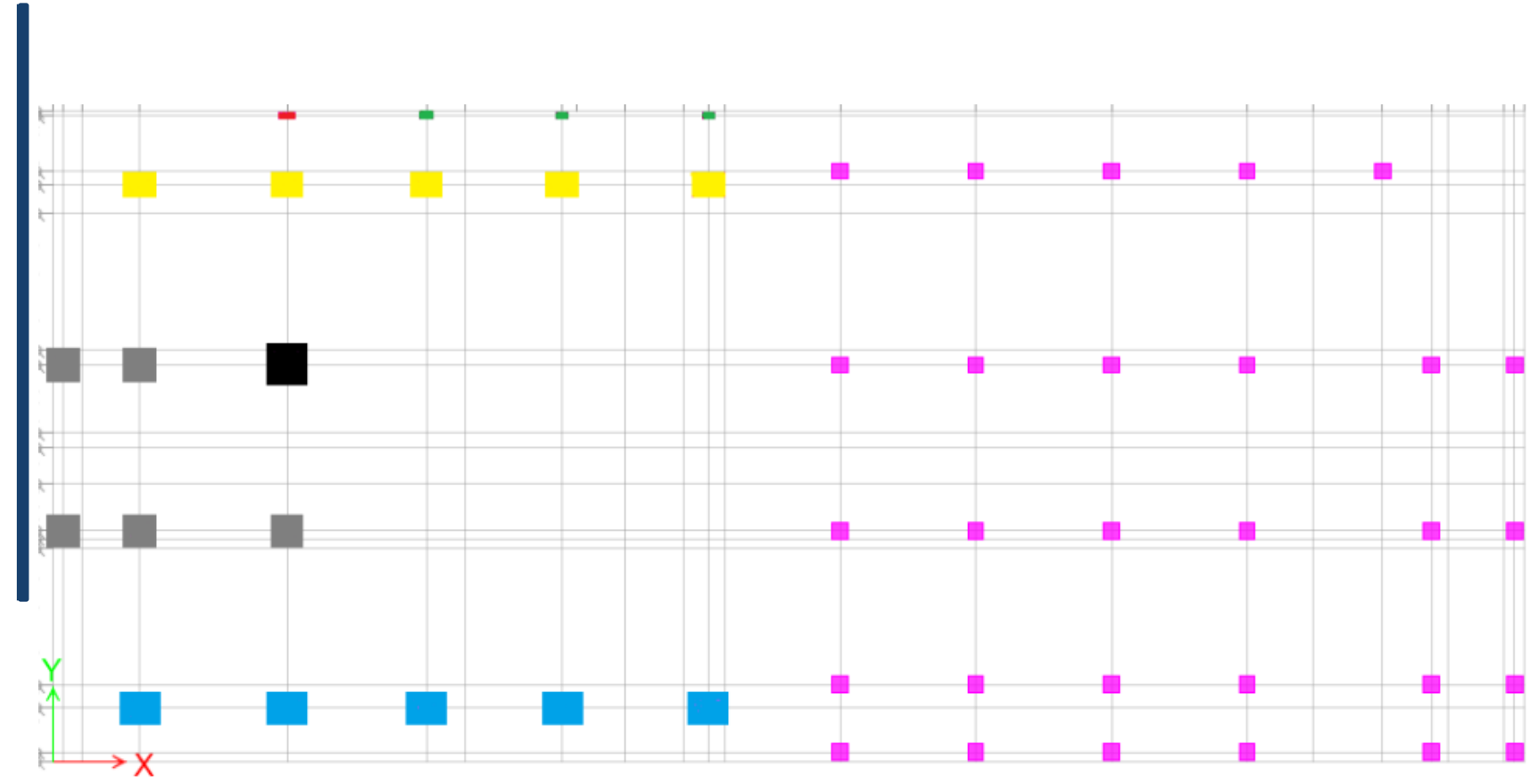
Floor	Live Load (kN/m <sup>2</sup> )	Dead Load (kN/m <sup>2</sup> )	Wu (kN/m <sup>2</sup> ) = 1.2DL+1.6LL
Sub Basement	2	9.46	14.516
Basment	2	9.46	14.516
Ground Floor	5	9.46	19.316
Mezzanine	5	9.46	19.316
Podiums	2	9.46	14.516
First Group	2.5	9.46	15.316
Second Group	2.5	9.46	15.316
Third Group	2.5	9.46	15.316
Fourth Group	2.5	9.46	15.316
Fifth Group	2.5	9.46	15.316
Sixth Group	2.5	9.46	15.316
Seventh Group	2.5	9.46	15.316
Eighth Group	2.5	9.46	15.316
Roof Deck Floor	2.5	9.46	15.316





# COLUMNS DIMENSIONS

Column Group	Dimensions (m)
	1 x 0.4
	0.8 x 0.4
	2 x 1.5
	2.5 x 2.5
	2 x 2
	2.5 x 2
	1 x 1



❖ ETABS 2013 Software

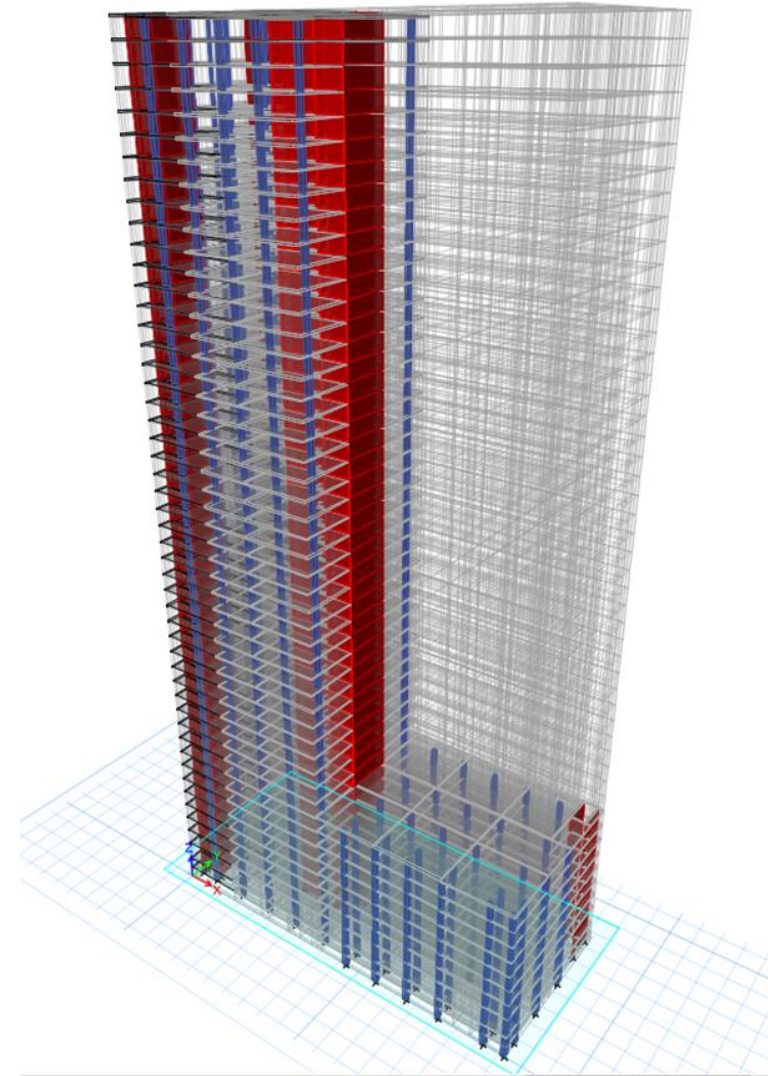


# ETABS MODELING



# ETABS MODELING

- 3D model



❖ ETABS 2013 Software

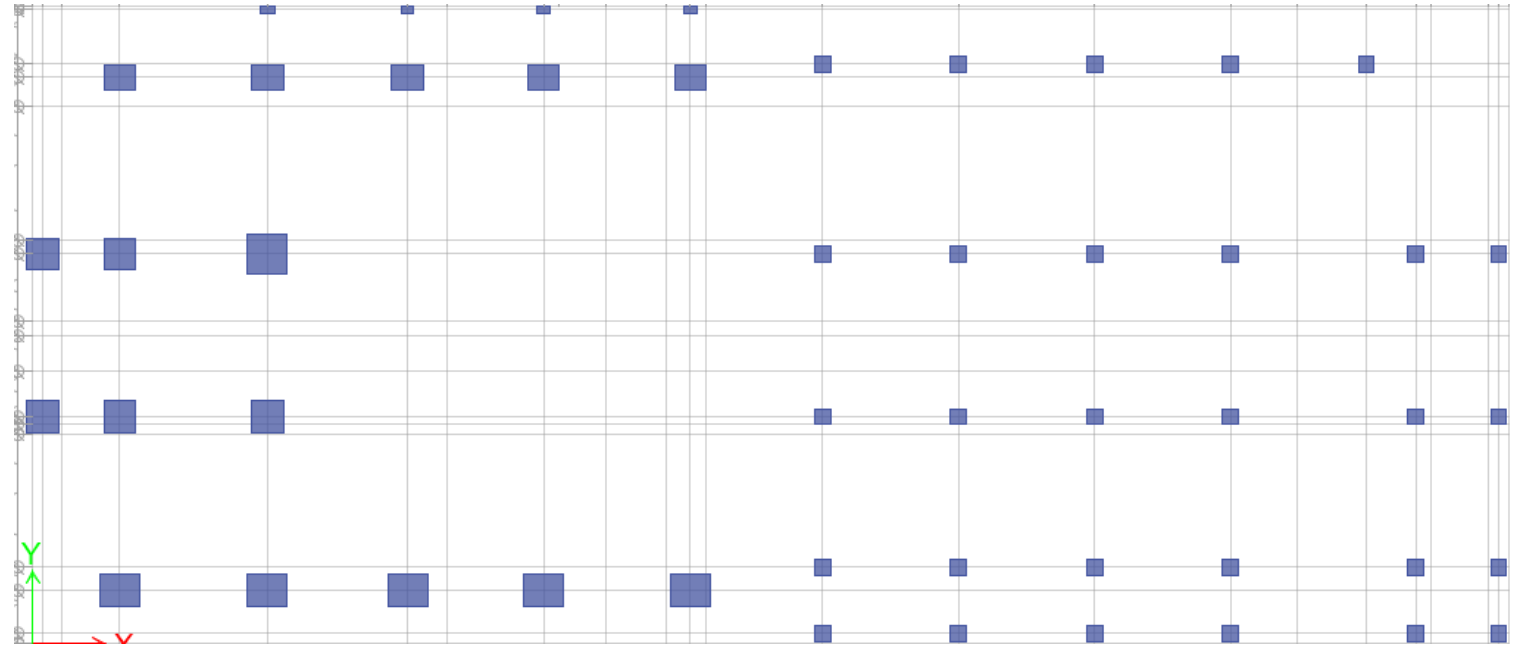




# ETABS MODELING

(CONTINUOUS)

- Typical Floor Plan (Columns)



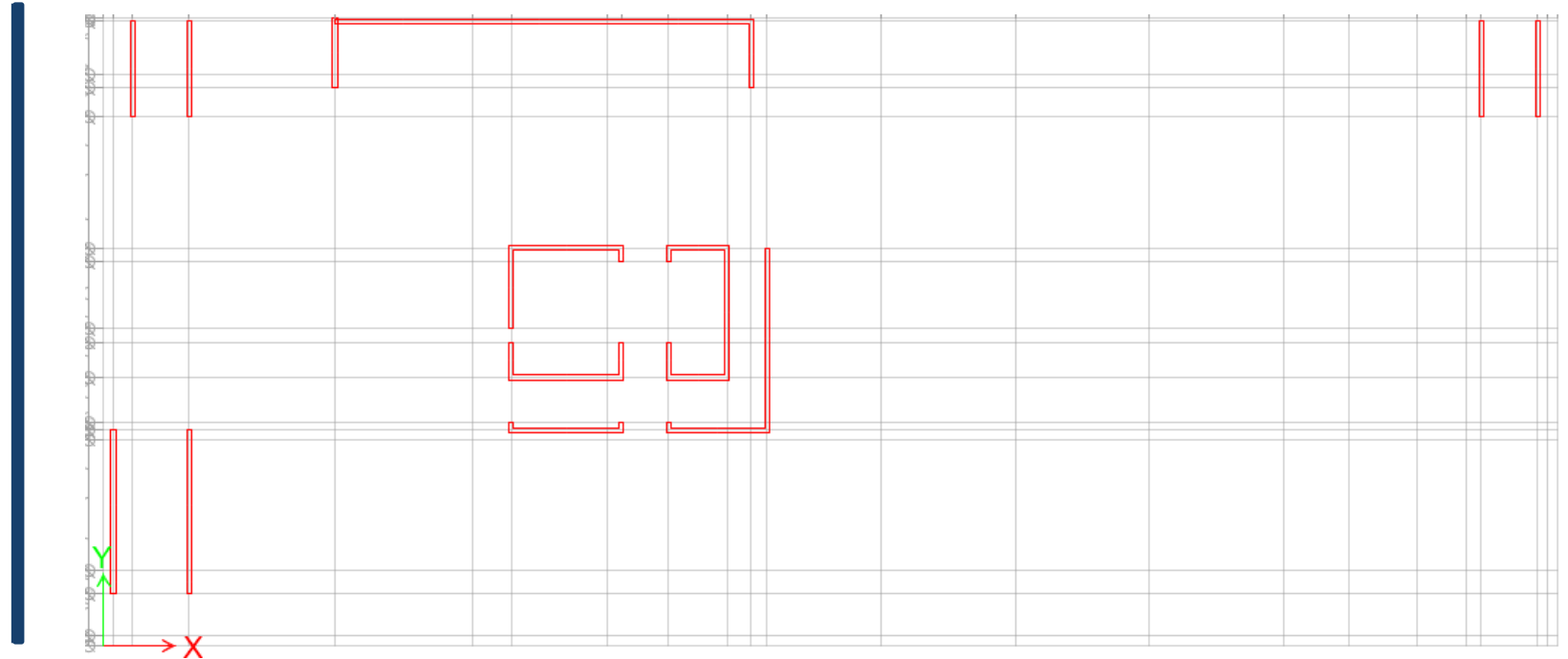
❖ ETABS 2013 Software





# ETABS MODELING (CONTINUOUS)

- Typical Floor Plan  
(Shear Walls)



❖ ETABS 2013 Software

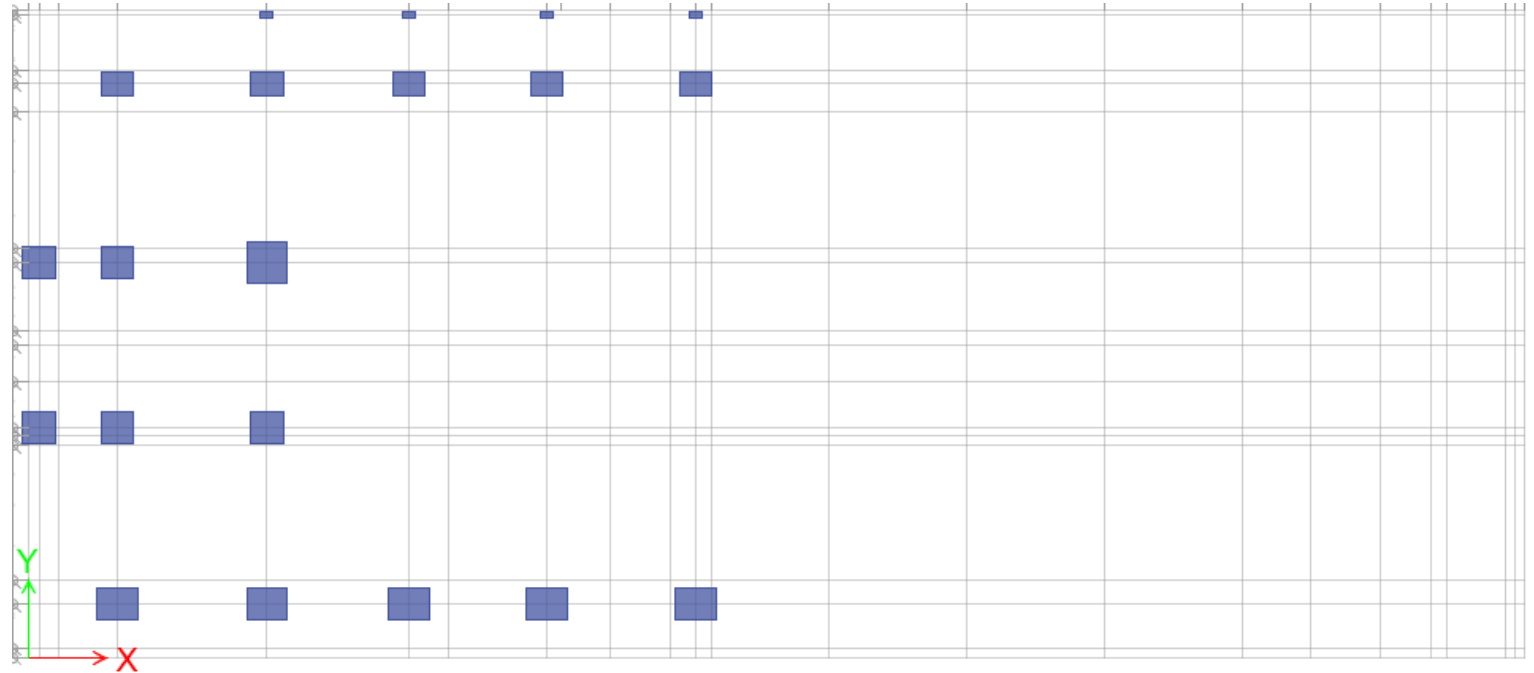




# ETABS MODELING

(CONTINUOUS)

- Typical Super Structure Floor Plan (Columns).



❖ ETABS 2013 Software

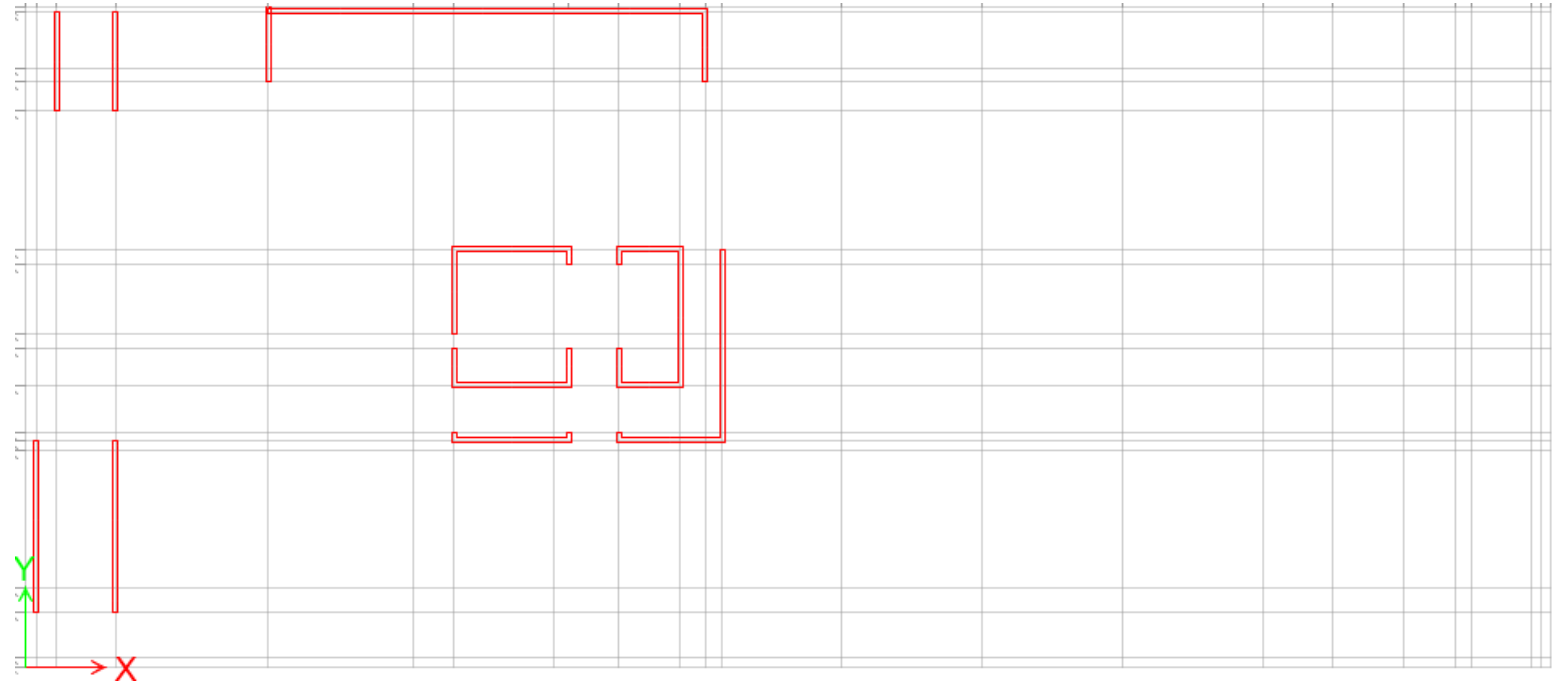




# ETABS MODELING

(CONTINUOUS)

- Typical Super Structure Floor Plan (Shear walls).



❖ ETABS 2013 Software

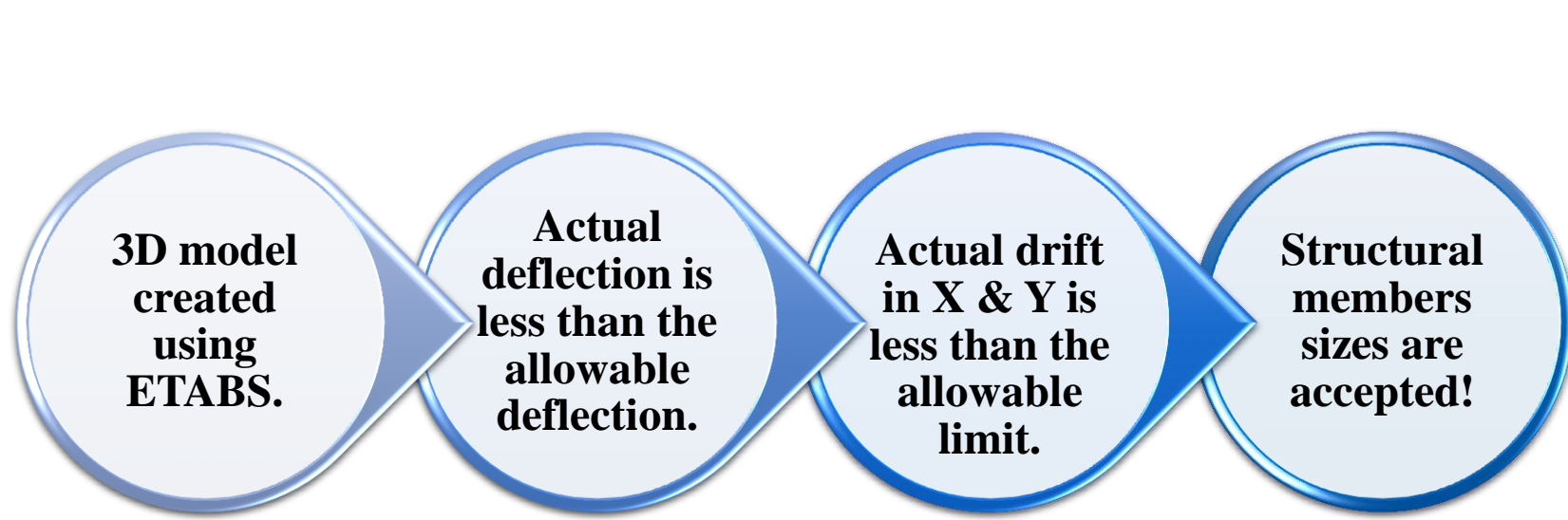




# ETABS ANALYSIS



# ETABS ANALYSIS



❖ According to SBC

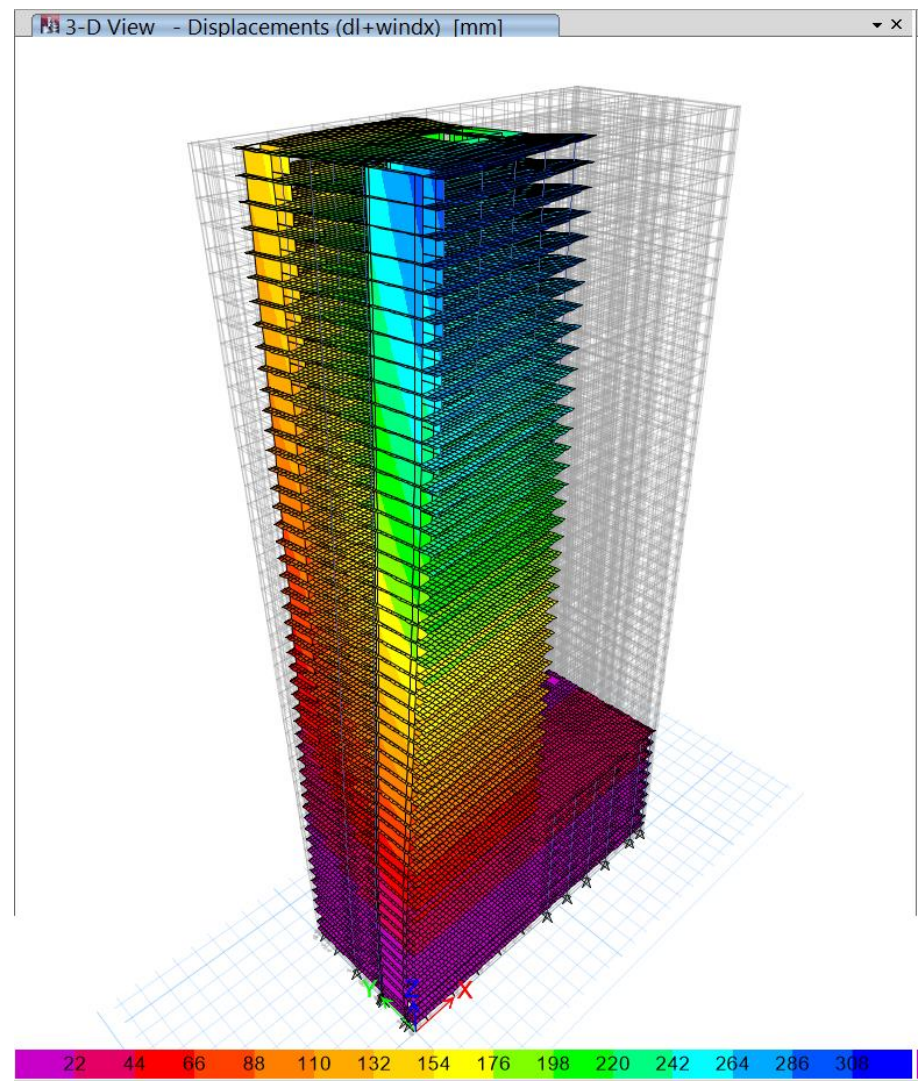
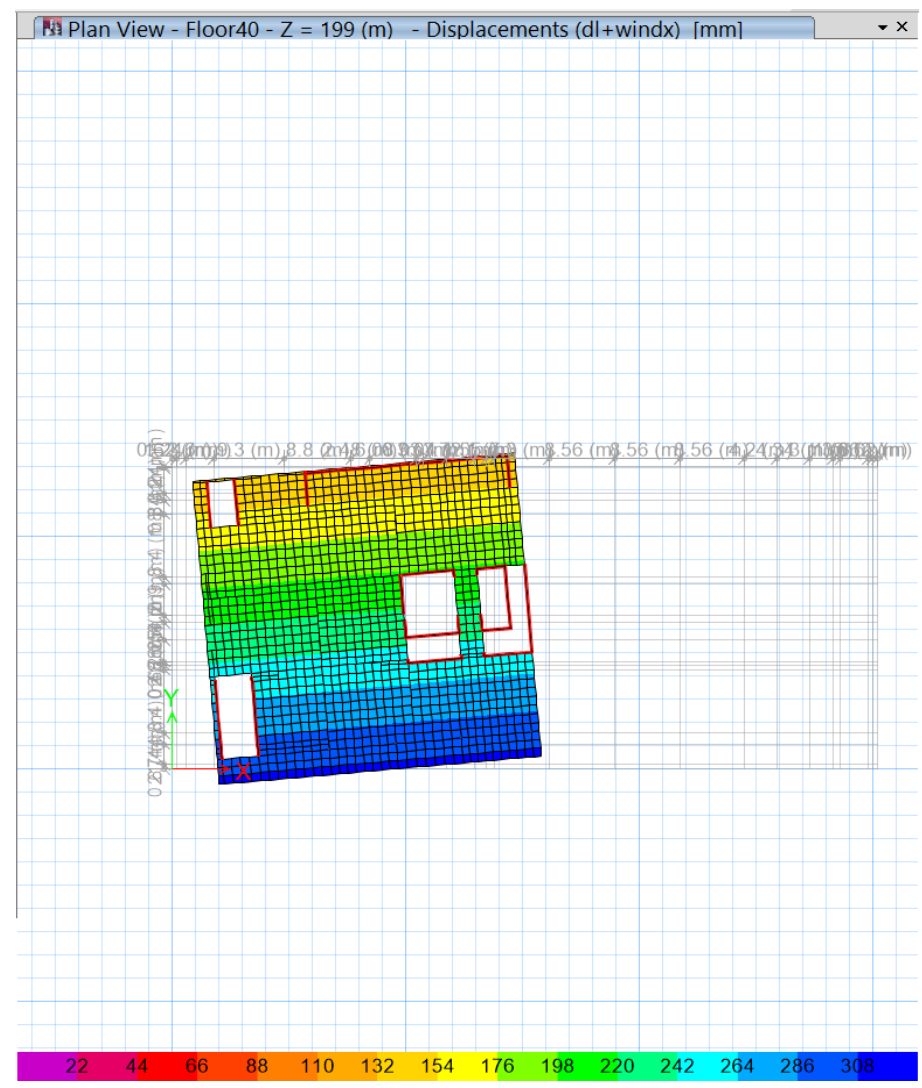






# ETABS ANALYSIS (CONTINUOUS)

- Load Combination: WindX + DL
- Allowable drift = 1930mm (according to SBC).



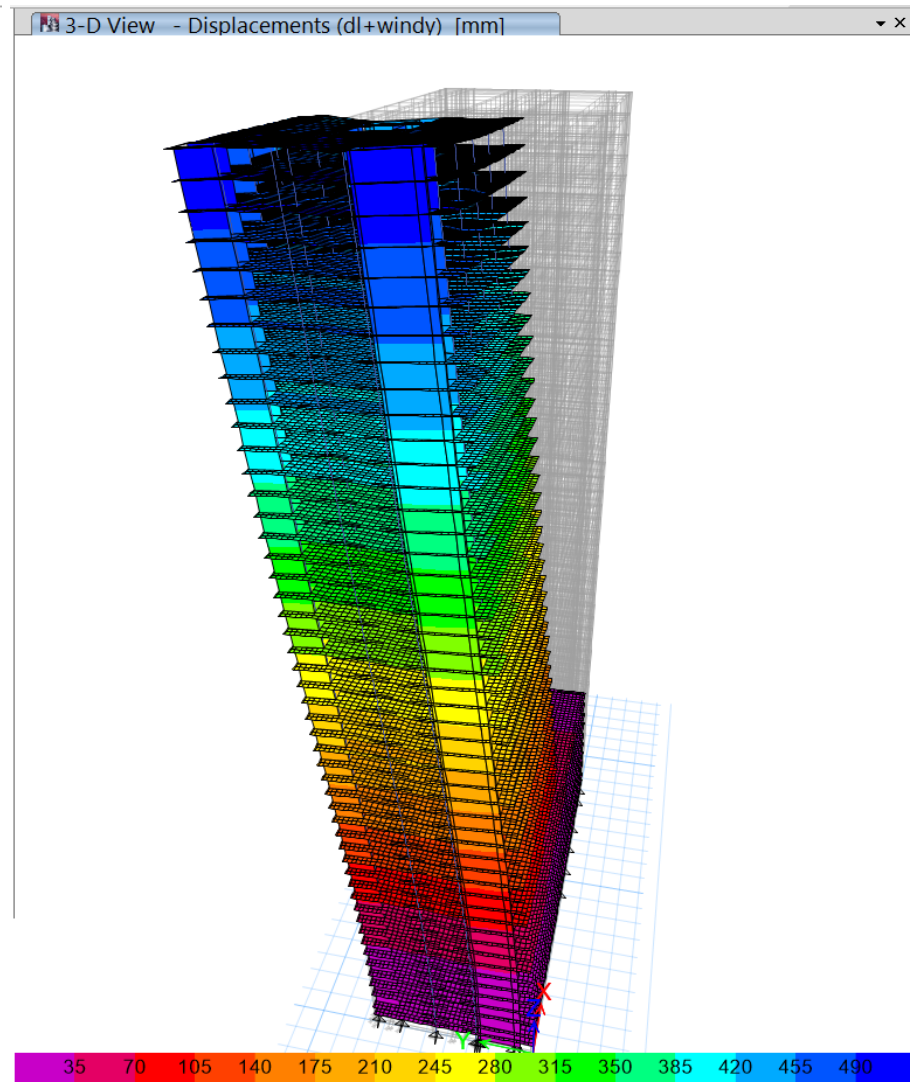
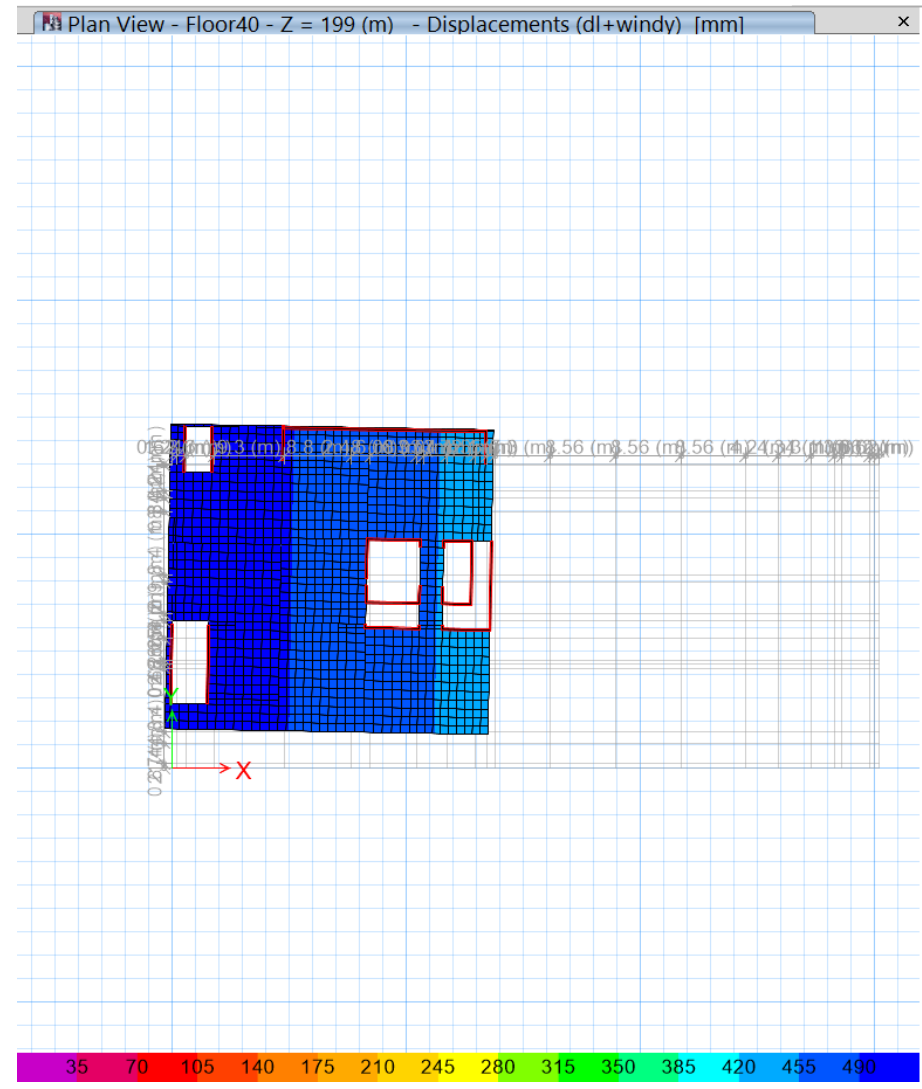
ETABS 2013 Software





# ETABS ANALYSIS (CONTINUOUS)

- Load Combination: WindY + DL
- Allowable drift = 1930mm (according to SBC).

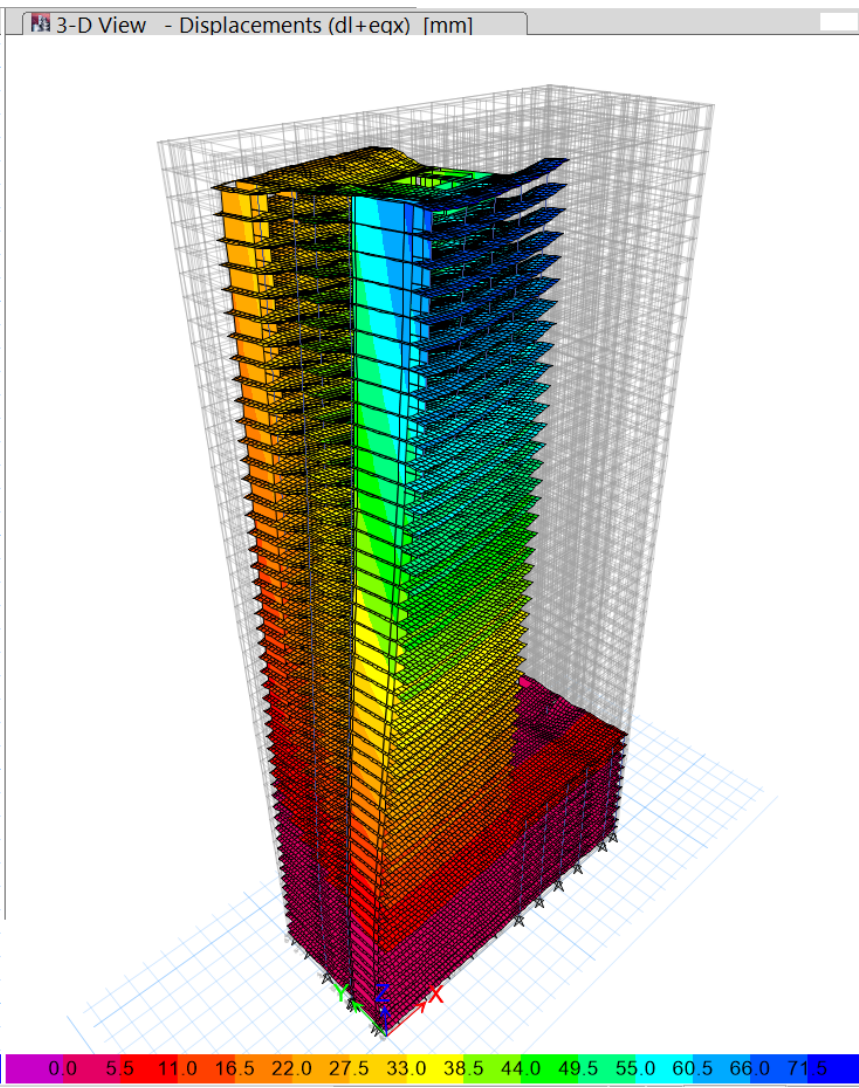
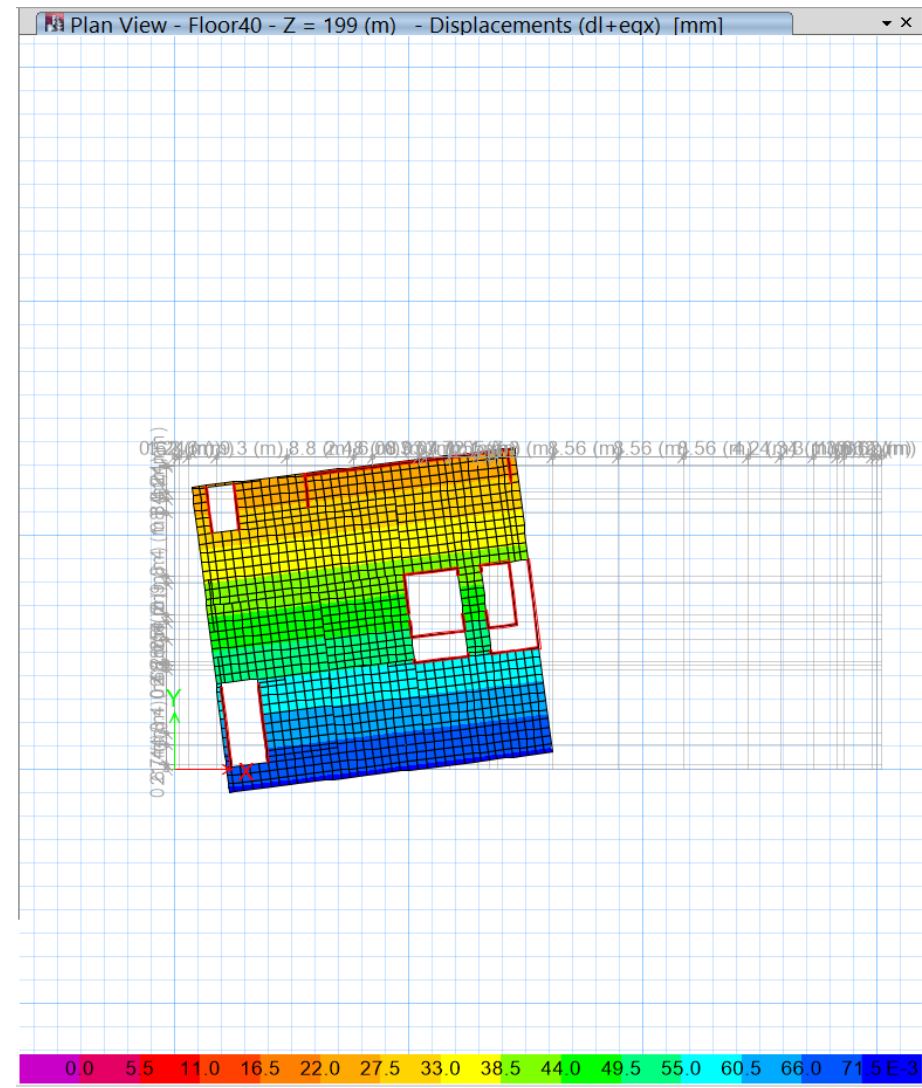


❖ ETABS 2013 Software



# ETABS ANALYSIS (CONTINUOUS)

- Load Combination: eqX + DL
- Allowable drift = 1930mm (according to SBC).



❖ ETABS 2013 Software

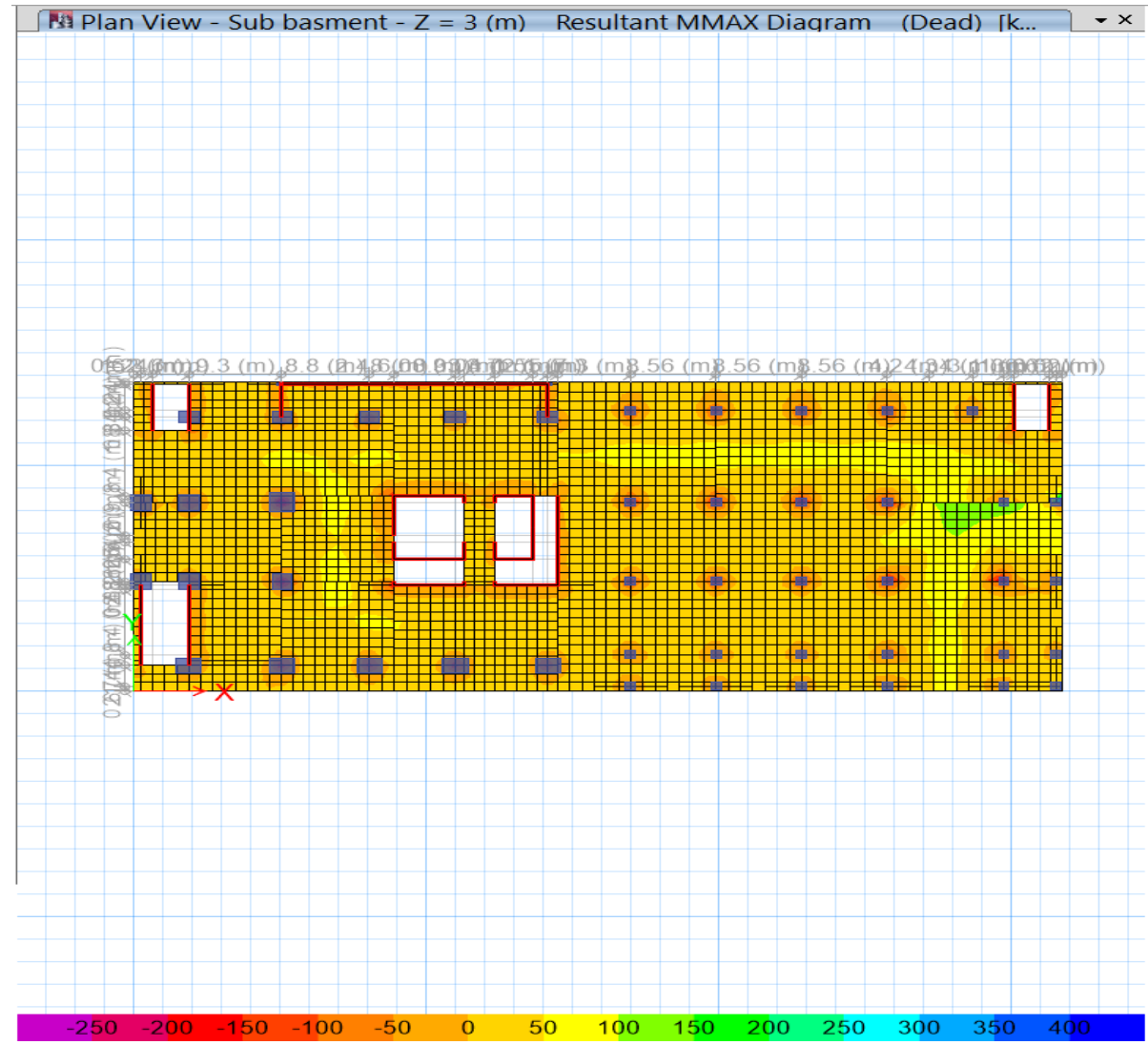






# ETABS ANALYSIS (CONTINUOUS)

- Maximum moment at Sub-Basement



❖ ETABS 2013 Software



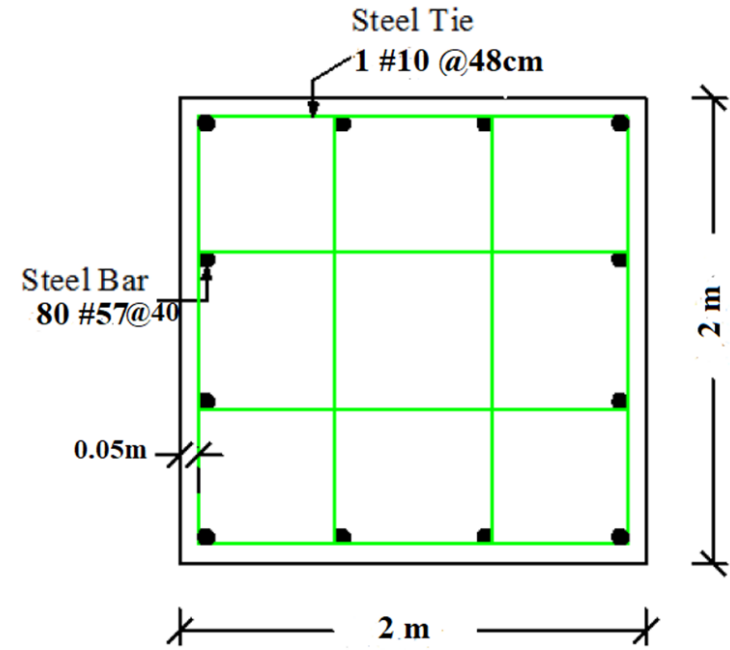
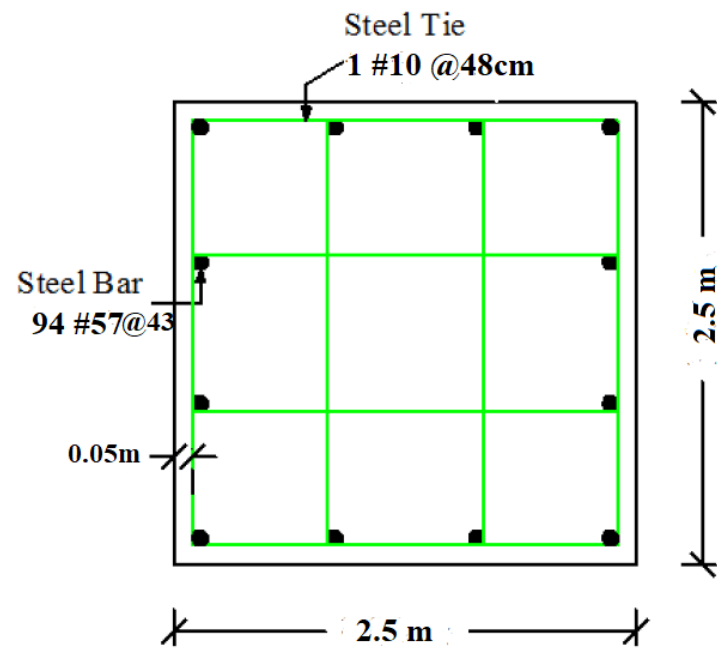
# REINFORCEMENT DETAILS





# REINFORCEMENT DETAILS (COLUMNS)

Column Group	# of bars	Diameter (mm)	Spacing (mm)
2.5 x 2.5	94	57	43
2 x 2	80	57	40

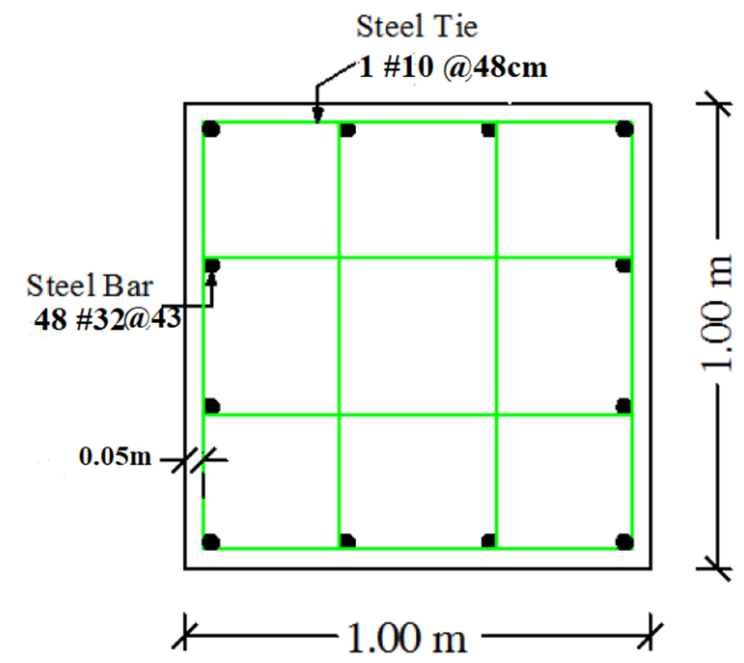
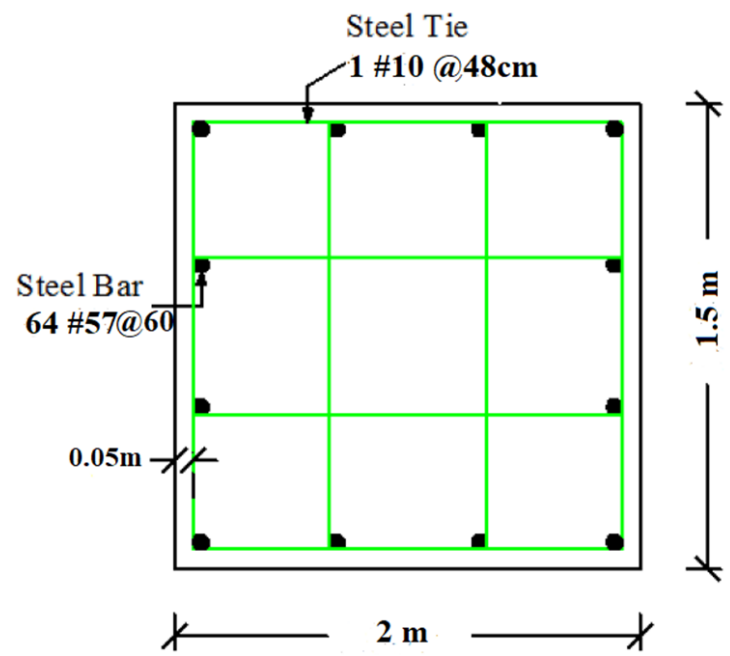


❖ AUTOCAD 2016 Software



# REINFORCEMENT DETAILS (COLUMNS)

Column Group	# of bars	Diameter (mm)	Spacing (mm)
2 x 1.5	64	57	60
1 x 1	48	32	43



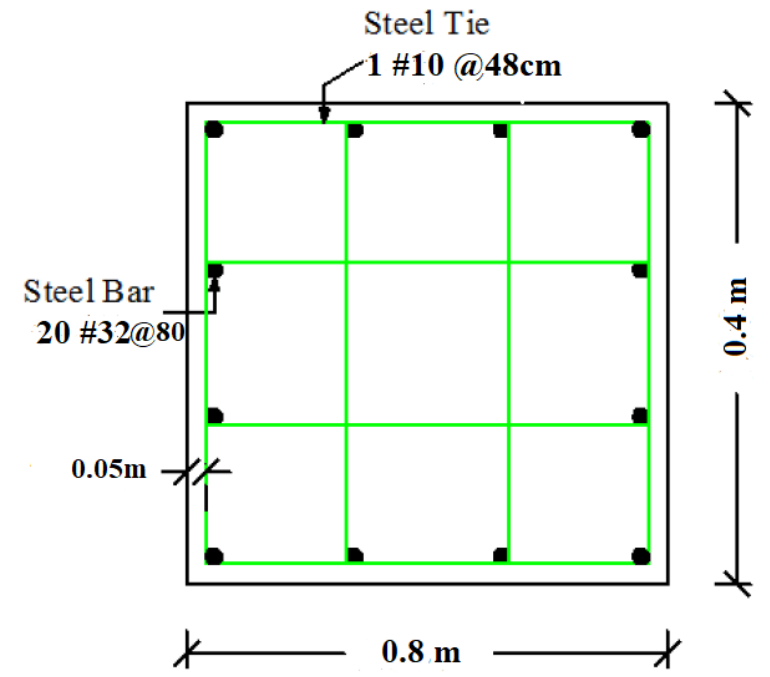
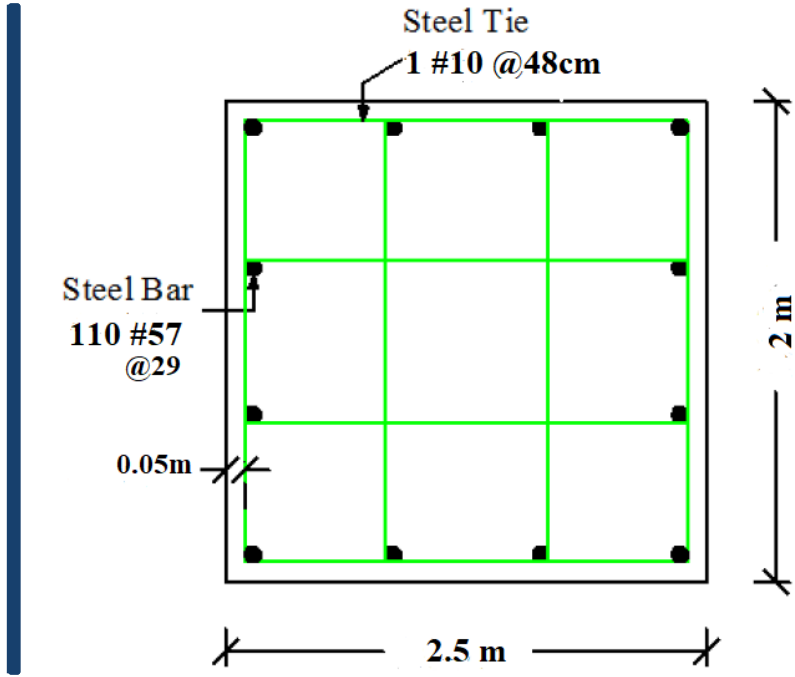
❖ AUTOCAD 2016 Software





# REINFORCEMENT DETAILS (COLUMNS)

Column Group	# of bars	Diameter (mm)	Spacing (mm)
2.5 x 2	110	57	29
0.8 x 0.4	20	32	80

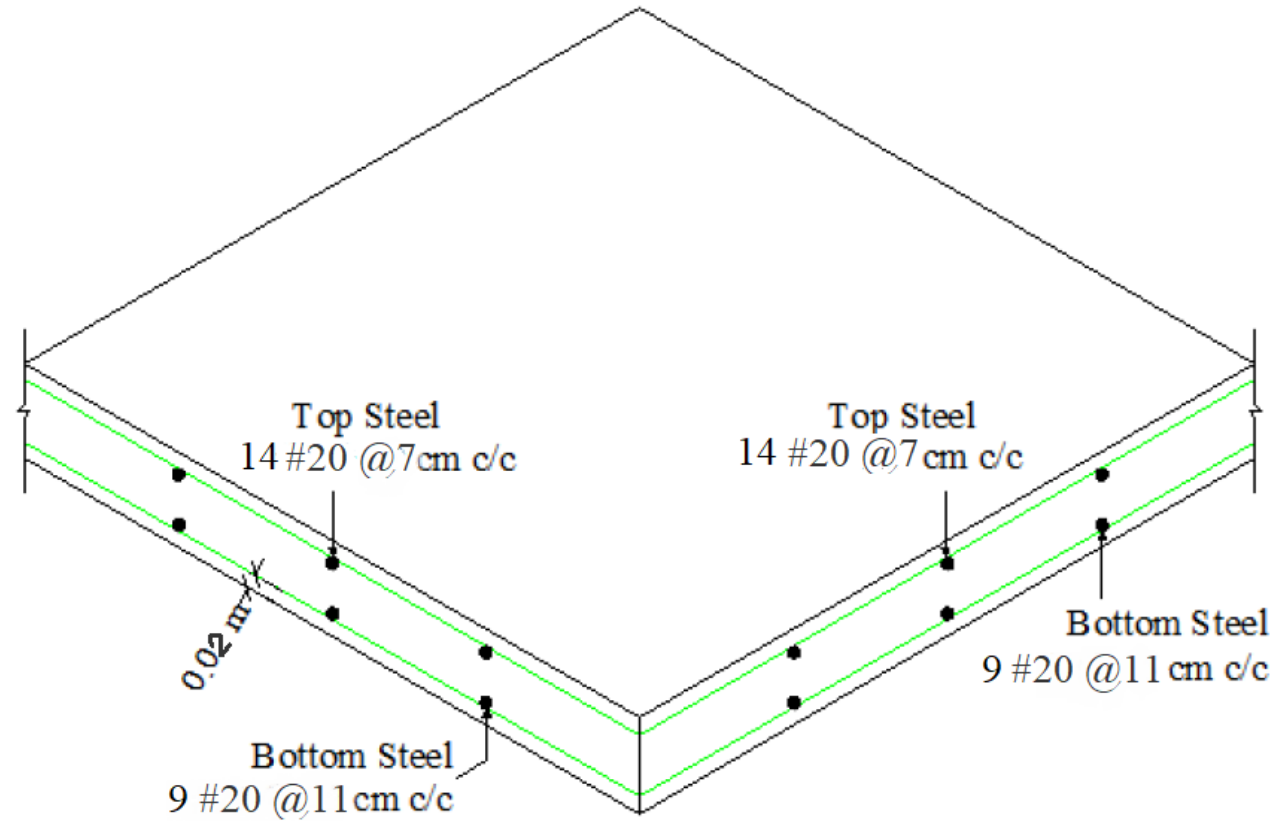


❖ AUTOCAD 2016 Software





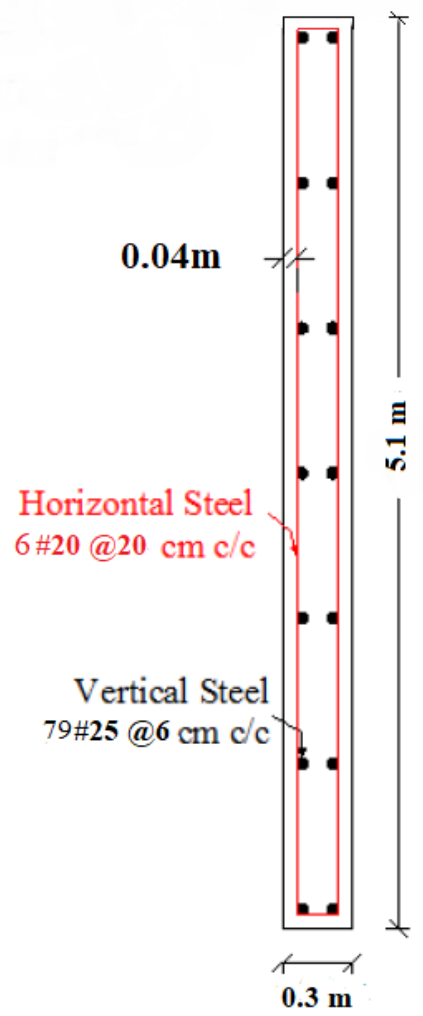
# REINFORCEMENT DETAILS (SLAB)



❖ AUTOCAD 2016 Software



# REINFORCEMENT DETAILS (SHEAR WALLS)



❖ AUTOCAD 2016 Software

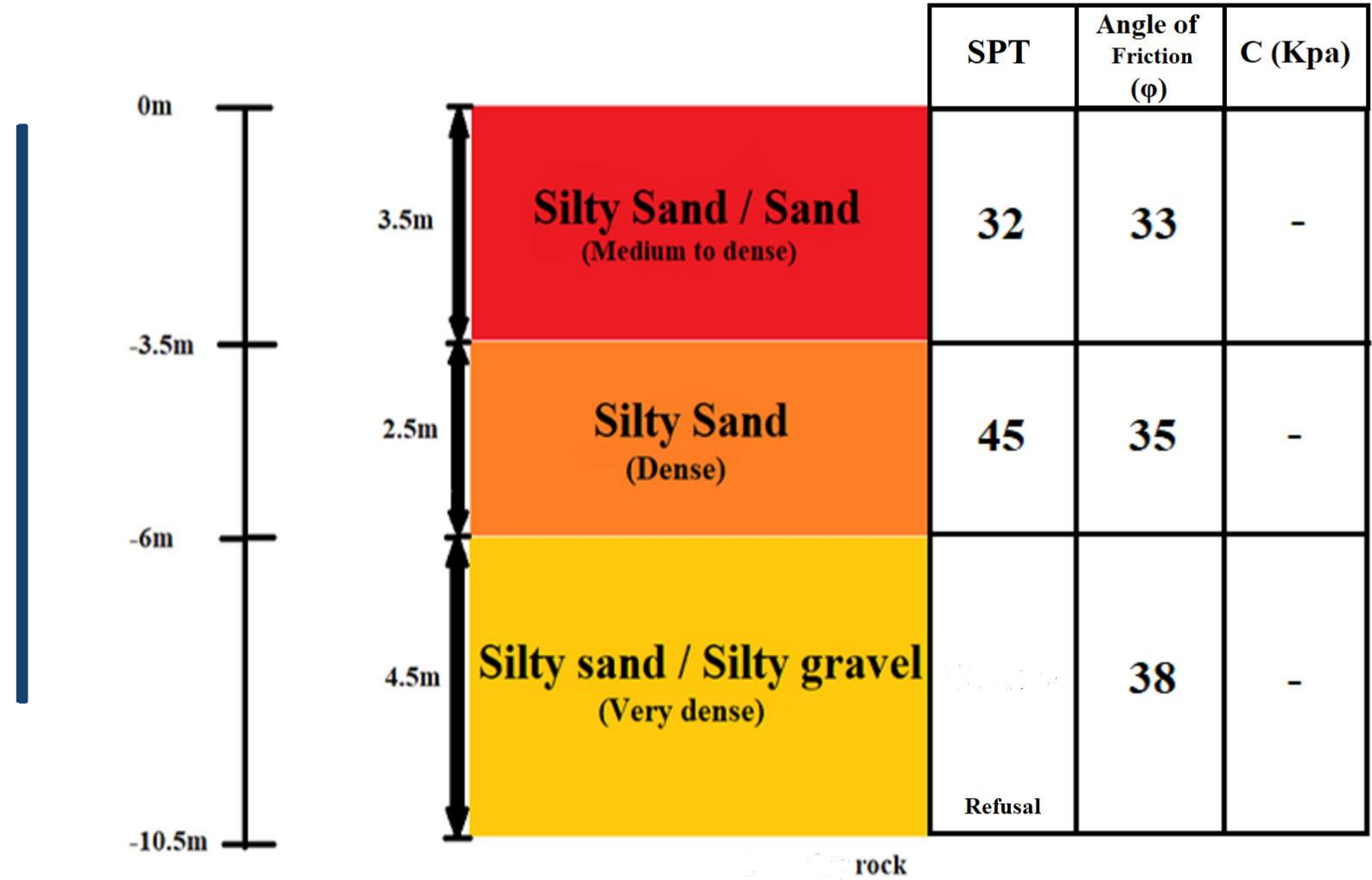


# GEOTECHNICAL DESIGN



# Geotechnical Design

○ Soil profile





# Geotechnical Design (Continues)

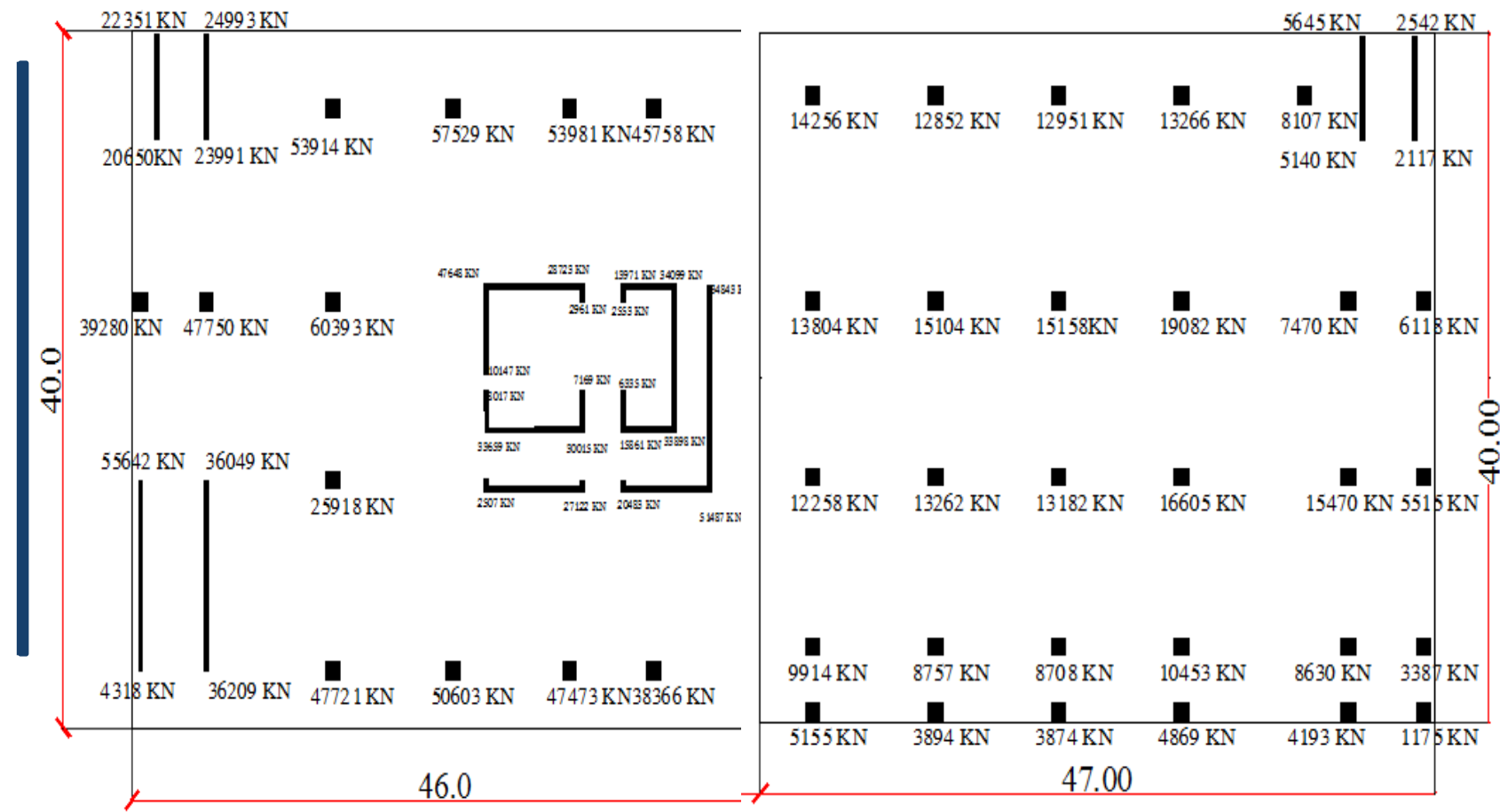
- Characteristics:
- Driven Piles.
- Bored Piles.

Foundations:	Section A	Section B
Selected Foundation system:	Piled Mat Foundation	Piled Mat Foundation
Factor of safety:	3	3
Mat Foundation Thickness	3.4m.	1.66m.
Net bearing capacity:	$q_u(\text{net})=31,795 \text{ kN/m}^2$ . $q_{\text{all}}(\text{net})=10,598 \text{ kN/m}^2$ .	$q_u(\text{net})=32,132 \text{ kN/m}^2$ . $q_{\text{all}}(\text{net})=10,710 \text{ kN/m}^2$



# Geotechnical Design (Continues)

- Mat Foundation With Applied Loads(DL+LL)



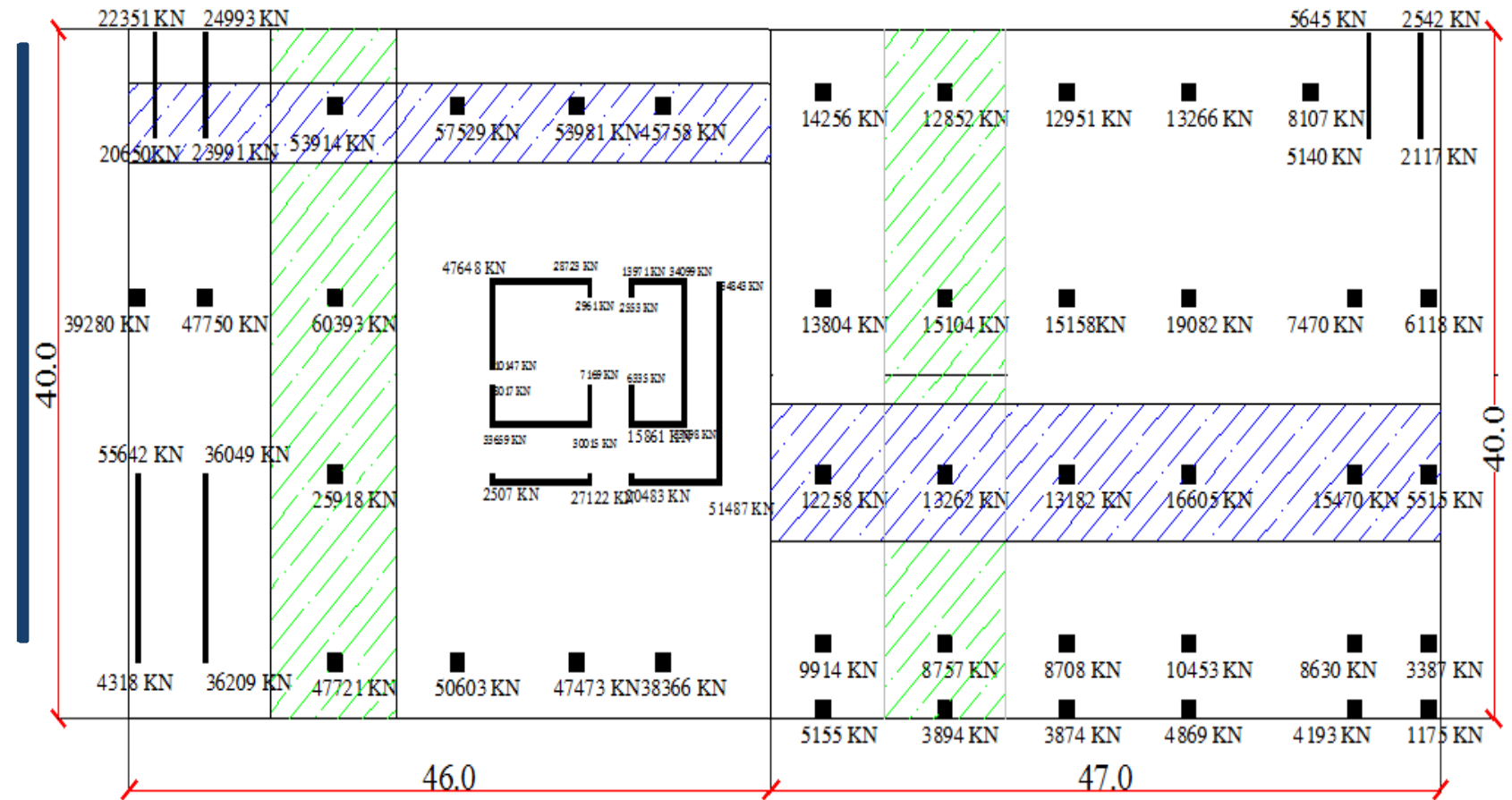
❖ AUTOCAD 2016 Software





# Geotechnical Design (Continues)

- Design of Mat foundation:
  - Strip Method



❖ AUTOCAD 2016 Software





# Geotechnical Design (Continues)

- Design of Mat foundation:
  - Steel Rebar.

Foundation	Top Steel	Bottom Steel
Section A	@D=12mm, #=4 bars.	@D=24mm, #=11 bars.
Section B	@D=10mm, #=4 bars.	@D=18mm, #=9 bars.





# Geotechnical Design (Continues)

- Piles Design.

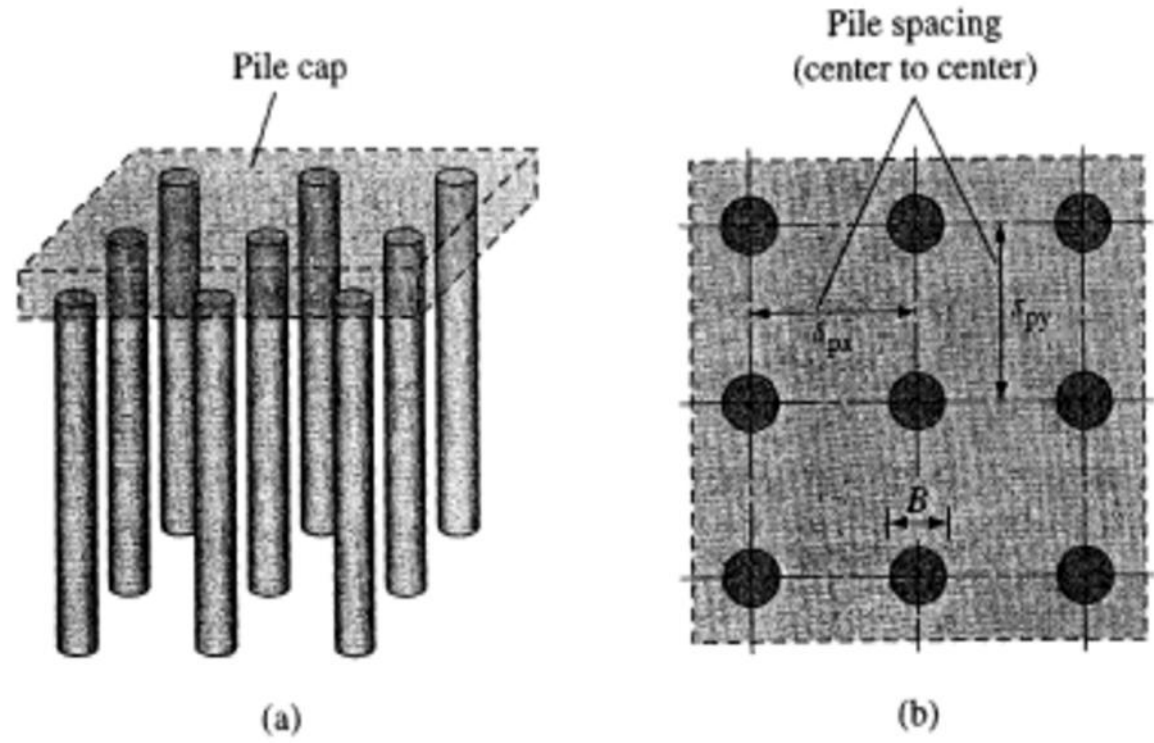
Foundations	Section A	Section B
Pile Diameter(m)	0.3	0.3
$Q_{all}(kN)$	2054.9	1356.2
Number of piles	238	266





# Geotechnical Design (Continues)

- Group of Piles



(a) 3D View  
(b) Top View For The Foundation

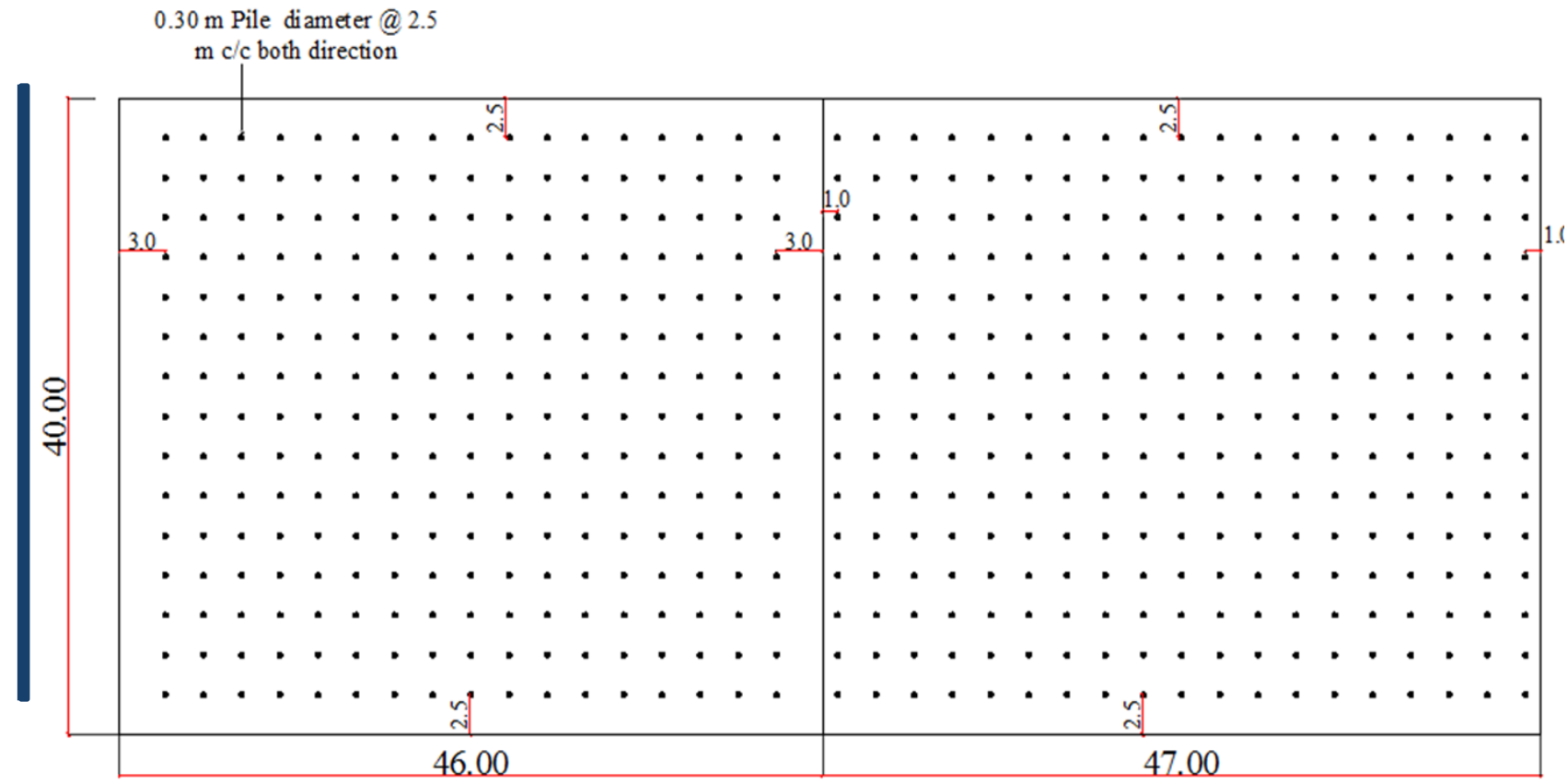
\* Das, 1999 slides Chapter 8: Group Piles





# Geotechnical Design (Continues)

- Piles Spacing and Dimensions.



❖ AUTOCAD 2016 Software

# COST ESTIMATION





# COST ESTIMATION

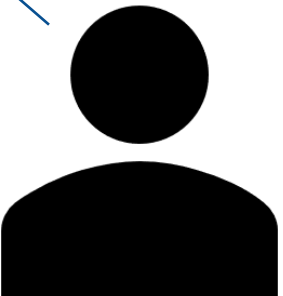
❖ Based on the construction prices for one unit m<sup>2</sup> in the region of Dammam city for the period 2017/2018

Floor Type	Unit Price (m <sup>2</sup> )	Floor Area (m <sup>2</sup> )	Total Area (m <sup>2</sup> )	Cost (SAR)
Super Structure	3000	1840	73600	220,800,000
Ground Floor & Mezzanine	4500	3720	7440	33,480,000
Podiums	2500	3720	29760	74,400,000
Total Cost				328,680,000

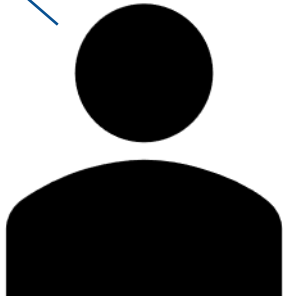




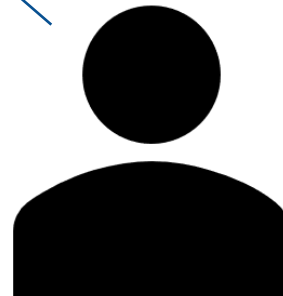
# ACKNOWLEDGMENT



Engr. Danish Ahmed



Dr. Tahar Ayadat



Dr. Andi Asiz





## CONCLUSION

- Choosing an adequate structural system.
- Preliminary design of structural members.
- Modeling using ETABS software for design & analysis.
- Geotechnical design of the foundation system.





## REFERENCES

- ACI 318-11 Code : American Concrete Institute.
- SBC (301) : Saudi Building Code.
- SBC(303): Saudi Building Code.
- International Building Code 2009.
- Principle of Foundation Engineering BRAJA DAS (7th edition).
- Arabtech Jardaneh.
- Abdulrahman Al-Otaishan Group.



T H A N K

Y O U

