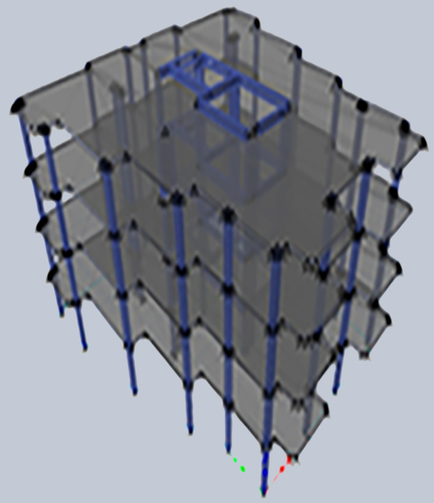
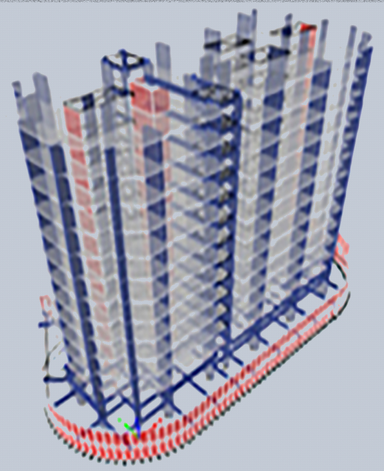
NAHDA UNIVERSITY
FACULTY OF ENGINEERING
CIVIL DEPARTMENT

REINFORCED CONCRETE PROJECT 2025



.first UNIT APARTMENT BUILDING.
.BUILDING CONSISTS OF 5 FLOORS
.BASEMENT,GROUND,2 TYPICAL FLOORS AND ROOF FLOOR
.BASEMENT(STORE),GROUND(RESIDENTIAL)
AND TYPICAL(RESIDENTIAL)
.THE HEIGHT OF THE FLOOR IS 3M

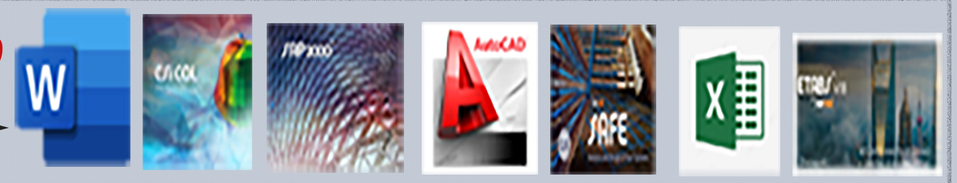


.THE SECOUND UNIT IS A HIGHRISE BUILDING
.BUILDING CONSISTS OF 14FLOORS AND ROOF
.2BASEMENT ,GROUND,11 TYPICAL FLOORS
.BASEMENT (GARAGE),GROUND(COMMERCIAL),TYPICAL(RESIDENTIAL)
.BUILDING AREA IS 1009.5M2
THE HEIGHT OF THE FLOOR IS 3M,EXCEPT FOR THE BASEMENT IS 3M
.TOTAL HEIGHT OF BUILDING IS 42M
.LOCATION OF THE PROJECT IS IN BENI SUEF , ZONE ONE, SOIL TYPE (C)



.THE THIRD UNIT IS SPORTING STADIUM
.THE PROJECT CONSISTS OF FLOORS
.BASEMENT,GROUND,3TYPICAL FLOORS
.BUILDING AREA IS 4415M2
.THE HEIGHT OF THE FLOOR IS 3.6M,
.AND GROUND FLOOR IS 3M ,EXCEPT FOR THE BASEMENT IS
2.40M ,AND GROUND FLOOR IS 3M
.CAPACITY 120000 WATCHING
.TOTAL HEIGHT OF BULIDING IS 15M

PROGRAMS USED



DESIGN CODE

.EGYPTION CODE FOR DESIGN CONCRETE STRUCTURE(ECP203-2020)
EGYPTION CODE FOR CALCULATING LOADS AND FORCES IN CONSTRUCTION AND BUILDINGWORKS
ECP(201-2019)

DEAN OF FACULTY OF ENGINEERING
PROF.DR/ SALEM M, ELKHODARY

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PROF.DR /SAYED ABD-ALKADR

HEAD OF DEPARTMENT
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PROF.DR/AHMED SERAG FARID,
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PREPARED BY
ENG/ALAA ABDELLAH
ENG/MOHAMED YOUSEF
ENG/AHEMD AHMED

أسم المشروع

" خرسانة مسلحة (مشروع 2) "

وصف مختصر عن مكوناته والمواد المستخدمه

يتضمن المشروع ثلاث وحدات مختلفة: الوحدة الأولى عبارة عن مبنى سكني مكون من 5 أدوار (بدروم للتخزين وأرضي وطابقين متكررين وسطح) بارتفاع 3 متر لكل طابق، الوحدة الثانية مبنى متعدد الطوابق يتكون من 14 طابقاً (بدرومين للجراج وطابق أرضي تجاري و11 طابق متكرر سكني) بمساحة 1000 متر مربع ، والوحدة الثالثة استاد رياضي يتكون من 5 طوابق (بدروم وأرضي و3 طوابق متكررة) بمساحة 4415 متر مربع وارتفاع 15 متر وسعة 120000 متفرج، ، وقد تم تصميم جميع الوحدات وفقاً استخدام الكود المصري للتنفيذ و التصميم و الكود المصري للأحمال .

تم بكل وحدة :-

- اختيار النظام الانشائي مع مراعاة الأمان و تكلفة المبني
- عمل التحليل الانشائي
- عمل التصميم الانشائي للعناصر المختلفة
- تصميم الاساسات
- رسم التفاصيل الانشائية و المساقط المطلوبة
- رسم تفاصيل التسليح
- اعداد النوتة الحسابية
- ا ستخدام البرامج الحديثة في التصميم SAP & CSI COLUMN & AUTO CAD & EXCEL (Etabs & Safe& SHEETS)

-

الجهات المشاركة (إن وجد) - أهداف المشروع

عمل تحليل إنشائي و تصميم واعداد لوحات انشائية لحميع العناصر الانشائية المختلفة للوحدات الثلاثة بالمشروع (فيلا – برج تجاري سكني – استاد رياضي

النتائج التي تم التوصل لها

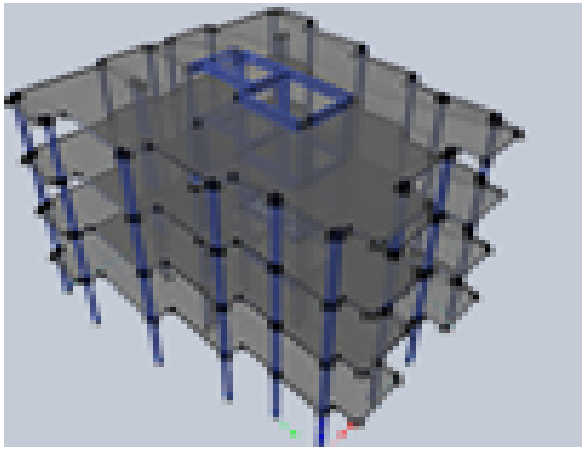
1- استخراج لوحات انشائية مفصلة لكل منشأ تشمل ابعاد القطاعات الخرسانية و حديد التسليح طبقا - لاشتراطات الكود المصرى

2-تفاصيل التسليح لجميع العناصر الإنشائية (أعمدة – كمرات – بلاطات – أساسات = اطارات - البلاطات القشرية)

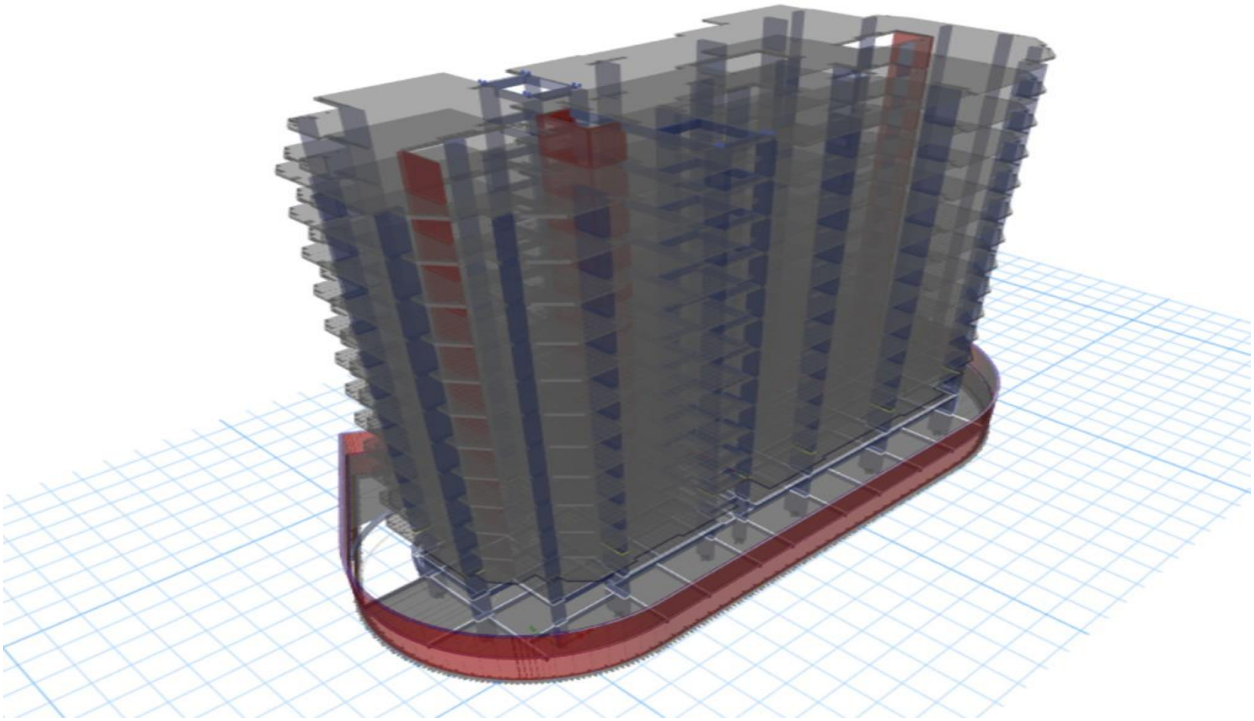
3-توثيق جميع مراحل التصميم في تقرير فني شامل-

صور للمشروع (مودل أو ماكيت أو ماكينة أو شكل تخطيطي له)

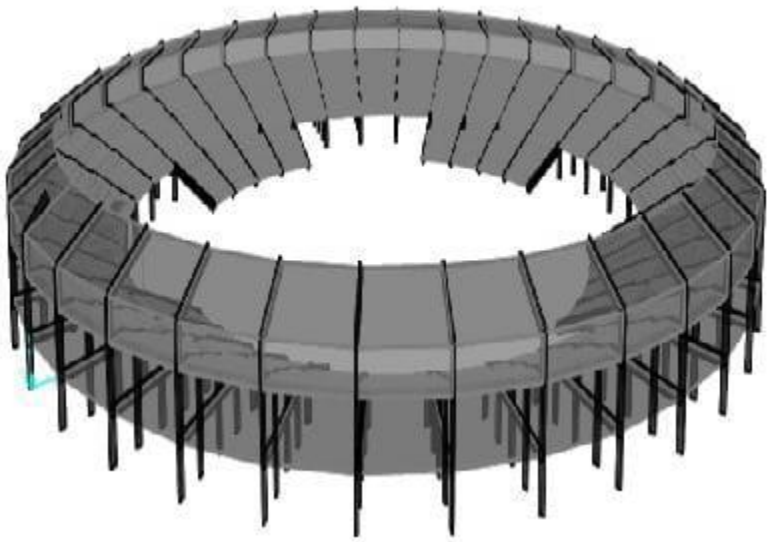




Unit one (Villa)

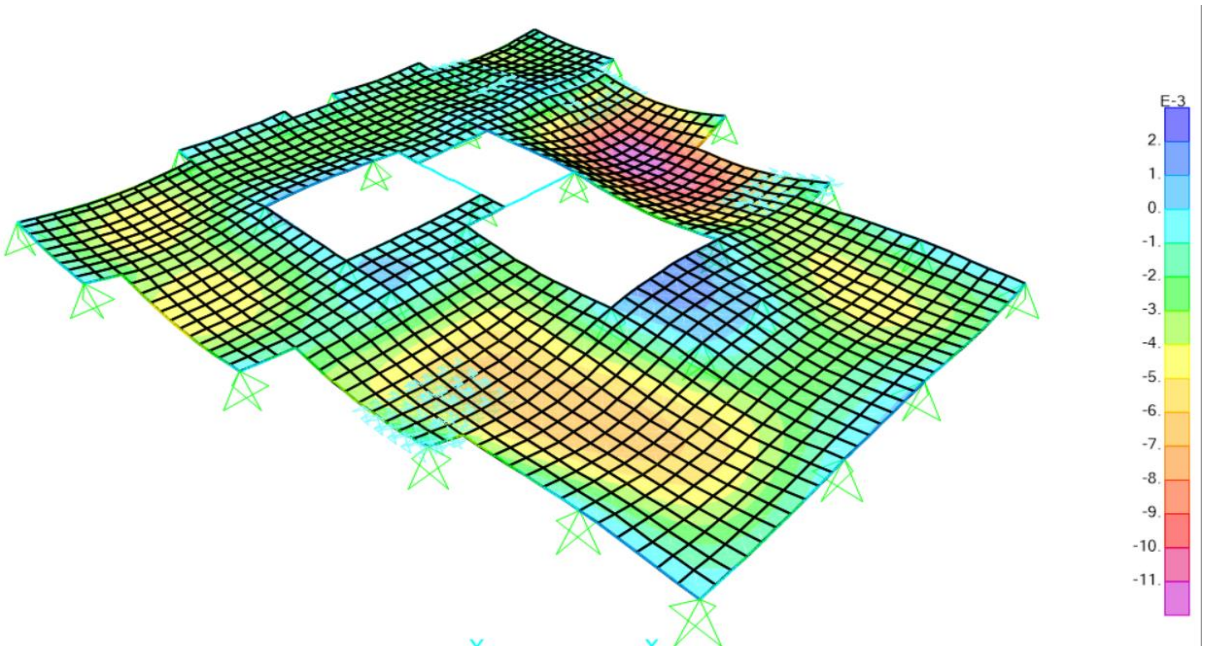


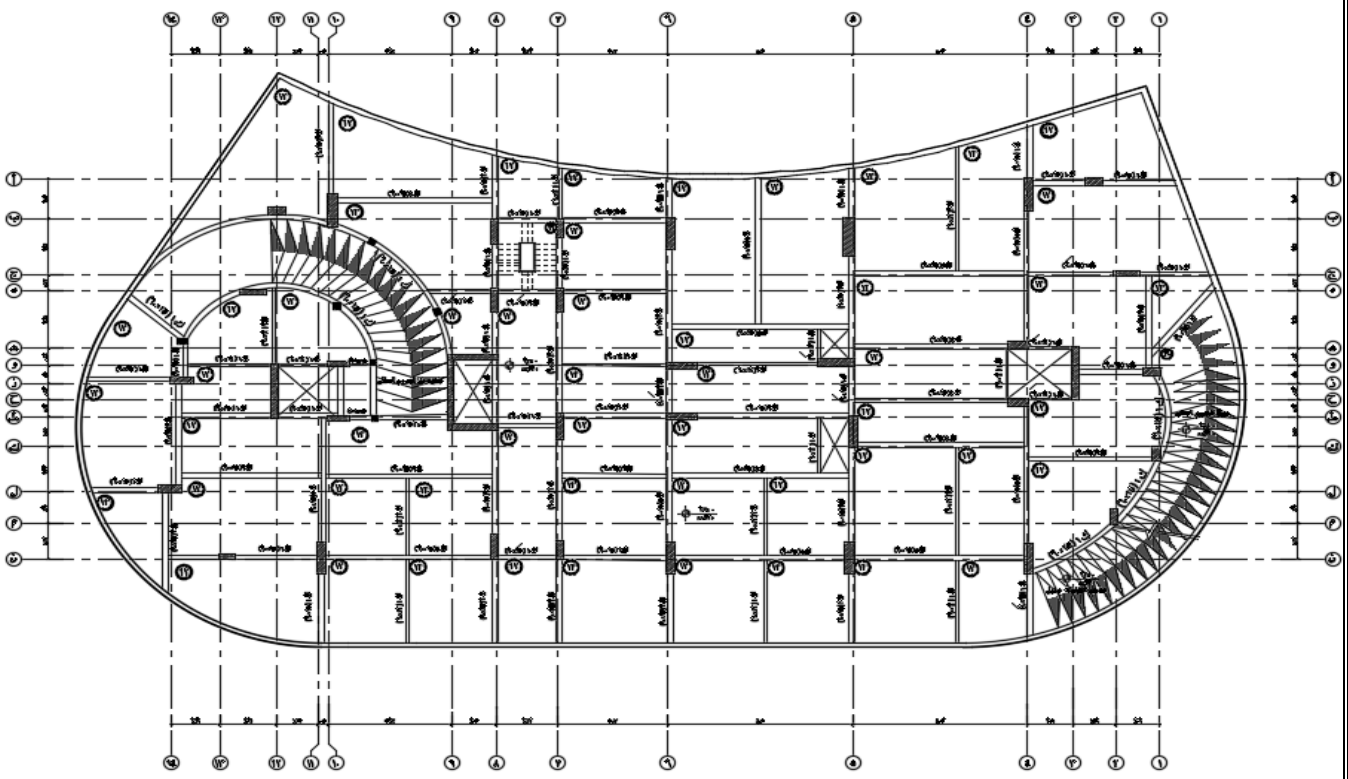
Unit two High rise building (garage- commercial- residential)



Unit three (Sporting Stadium)

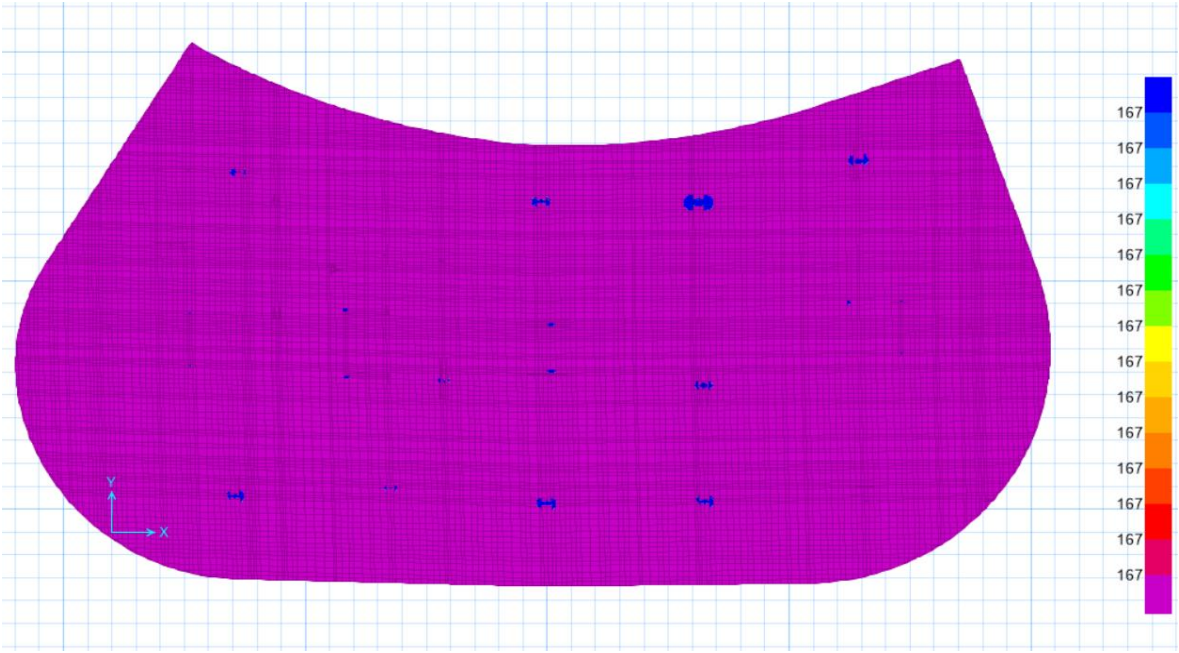
صور من عمل الطلاب أثناء مشروع التخرج التى تمت فى المعامل الهندسية

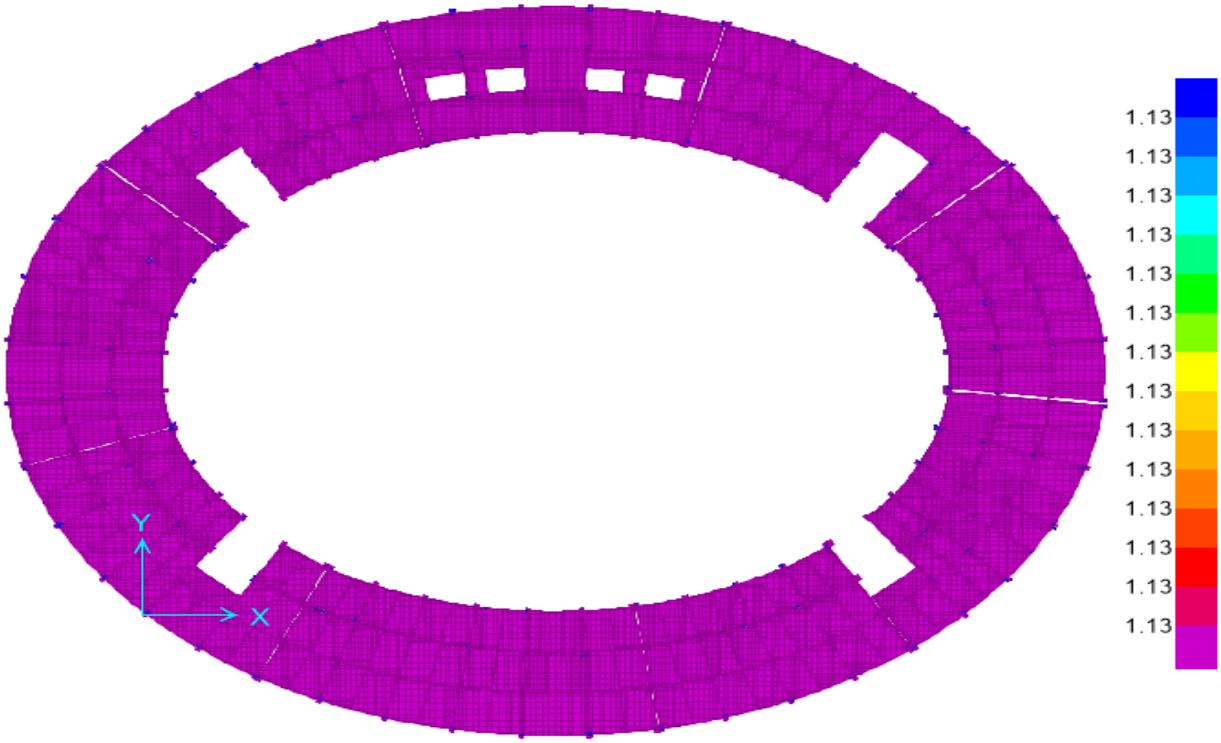




رئيس التحرير
م.م/ عبدالرحمن الشريف

رئيس مجلس إدراة مجلة كلية الهندسة
أ.د/ سالم الخضرى





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أ.د/ سالم الخضرى

صور من مناقشة الطلاب








NAHDA UNIVERSITY
FACULTY OF ENGINEERING
CIVIL DEPARTMENT
MATARIAL
GRADUATION PROJECT
2025

Al-Nahda University
Faculty of Engineering

REINFORCED CONCRETE PROJECT (2025)

SUPERVISORS

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ENG/ Kerolous magdy
ENG/ Andrew ayad seif

PRESENTED BY

ENG: Alaa Abdellah Algoul
ENG: Mohamed Yousef
ENG: Ahemd Ahmed Abdallah

UNIT 1/ Residential Villa

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1.1	Project description	3
1.2	The programs used	4
1.3	The Architecture plans	5-9
1.4	Design of Basement	10-19
1.5	Design of the ground floors	20-31
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1.11	Design of Retaining walls	62

1. Project description

- Building consists of 5 floors.
- Basement, ground ,2 typical floors and roof floor.
- Basement (store), ground (residential) and typical (residential).
- The height of the floor is 3 m.

Design Codes

- Egyptian code for design concrete structure (ECP 203-2018).
- Egyptian code for calculating loads and forces in construction andbuilding works ECP(201-2018).

2. The programs used

Word

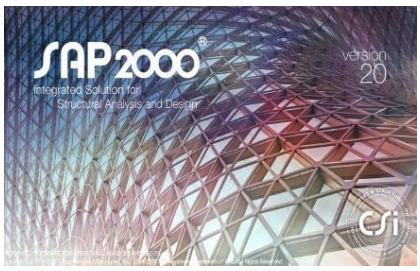
Excel



EGYPTION CODE (C.D.P)

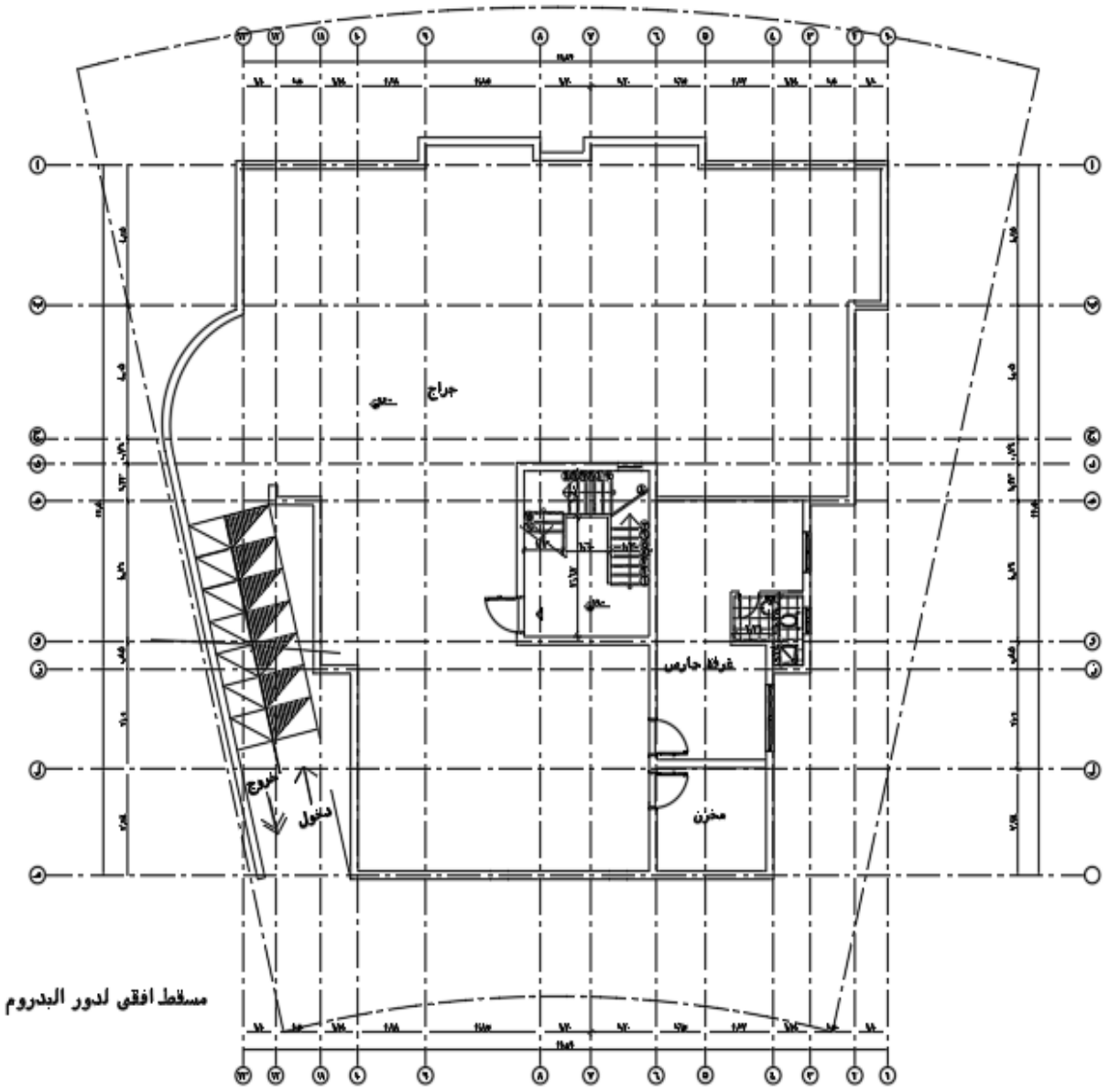


Autocad 2022

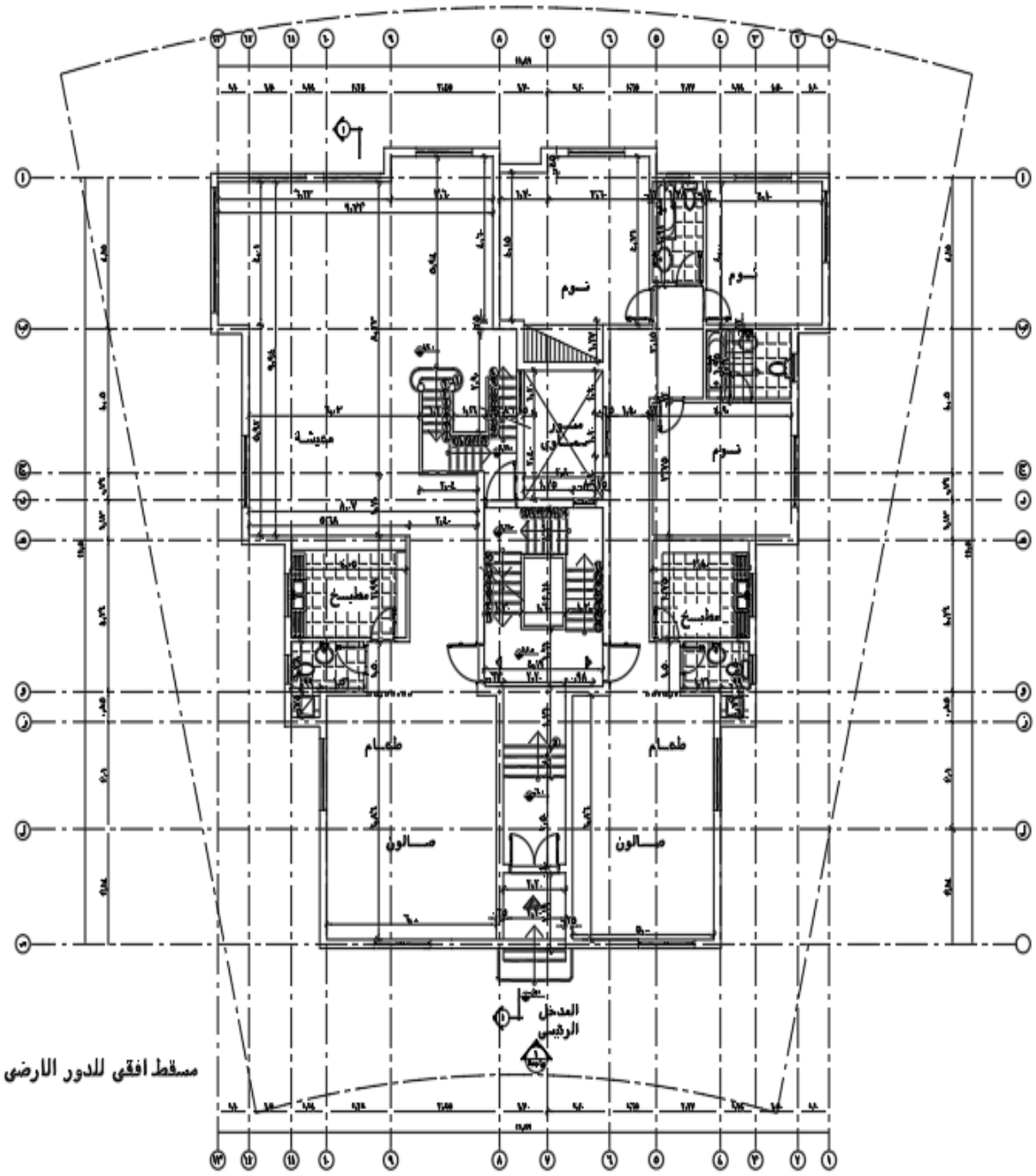


Sap 2020

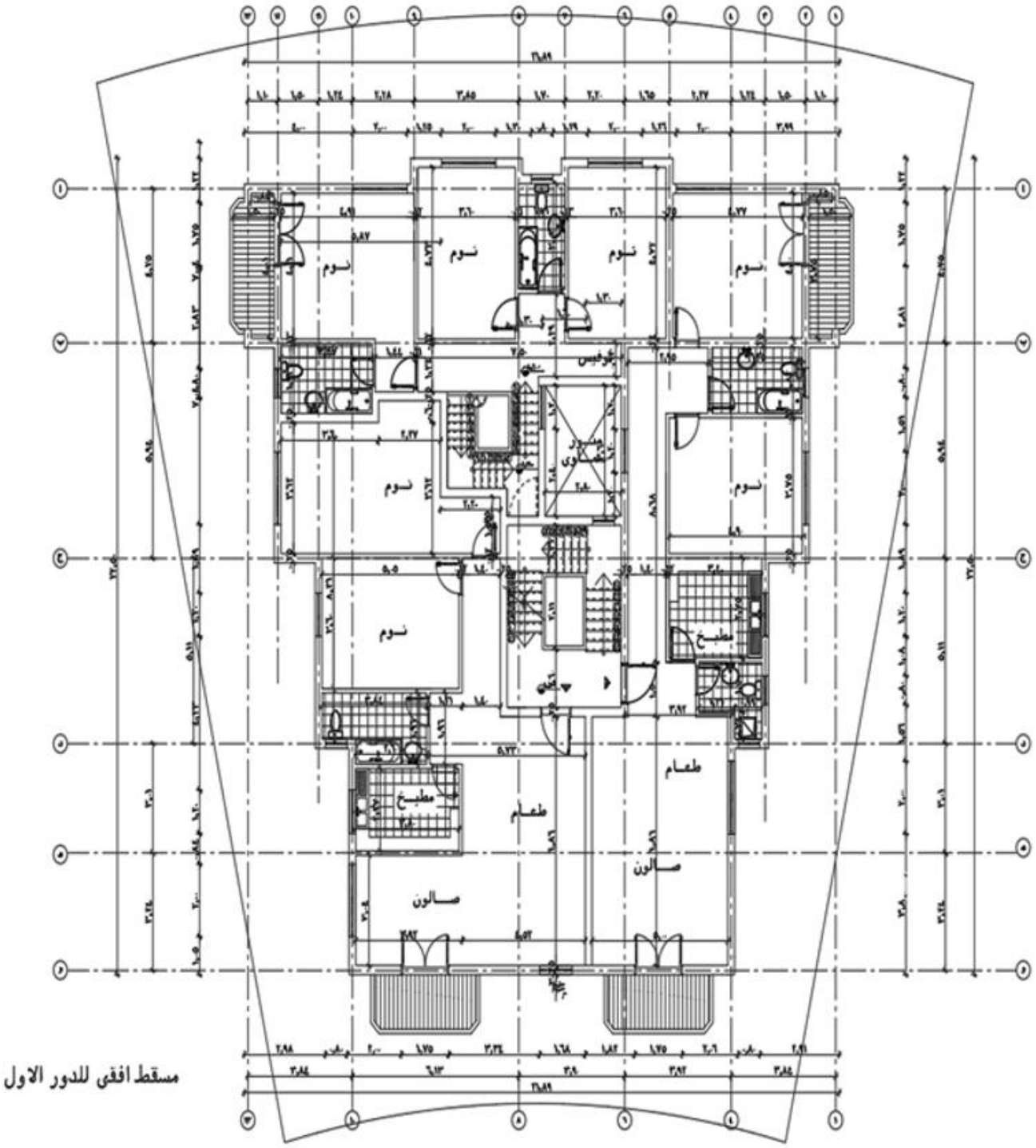
3.The Architecture plans



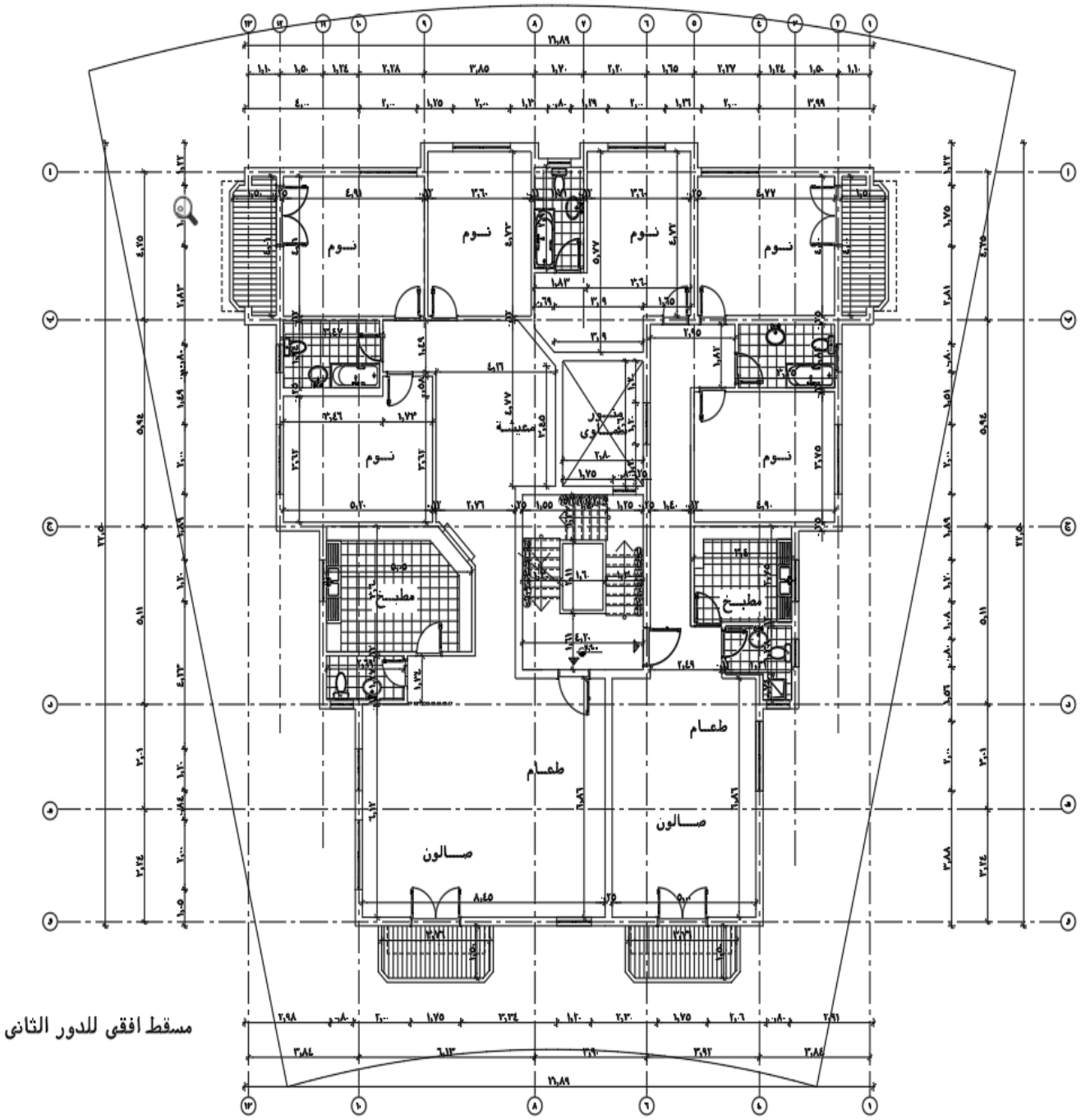
مسقط افقي دور البدروم



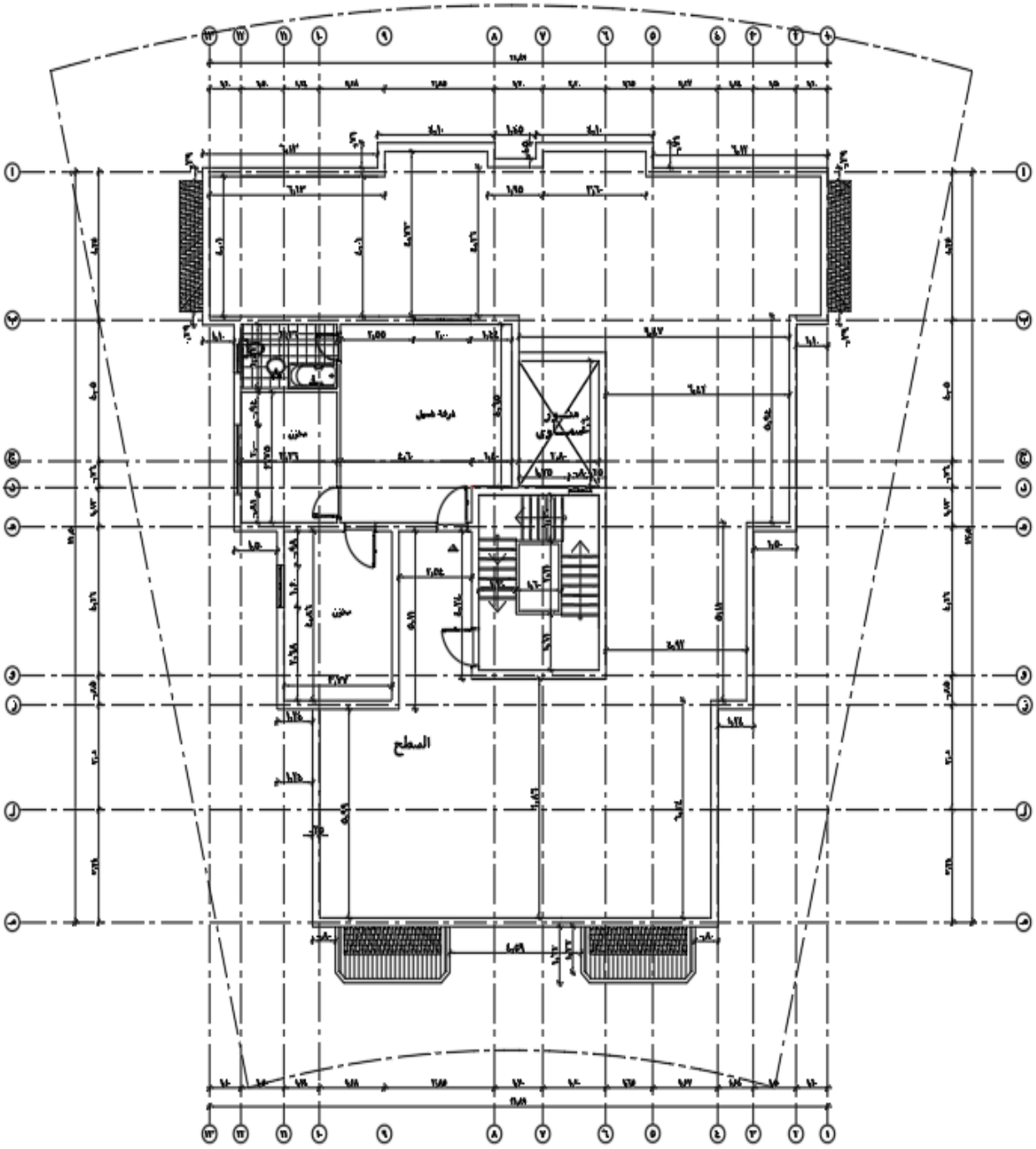
مسقط افقي دور الارضي



مسقط افقي الدور الاول



مسقط افقي الدور الثاني



مسقط افقي دور السطح

4. Design of Basement

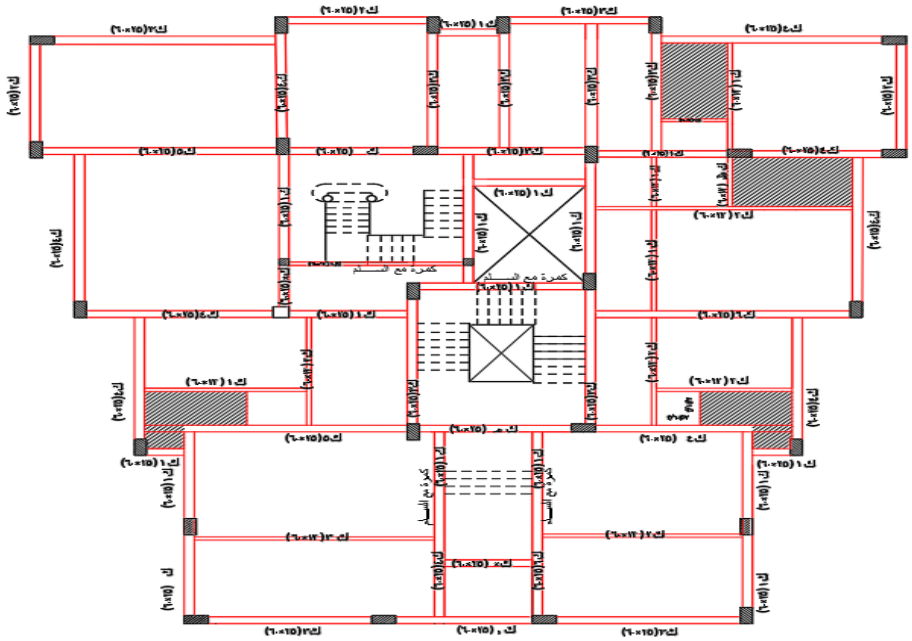
4.1. Design Notes

- The roof is designed in solid and flat slab system

Designed on:

- Own wight calculated by sap
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3600 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

4.2. Statical system



4.3. Moment of slabs

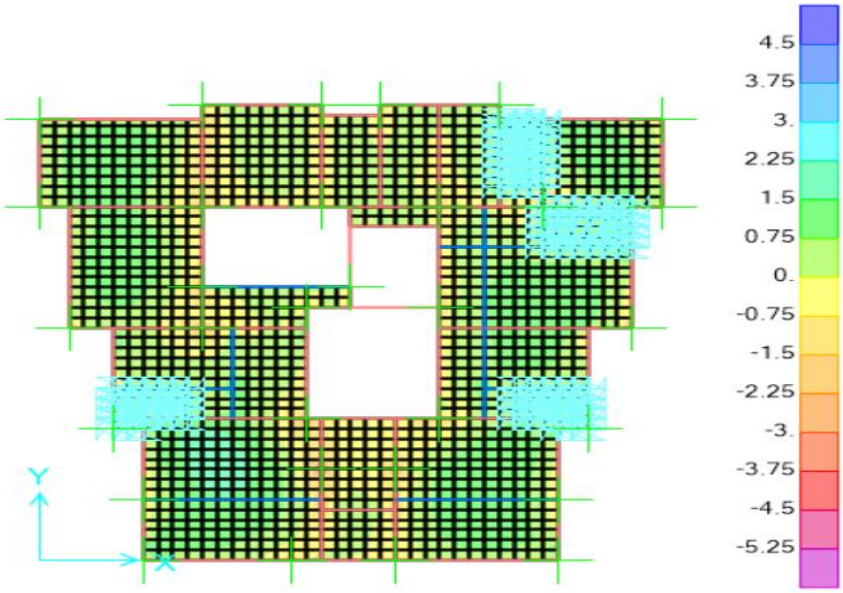


Figure 1.1: M1.1 positive

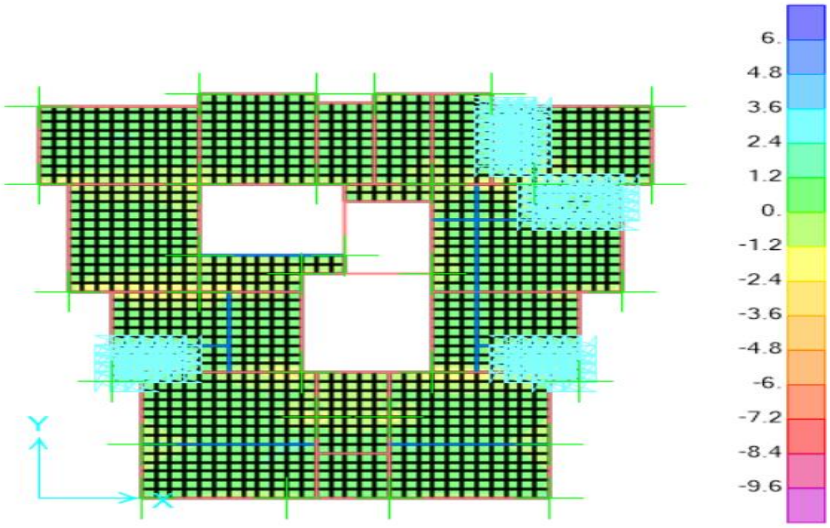


Figure 1.2: M2.2 positive

4.4. Design of slabs

- *Solid slab (ts = 15cm, ts =12cm, ts =10cm)*

For slab *ts = 15cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	150	130	0.826	1	1.475881

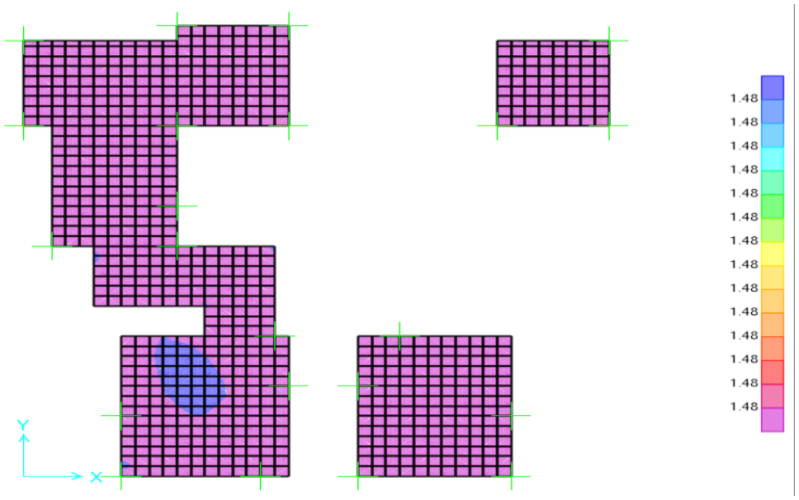


Figure 1.3: M1.1 positive

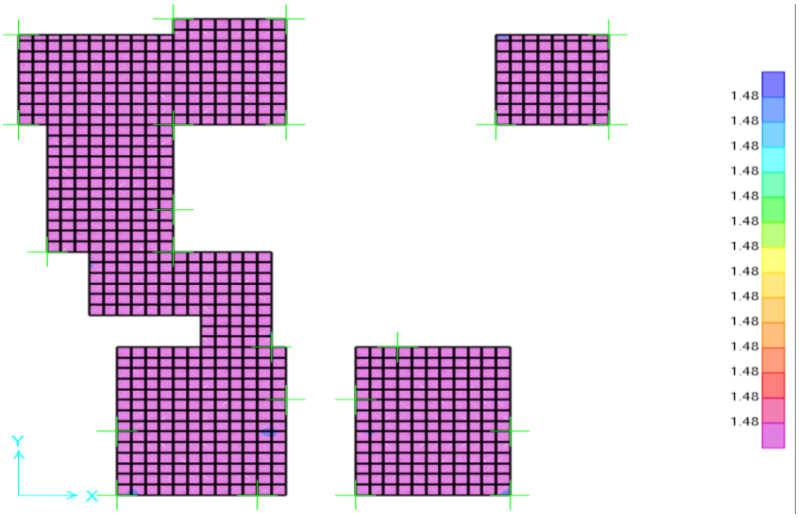


Figure 1.4: M2.2 positive

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	7	10	549.779	350	150	130	0.826	1	2.0662333

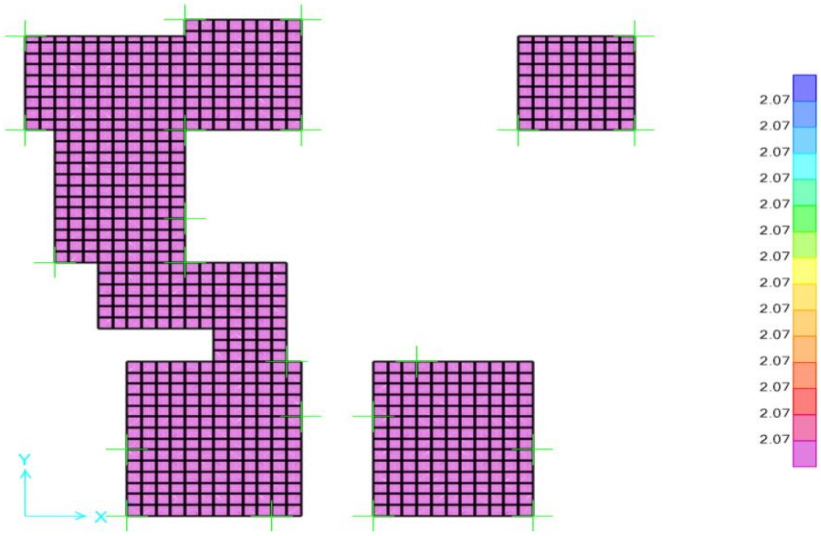


Figure 1.5: M1.1 positive

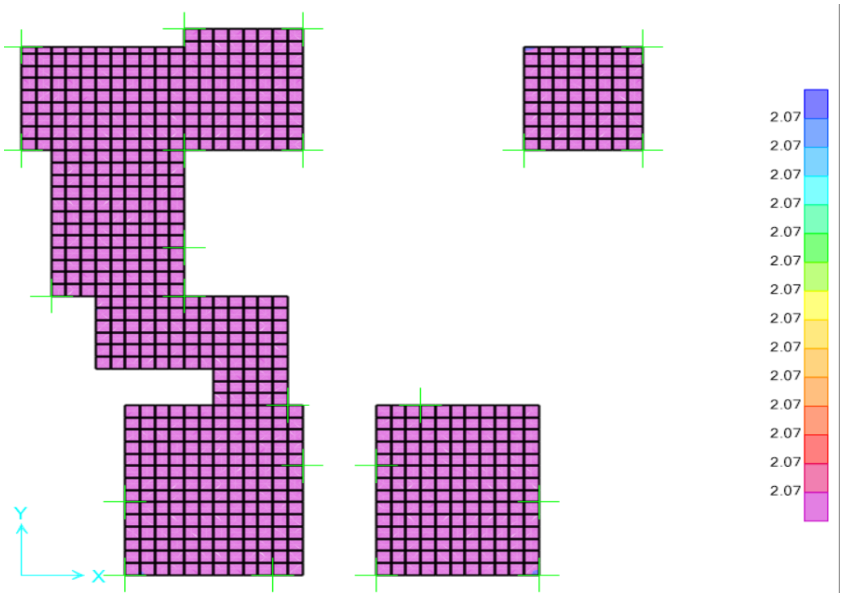


Figure 1.6: M2.2 positive

For slab *ts = 12cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	120	100	0.826	1	1.135293

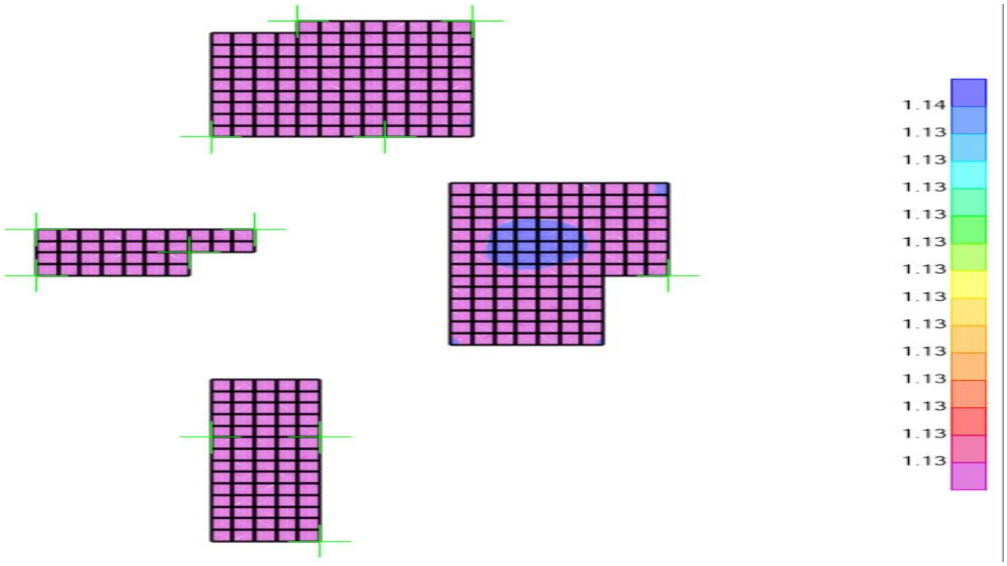


Figure 1.7: M1.1 positive

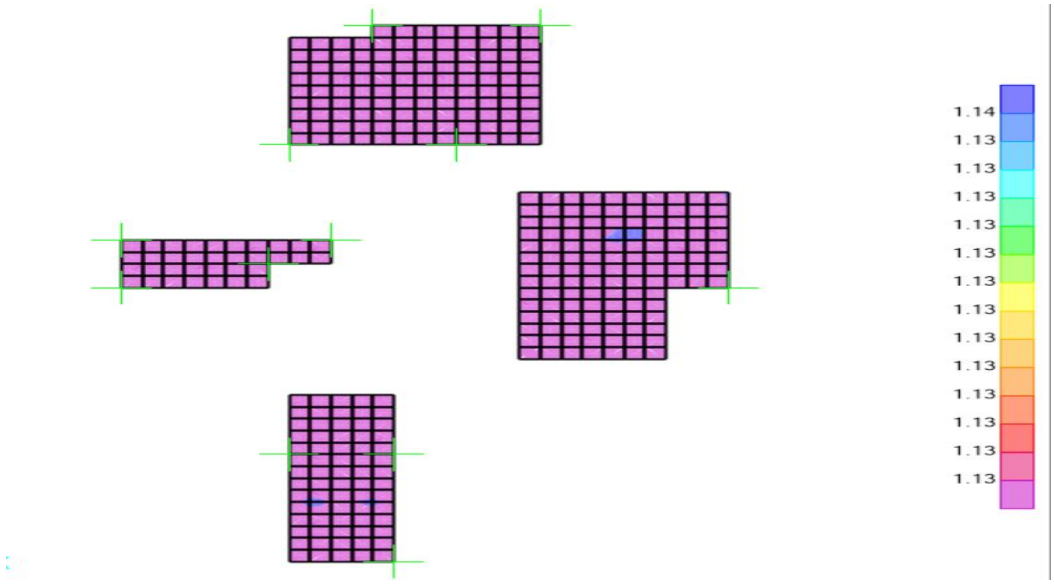


Figure 1.8: M2.2 positive

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	10	471.239	350	120	100	0.826	1	1.3623517

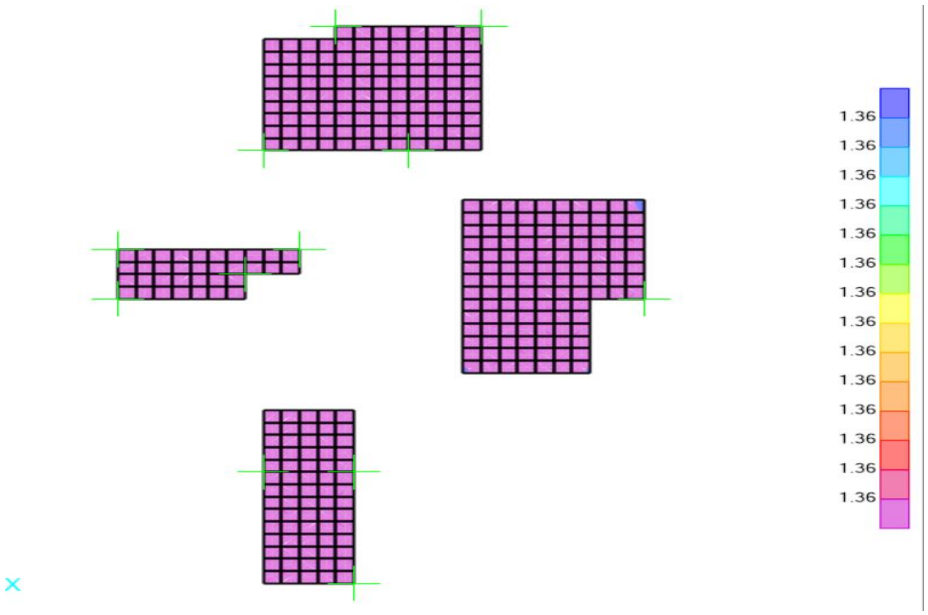


Figure 1.9: M1.1 positive

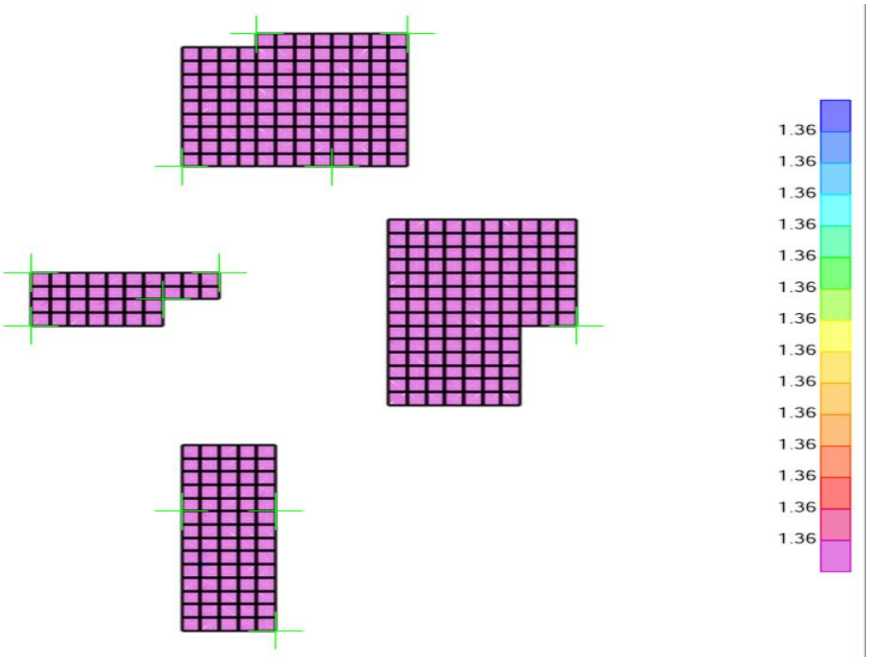


Figure 1.10: M2.2 positive

For slab *ts = 10cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	100	80	0.826	1	0.9082344

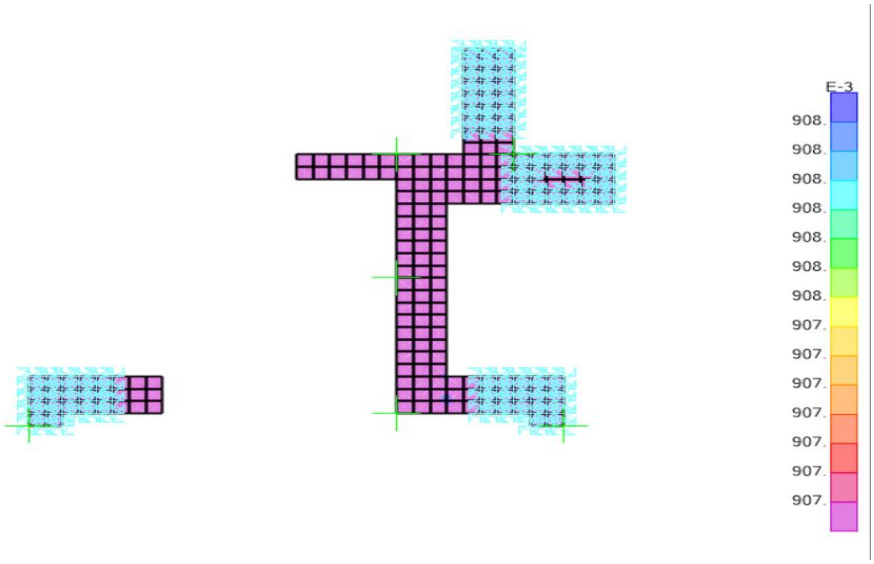


Figure 1.11: M1.1 positive

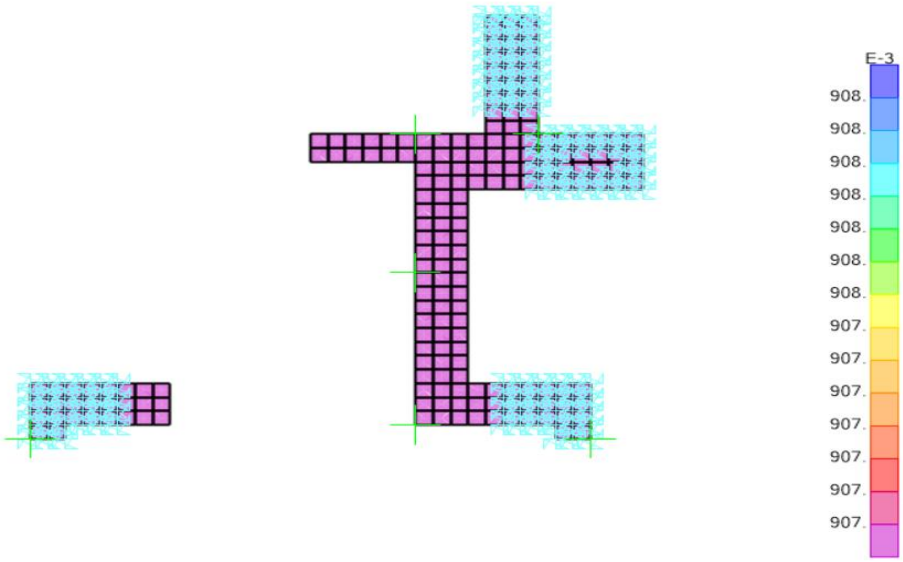
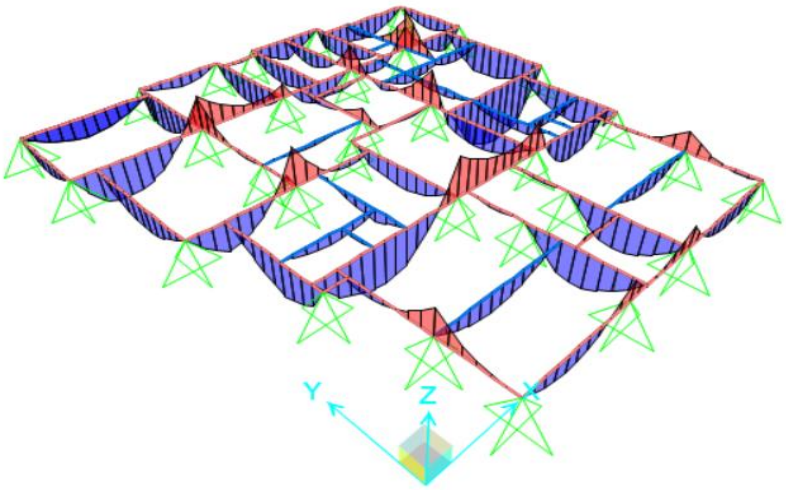


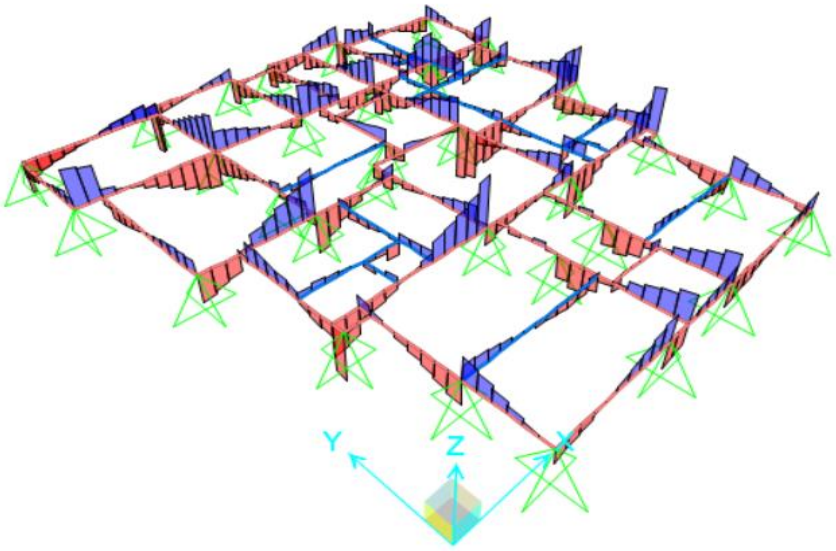
Figure 1.12: M2.2 positive

4.5. Design of beams

Moment of beams



Shear of beams



Design of beam

Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	360	600	575	0.72	1	5.1
B2	5	12	565.4866777	360	600	575	0.72	1	8.4
B3	4	16	804.2477194	360	600	575	0.72	1	12.0
B4	6	16	1206.371579	360	600	575	0.72	1	18.0
B5	6	18	1526.81403	360	600	575	0.72	1	22.8
B6	8	20	2513.274123	360	600	575	0.72	1	37.5
B7			0	360		-25	0.72	1	0.0
B8			0	360		-25	0.72	1	0.0

Check shear

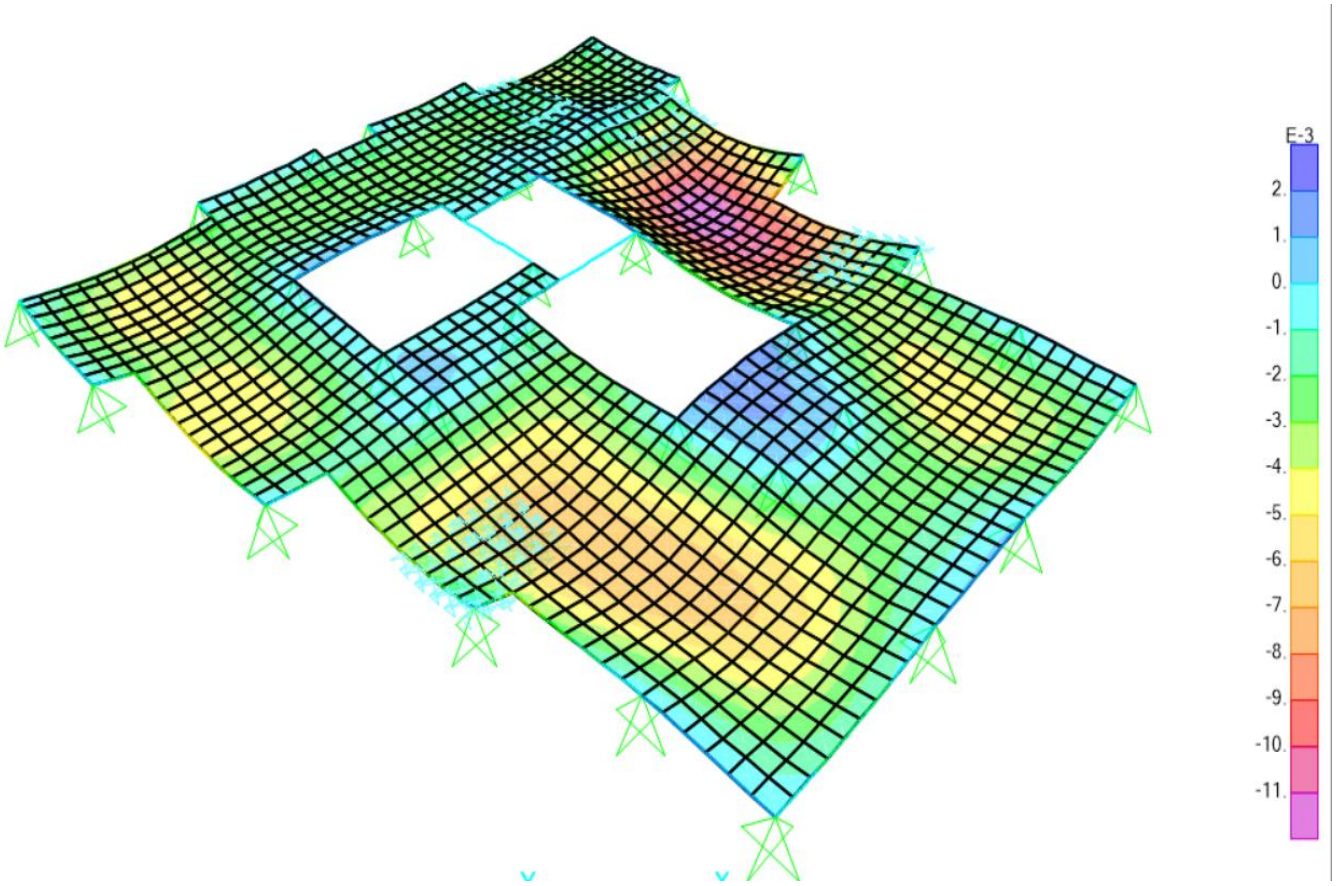
Concrete F_{cu} =	250	kg/cm^2
Concrete q_{all} =	9.682	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
				#DIV/0!	#DIV/0!		##### ϕ 8	#DIV/0!
1	20	25	57.5	13.91	0.075	2	5 ϕ 10	safe

Concrete F_{cu} =	250	kg/cm^2
Concrete q_{all} =	9.682	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
				#DIV/0!	#DIV/0!		##### ϕ 8	#DIV/0!
2	20	12	57.5	28.99	0.095	2	7 ϕ 10	safe

check of deflection



Δ max =1.1 cm (from SAP)

Δ all = span / 250

Δ all = 485/ 250 = 1.94cm

SAFE DEFLECTION

5. Design of the ground floors

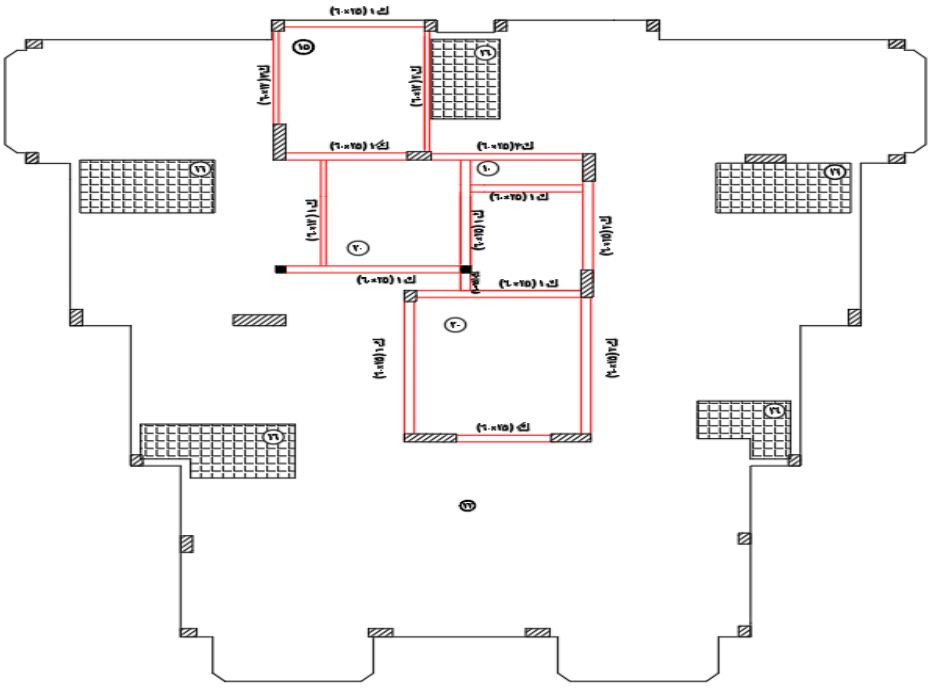
5.1. Design Notes

- The typical floors is designed in solid and flat slab system

Designed on:

- Own wight calculated by sap
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3600 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

5.2. Statical system



5.3. Moment of Solid slab

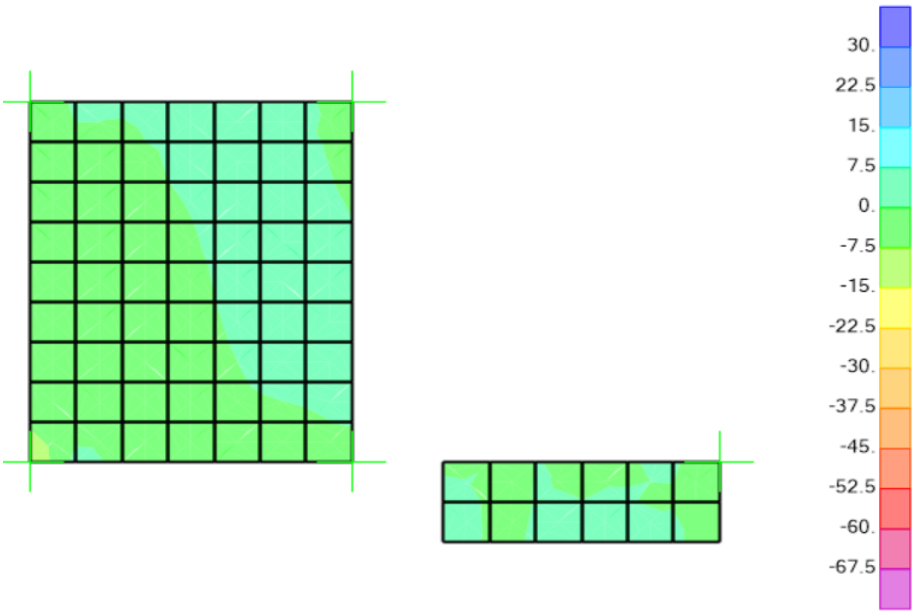


Figure 1.13: M1.1 positive

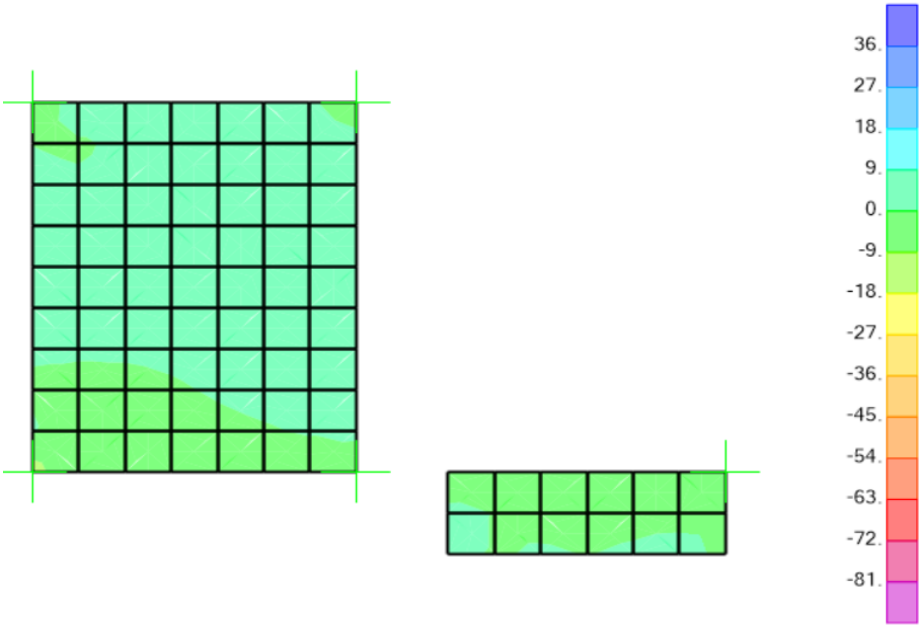


Figure 1.14: M2.2 positive

5.4. Moment of Flat slab

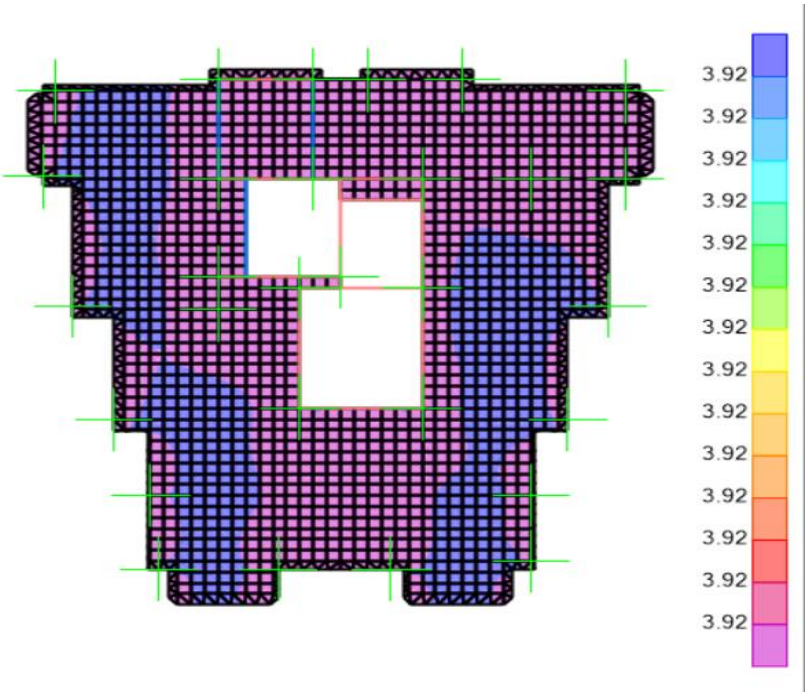


Figure 1.15: M1.1 positive

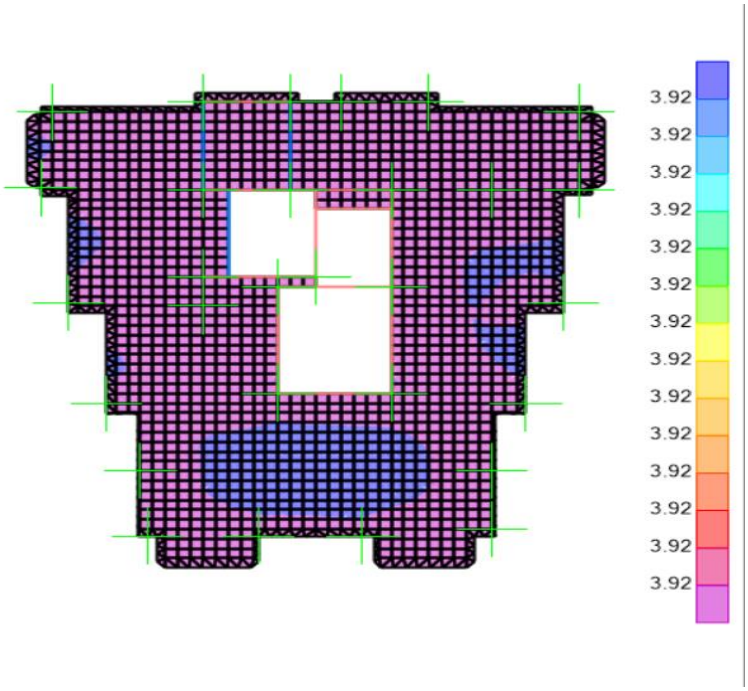


Figure 1.16: M2.2 positive

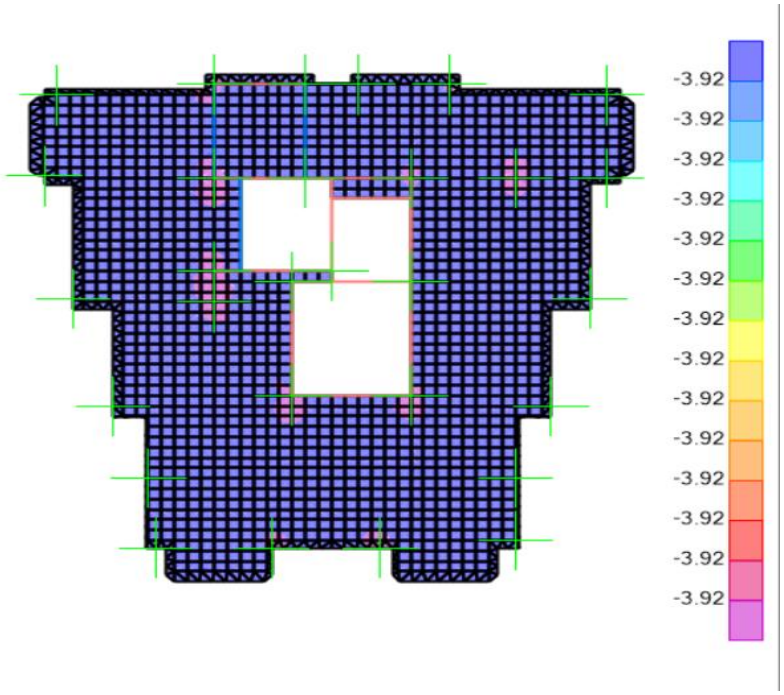


Figure 1.17: M1.1 Negative

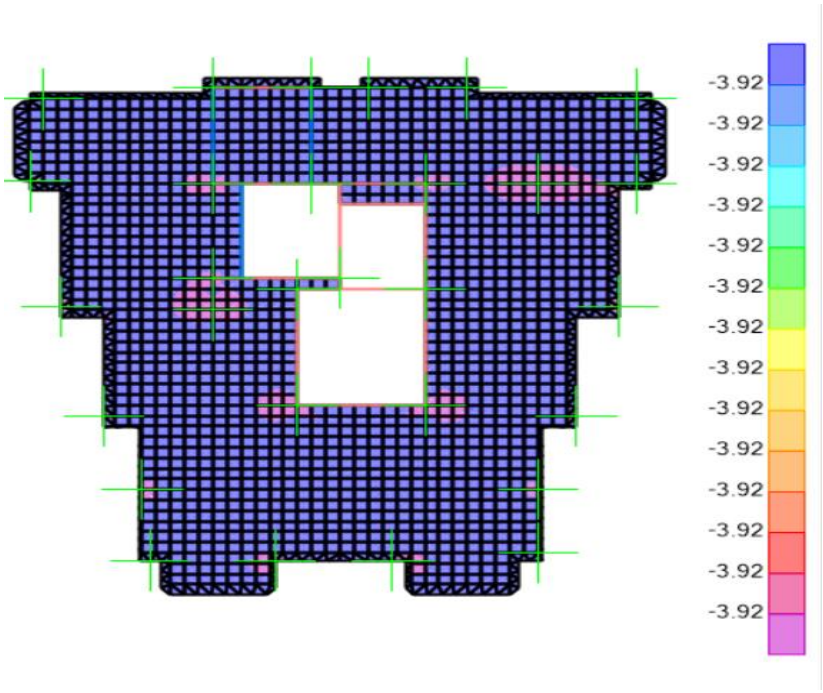


Figure 1.18: M2.2 Negative

5.5. Design of slabs

- *Flat slab (ts = 22 cm) , Solid slab (ts = 15 cm, ts =10)*

REINFORCEMENT FOR SOLID SLAB

For slab *ts = 15cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	150	130	0.826	1	1.475881

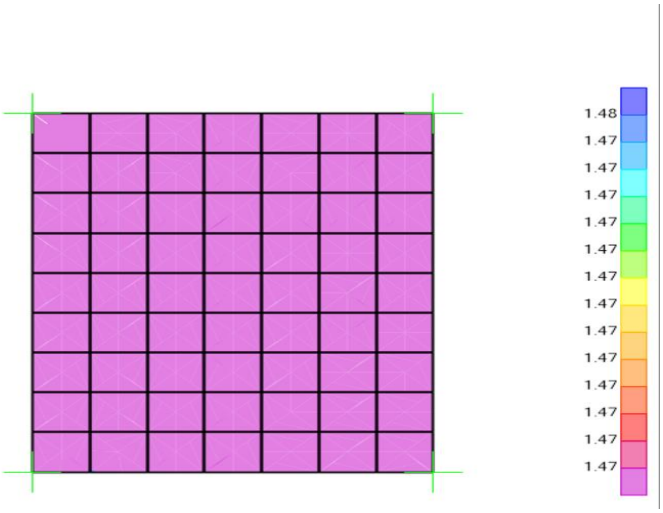


Figure 1.19: M1.1 positive

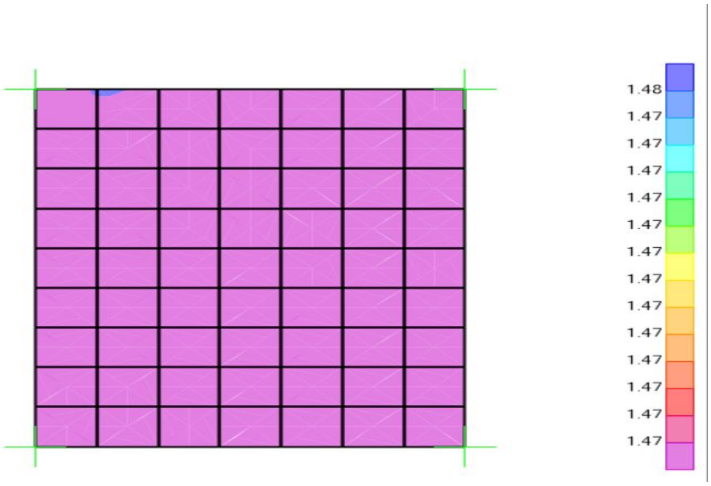


Figure 1.20: M2.2 positive

For slab *ts = 10cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	100	80	0.826	1	0.9082344

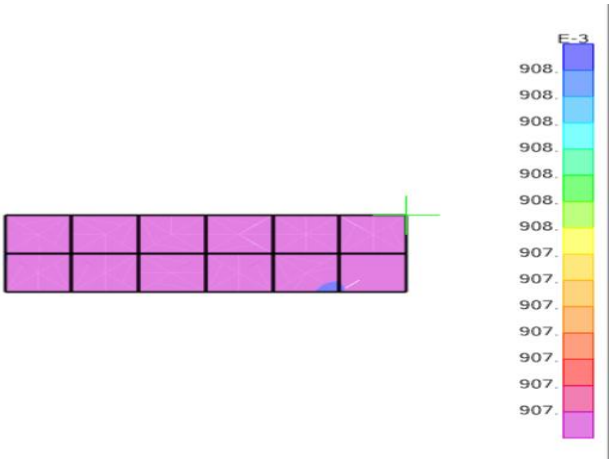


Figure 1.21: M1.1 positive

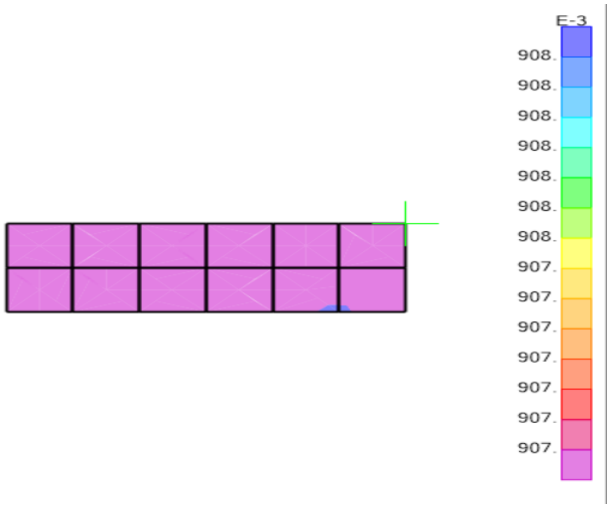


Figure 1.22: M2.2 positive

BOTTOM REINFORCEMENT FOR FLAT SLAB:

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	220	200	0.826	1	3.9235728

Additional		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	220	200	0.826	1	6.9752405

Total	10.90

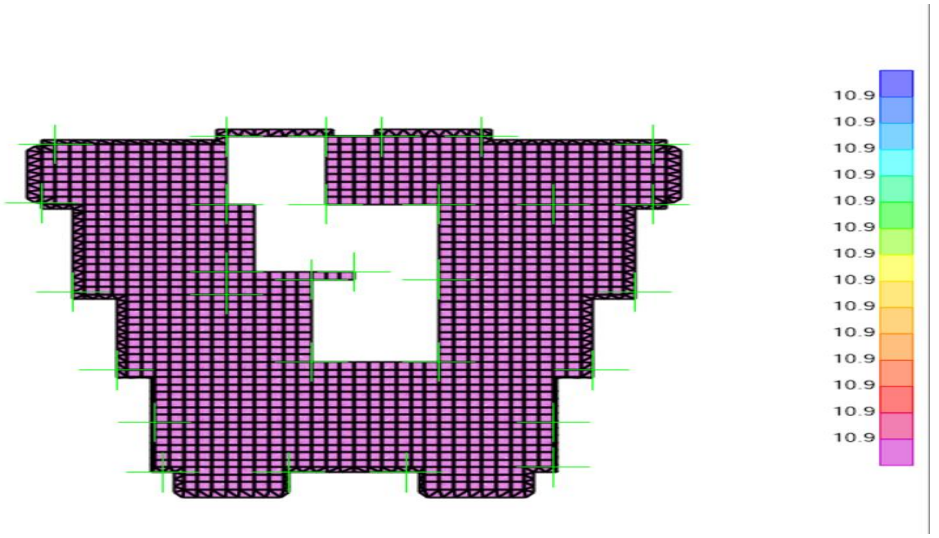


Figure 1.23: M1.1 positive



Figure 1.24: M2.2 positive

TOP REINFORCEMENT FOR FLAT SLAB:

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	220	200	0.826	1	3.9235728

Additional		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	220	200	0.826	1	6.9752405

Total	10.90

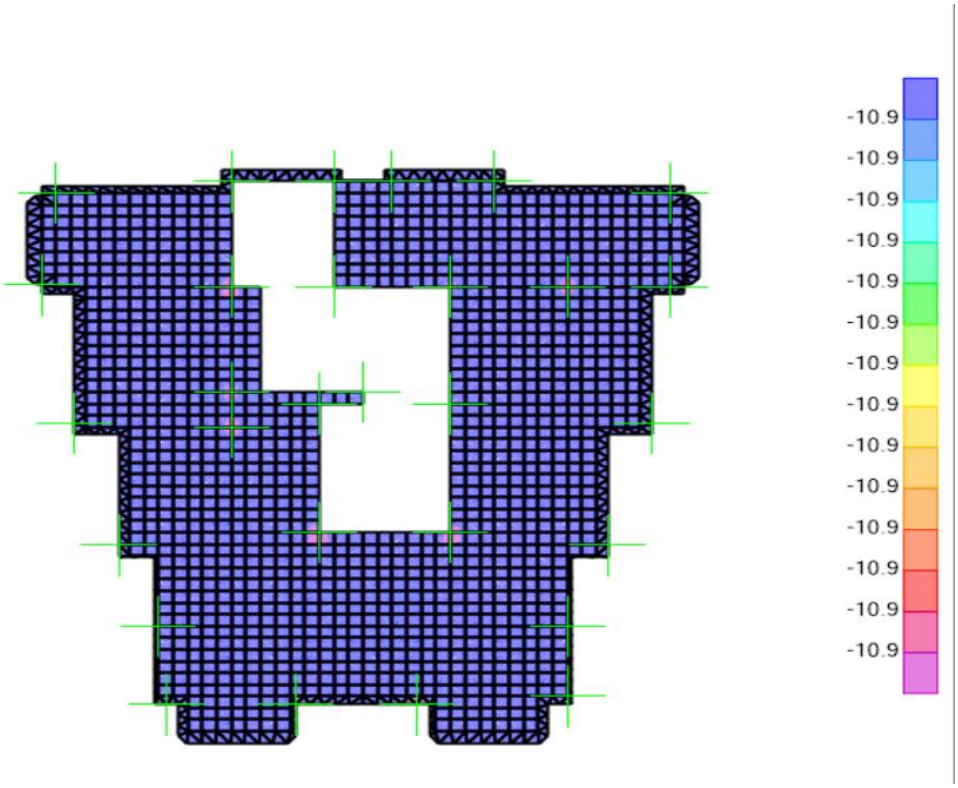


Figure 1.25: M1.1 negative with additional

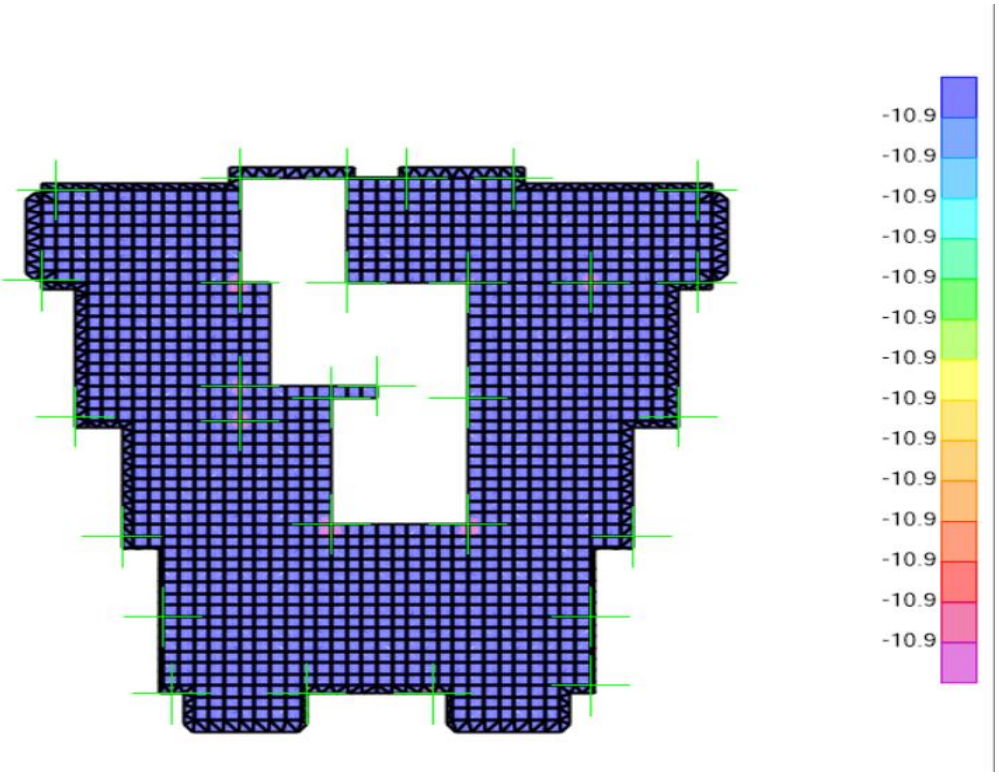
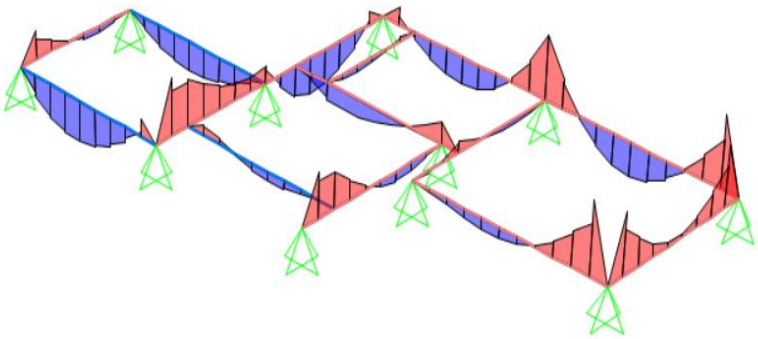


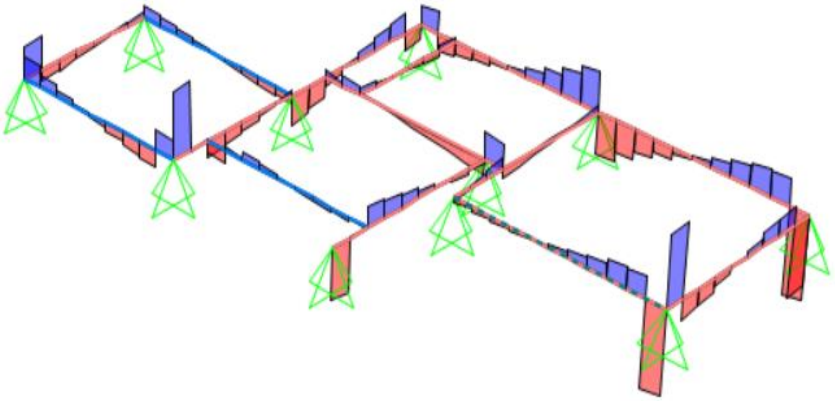
Figure 1.26: M2.2 negative with additional

5.6. Design of beams

Moment of beams



Shear of beams



Design of beam

Main RFT		Ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	360	600	575	0.72	1	5.1
B2	5	12	565.4866777	360	600	575	0.72	1	8.4
B3	4	16	804.2477194	360	600	575	0.72	1	12.0

Check shear

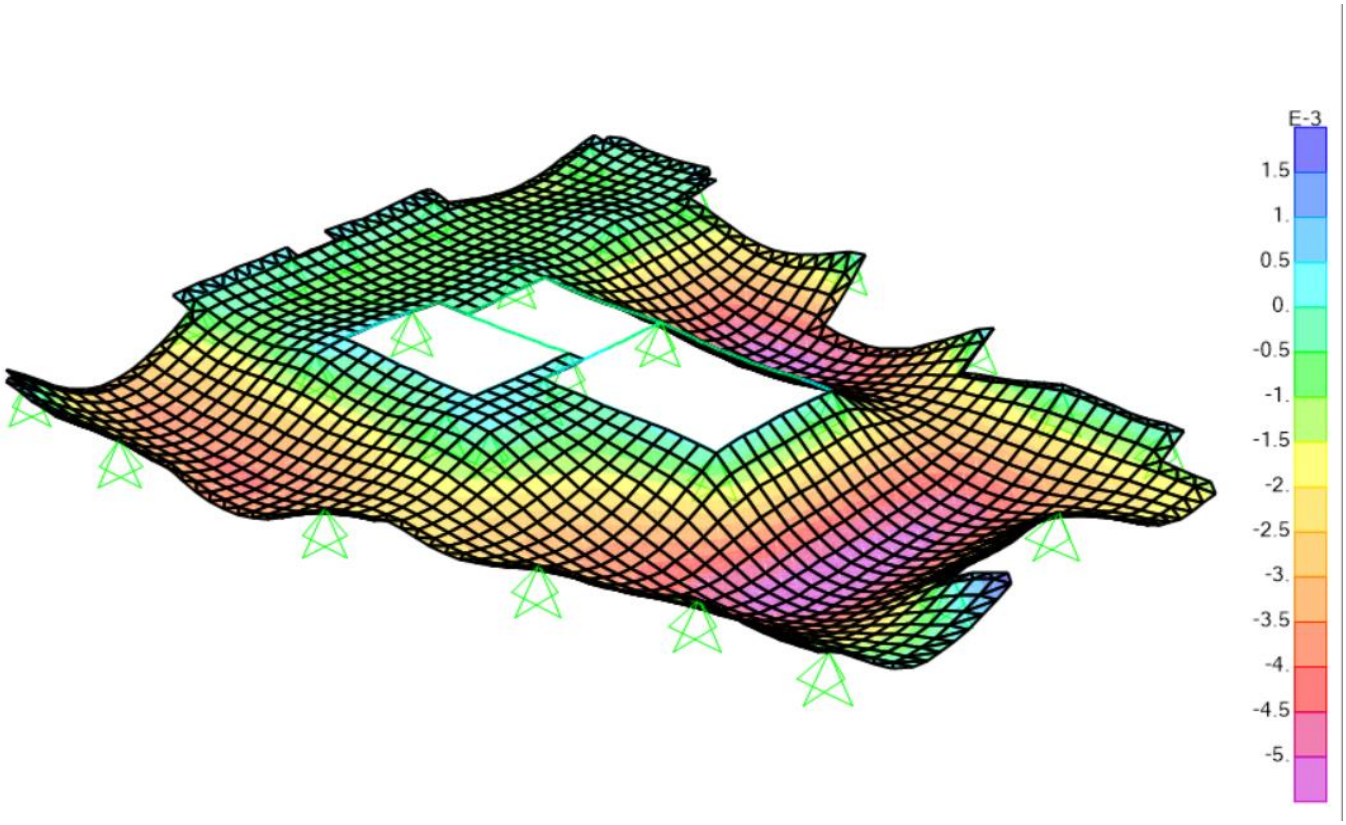
Concrete F_{cu} =	250	kg/cm^2
Concrete q_{all} =	9.682	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups			Notes
				#DIV/0!	#DIV/0!		#####	ϕ	8	#DIV/0!
1	17	12	57.5	24.64	0.078	2	5	ϕ	10	safe

Concrete F_{cu} =	250	kg/cm^2
Concrete q_{all} =	9.682	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups			Notes
				#DIV/0!	#DIV/0!		#####	ϕ	8	#DIV/0!
2	17	25	57.5	11.83	0.057	2	4	ϕ	10	safe

check of deflection



Δ max = .5 cm (from SAP)

Δ all = span / 250

Δ all = 681 / 250 = 2.724cm

SAFE DEFLECTION

check of Punching

	Input	
	Output	
F_{cu} =	2500	t/m^2

β	
interior	1.15
Edge	1.3
Corner	1.5

	Coulmn Dim.		Area Method													
Coulmn	b	t	L1	L2	β	Ts	F.C	Wall	L.L	Ws	A	Qpu	Area Punch	Punching Stress Actual	Punching Stress Allawble	Note
	m	m	m	m		m	T/m2	T/m2	T/m2	T/m2	m2	ton	m2	t/m2	t/m2	
C1	0.3	0.4	2.885	1.915	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.01698	0.44	40.9669858	129.0064598	Safe
C2	0.3	0.4	1.75	2.235	1.3	0.22	0.15	0.6	0.3	2.3	0.3	8.305875	0.44	24.54008523	129.0064598	Safe
C3	0.3	0.4	1.75	2.235	1.3	0.22	0.15	0.6	0.3	2.3	0.3	8.305875	0.44	24.54008523	129.0064598	Safe
C4	0.3	0.4	2.86	1.95	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.1371	0.44	41.37647727	129.0064598	Safe
C5	0.3	0.4	2.885	1.915	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.01698	0.44	40.9669858	129.0064598	Safe
C6	0.3	1	1.875	2.68	1.15	0.22	0.15	0.6	0.3	2.3	0.6	10.1775	0.68	17.21194853	129.0064598	Safe
C7	0.3	0.4	1.285	1.95	1.5	0.22	0.15	0.6	0.3	2.3	0.3	5.073225	0.44	17.29508523	129.0064598	Safe
C8	0.3	0.6	1.885	2.725	1.15	0.22	0.15	0.6	0.3	2.3	0.4	10.89424	0.52	24.09302524	129.0064598	Safe
C9	0.3	1.3	1.48	2.36	1.5	0.22	0.15	0.6	0.3	2.3	0.75	6.30844	0.8	11.828325	129.0064598	Safe
C10	0.3	0.6	3.15	2.86	1.5	0.22	0.15	0.6	0.3	2.3	0.4	19.8007	0.52	57.11740385	129.0064598	Safe
C11	0.3	0.4	3.26	2.265	1.5	0.22	0.15	0.6	0.3	2.3	0.3	16.29297	0.44	55.54421591	129.0064598	Safe
C12	0.3	0.4	2.46	2.875	1.5	0.22	0.15	0.6	0.3	2.3	0.3	15.57675	0.44	53.10255682	129.0064598	Safe
C13	0.3	0.6	6.8	1.715	1.3	0.22	0.15	0.6	0.3	2.3	0.4	25.9026	0.52	64.7565	129.0064598	Safe
C14	0.3	0.4	6.8	1.715	1.3	0.22	0.15	0.6	0.3	2.3	0.3	26.1326	0.44	77.20995455	129.0064598	Safe
C15	0.3	0.4	2.45	1.395	1.5	0.22	0.15	0.6	0.3	2.3	0.3	7.170825	0.44	24.44599432	129.0064598	Safe
C16	0.3	0.4	2.45	1.395	1.5	0.22	0.15	0.6	0.3	2.3	0.3	7.170825	0.44	24.44599432	129.0064598	Safe
C17	0.3	0.6	2.45	1.335	1.3	0.22	0.15	0.6	0.3	2.3	0.4	6.602725	0.52	16.5068125	129.0064598	Safe
C18	0.3	0.6	2.45	1.335	1.3	0.22	0.15	0.6	0.3	2.3	0.4	6.602725	0.52	16.5068125	129.0064598	Safe

6. Design of the typical floors

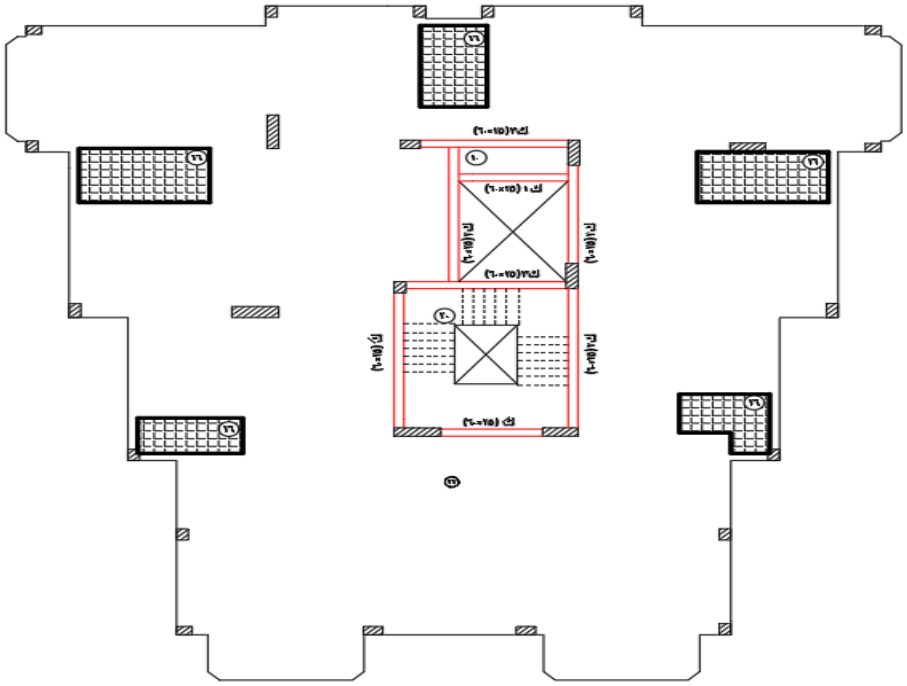
6.1. Design Notes

- The typical floors is designed in solid and flat slab system

Designed on:

- Own wight calculated by sap
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

6.2. Statical system



6.3. Moment of Solid slab

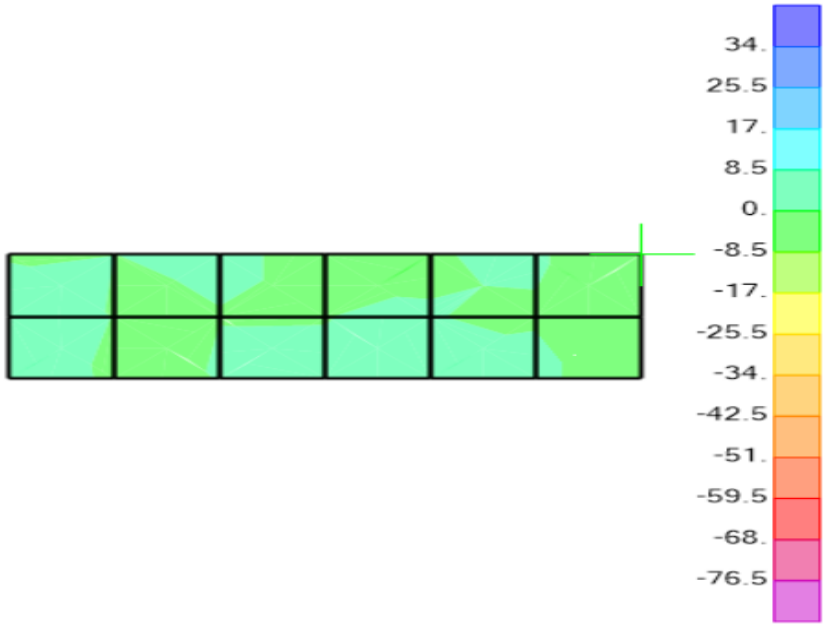


Figure 1.27: M1.1 positive

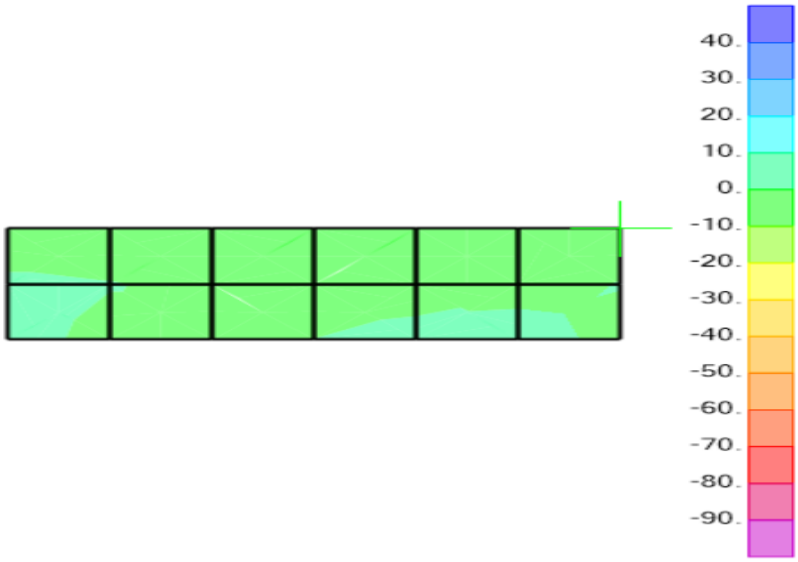


Figure 1.28: M1.1 positive

6.4. Moment of Flat Slab

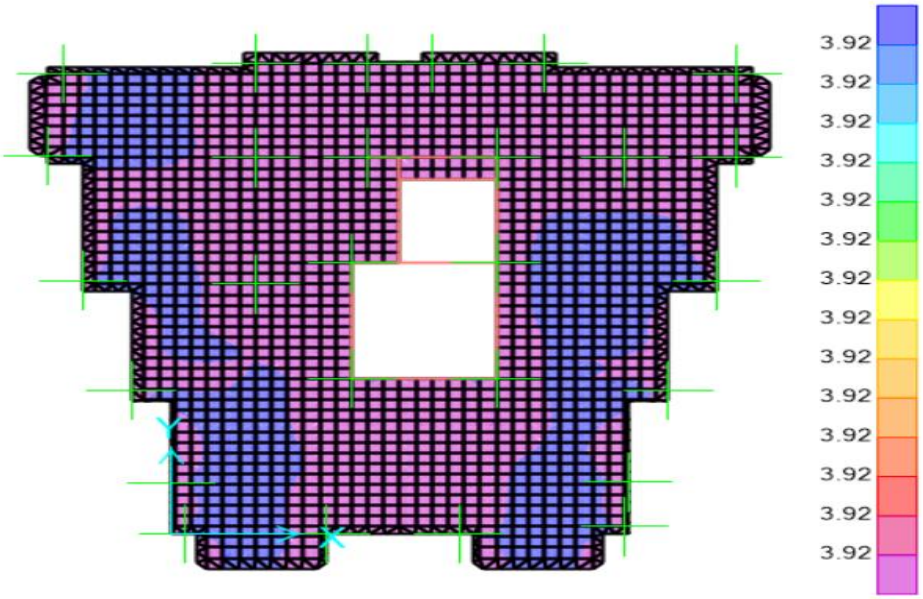


Figure 1.29: M1.1 positive

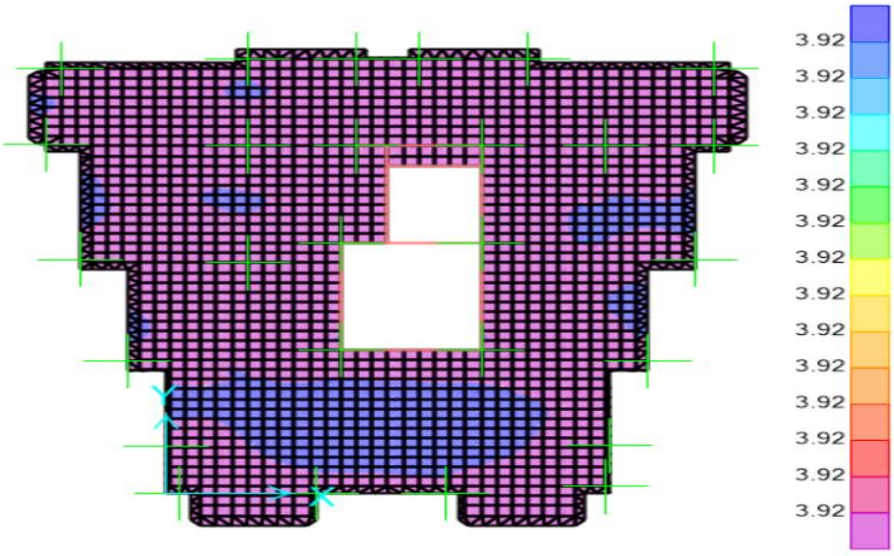


Figure 1.30: M2.2 positive

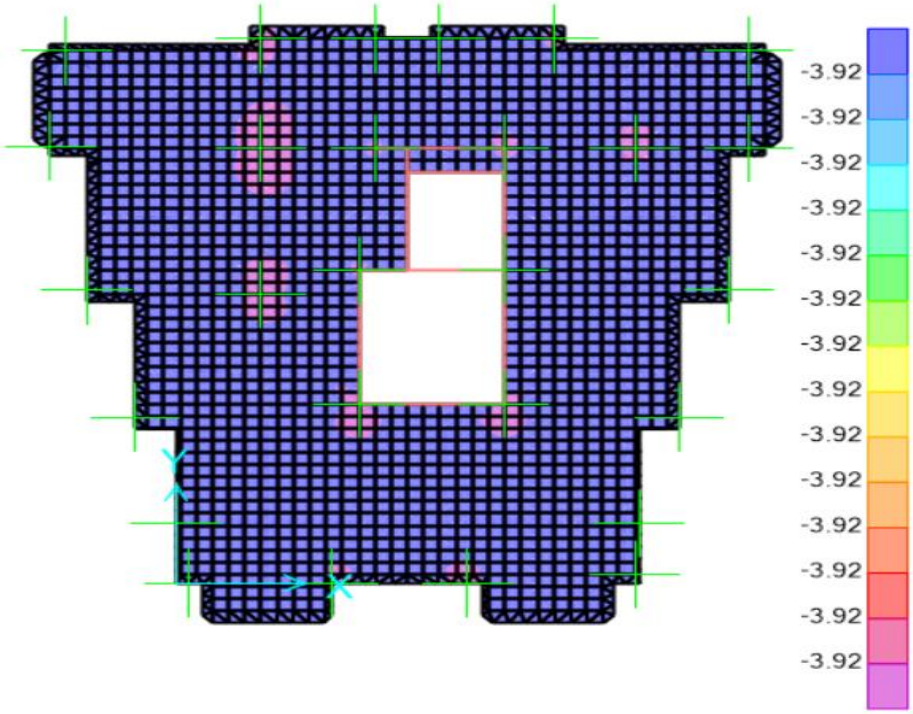


Figure 1.31: M1.1 Negative

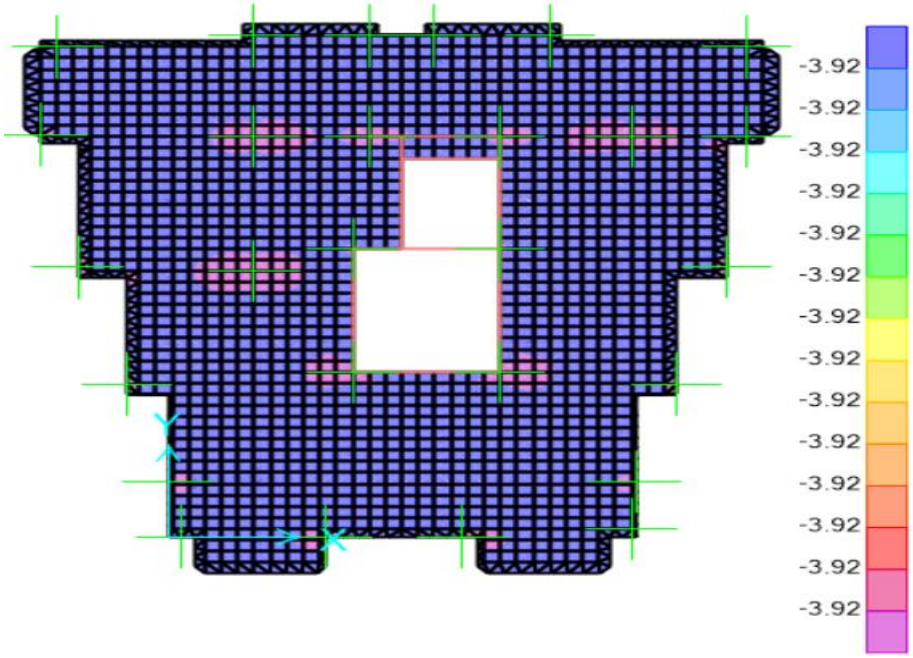


Figure 1.32: M1.1 Negative

6.5. Design of slabs

- *Flat slab (ts = 22 cm) , Solid slab (ts = 10 cm)*

REINFORCEMENT FOR SOLID SLAB

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	100	80	0.826	1	0.9082344

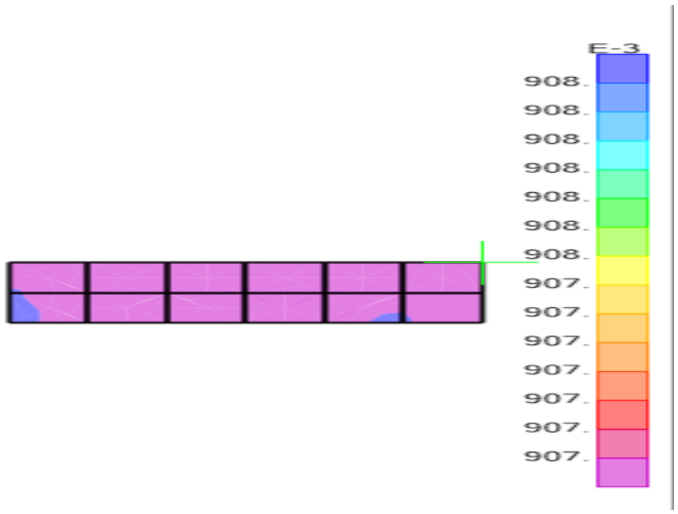


Figure 1.33: M1.1 positive

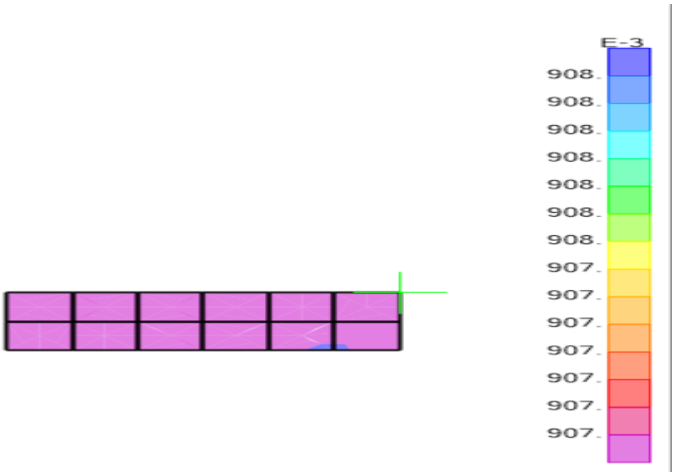


Figure 1.34: M2.2 positive

BOTTOM REINFORCEMENT FOR FLAT SLAB:

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	220	200	0.826	1	3.9235728

Additional		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	220	200	0.826	1	6.9752405

Total	10.90

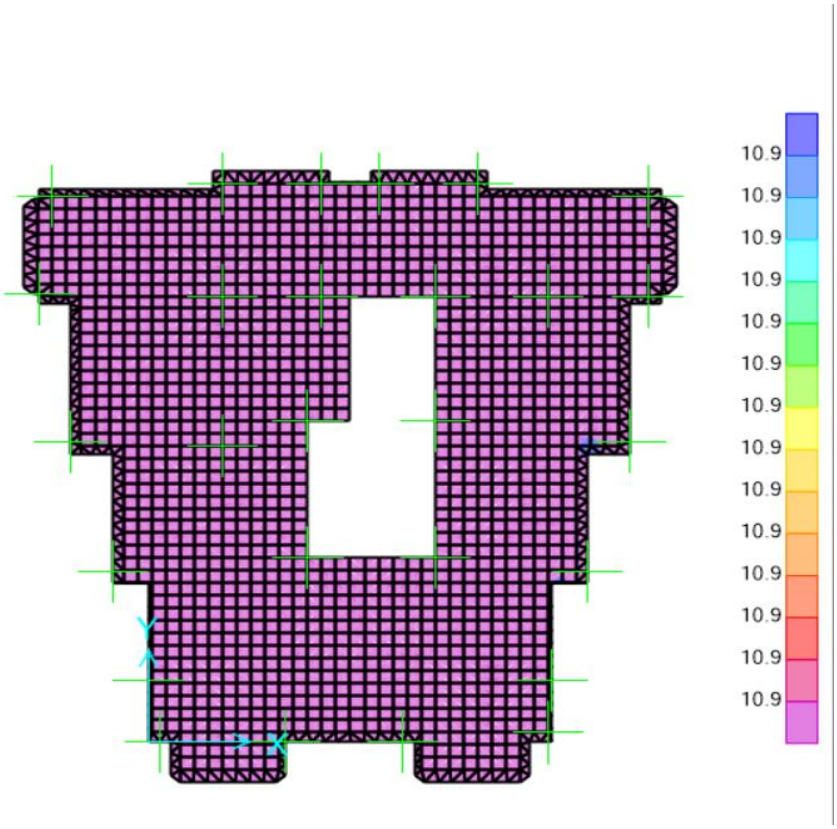


Figure 1.35: M1.1 positive

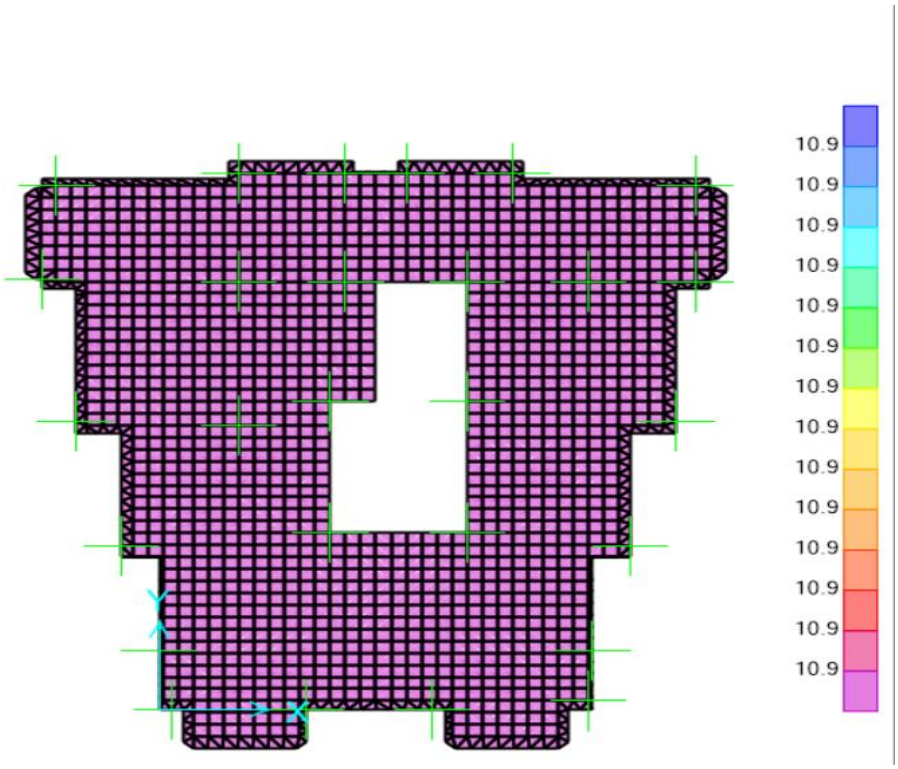


Figure 1.36: M2.2 positive

TOP REINFORCEMENT FOR FLAT SLAB:

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	220	200	0.826	1	3.9235728

Additional		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	220	200	0.826	1	6.9752405

Total	10.90

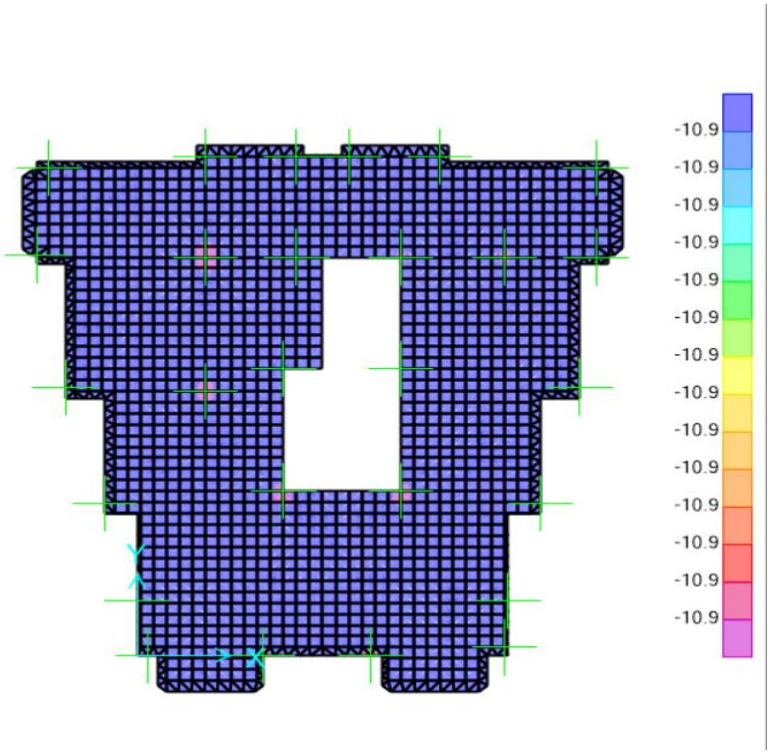


Figure 1.37: M1.1 negative with additional

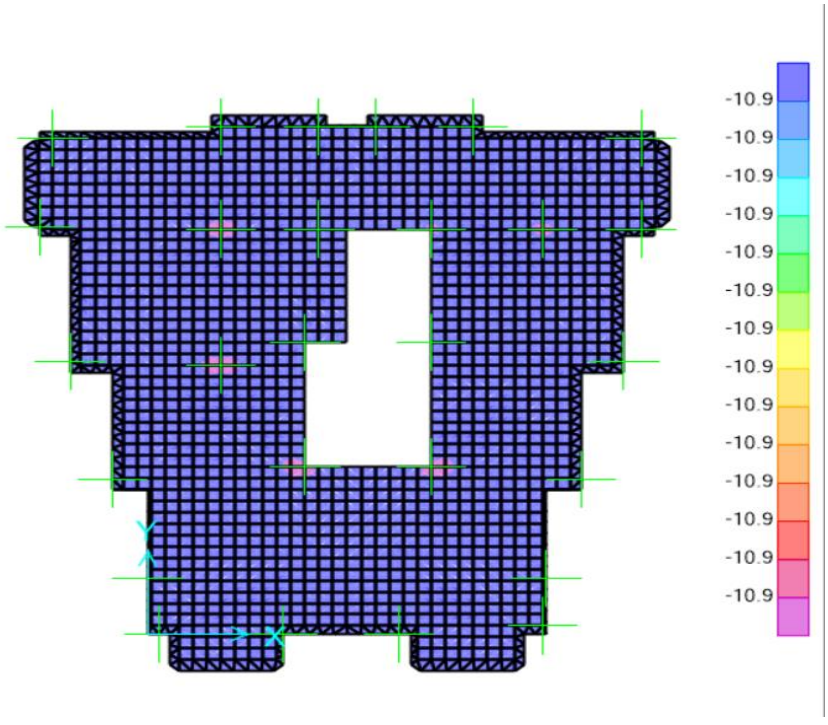
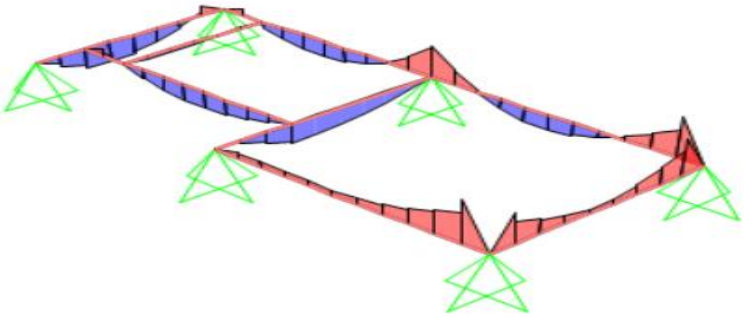


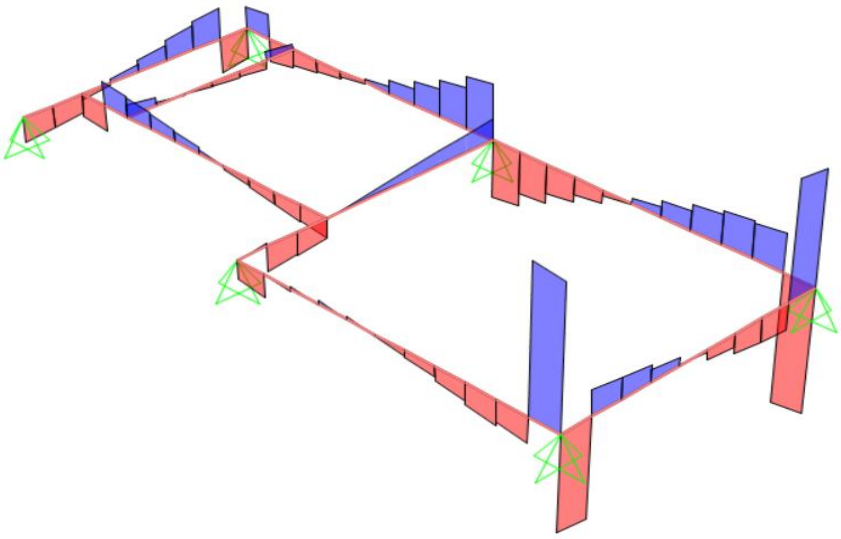
Figure 1.38: M2.2 negative with additional

6.6. Design of beams

Moment of beams



Shear of beams



Design of beam

Main RFT		Ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	360	600	575	0.72	1	5.1
B2	5	12	565.4866777	360	600	575	0.72	1	8.4
B3	4	16	804.2477194	360	600	575	0.72	1	12.0

Check shear

Concrete	F_{cu} =	250	kg/cm^2
Steel	F_y =	3500	kg/cm^2

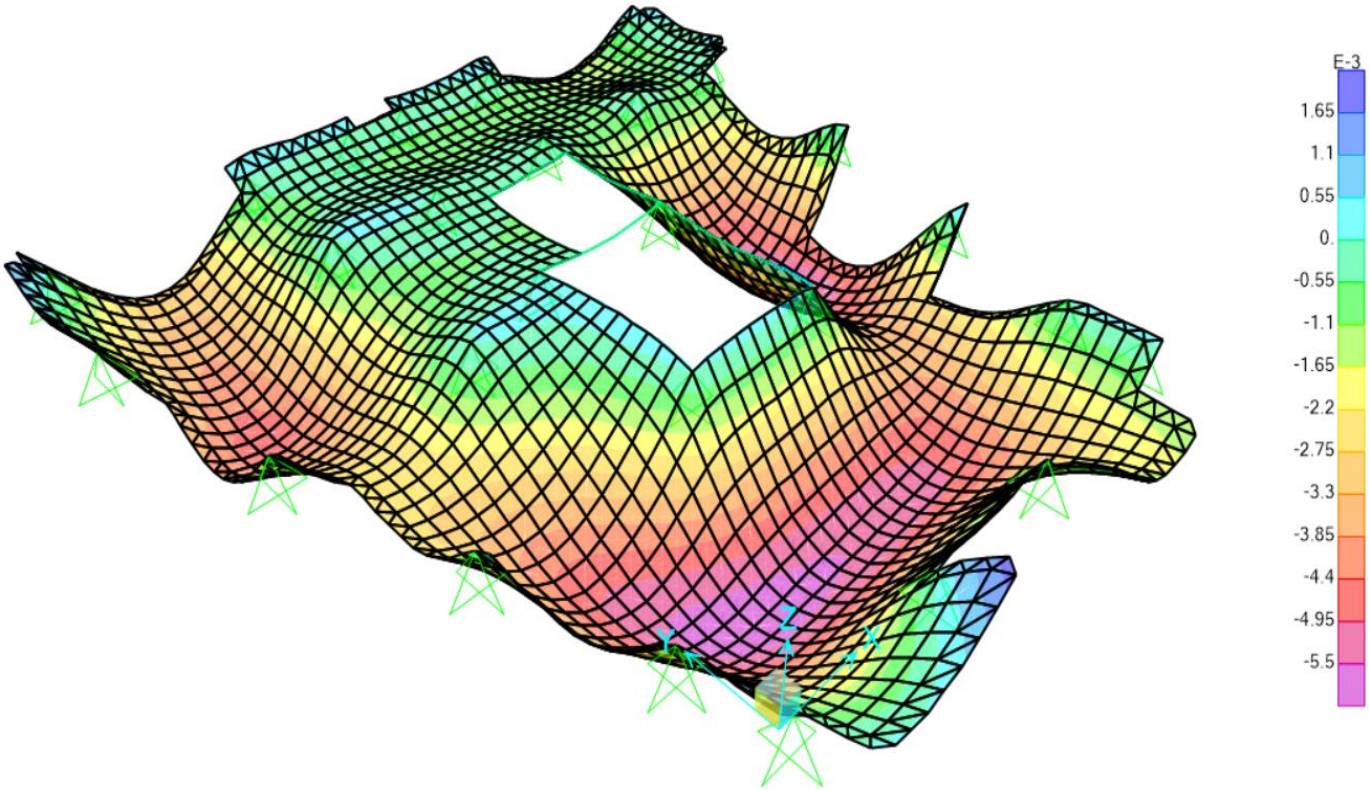
R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
					#DIV/0!	######	######	######	### ϕ 12	#DIV/0!
					#DIV/0!	######	######	######	### ϕ 16	#DIV/0!
1	17	25	25	57.5	3.486	0.781	4.52	10.82	5 ϕ 18	safe

check of deflection



Δ max = .6 cm (from SAP)
Δ all = span / 250
Δ all = 681 / 250 = 2.724cm
SAFE DEFLECTION

check of Punching

	Input	
	Output	
F_{cu} =	2500	t/m^2

β	
interior	1.15
Edge	1.3
Corner	1.5

	Coulmn Dim.		Area Method													
Coulmn	b	t	L1	L2	β	Ts	F.C	Wall	L.L	Ws	A	Qpu	Area Punch	Punching Stress Actual	Punching Stress Allawble	Note
	m	m	m	m		m	T/m2	T/m2	T/m2	T/m2	m2	ton	m2	t/m2	t/m2	
C1	0.3	0.4	2.865	1.91	1.5	0.22	0.15	0.6	0.3	2.3	0.3	11.8959	0.44	40.55435795	129.00646	Safe
C2	0.3	0.4	1.75	1.75	1.5	0.22	0.15	0.6	0.3	2.3	0.3	6.35375	0.44	21.66051136	129.00646	Safe
C3	0.3	0.4	1.75	2.2	1.5	0.22	0.15	0.6	0.3	2.3	0.3	8.165	0.44	27.83522727	129.00646	Safe
C4	0.3	0.4	1.75	2.2	1.5	0.22	0.15	0.6	0.3	2.3	0.3	8.165	0.44	27.83522727	129.00646	Safe
C5	0.3	0.4	1.75	2.2	1.5	0.22	0.15	0.6	0.3	2.3	0.3	8.165	0.44	27.83522727	129.00646	Safe
C6	0.3	0.4	2.86	1.95	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.1371	0.44	41.37647727	129.00646	Safe
C7	0.3	0.4	2.935	1.91	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.2035	0.44	41.6026875	129.00646	Safe
C8	0.3	1.2	2.935	2.385	1.15	0.22	0.15	0.6	0.3	2.3	0.7	14.4899	0.76	21.92557089	129.00646	Safe
C9	0.3	0.9	1.925	2.1	1.15	0.22	0.15	0.6	0.3	2.3	0.55	8.03275	0.64	14.43384766	129.00646	Safe
C10	0.3	0.4	1.29	1.95	1.5	0.22	0.15	0.6	0.3	2.3	0.3	5.09565	0.44	17.37153409	129.00646	Safe
C11	0.3	0.5	1.935	2.715	1.5	0.22	0.15	0.6	0.3	2.3	0.35	11.2781	0.48	35.24408594	129.00646	Safe
C12	0.3	1.2	1.935	2.83	1.15	0.22	0.15	0.6	0.3	2.3	0.7	10.9849	0.76	16.62191086	129.00646	Safe
C13	0.3	0.5	3.185	2.72	1.5	0.22	0.15	0.6	0.3	2.3	0.35	19.1204	0.48	59.751125	129.00646	Safe
C14	0.3	0.4	3.26	2.36	1.5	0.22	0.15	0.6	0.3	2.3	0.3	17.0053	0.44	57.97254545	129.00646	Safe
C15	0.3	0.4	2.435	2.36	1.5	0.22	0.15	0.6	0.3	2.3	0.3	12.5272	0.44	42.70629545	129.00646	Safe
C16	0.3	0.5	6.8	1.675	1.3	0.22	0.15	0.6	0.3	2.3	0.35	25.392	0.48	68.77	129.00646	Safe
C17	0.3	0.4	6.8	1.675	1.3	0.22	0.15	0.6	0.3	2.3	0.3	25.507	0.44	75.36159091	129.00646	Safe
C18	0.3	0.4	2.195	1.55	1.5	0.22	0.15	0.6	0.3	2.3	0.3	7.13518	0.44	24.32446023	129.00646	Safe
C19	0.3	0.5	2.195	1.55	1.3	0.22	0.15	0.6	0.3	2.3	0.35	7.02018	0.48	19.01297396	129.00646	Safe
C20	0.3	0.5	2.195	1.55	1.3	0.22	0.15	0.6	0.3	2.3	0.35	7.02018	0.48	19.01297396	129.00646	Safe
C21	0.3	0.4	2.35	1.55	1.5	0.22	0.15	0.6	0.3	2.3	0.3	7.68775	0.44	26.20823864	129.00646	Safe

7. Design of the roof floors

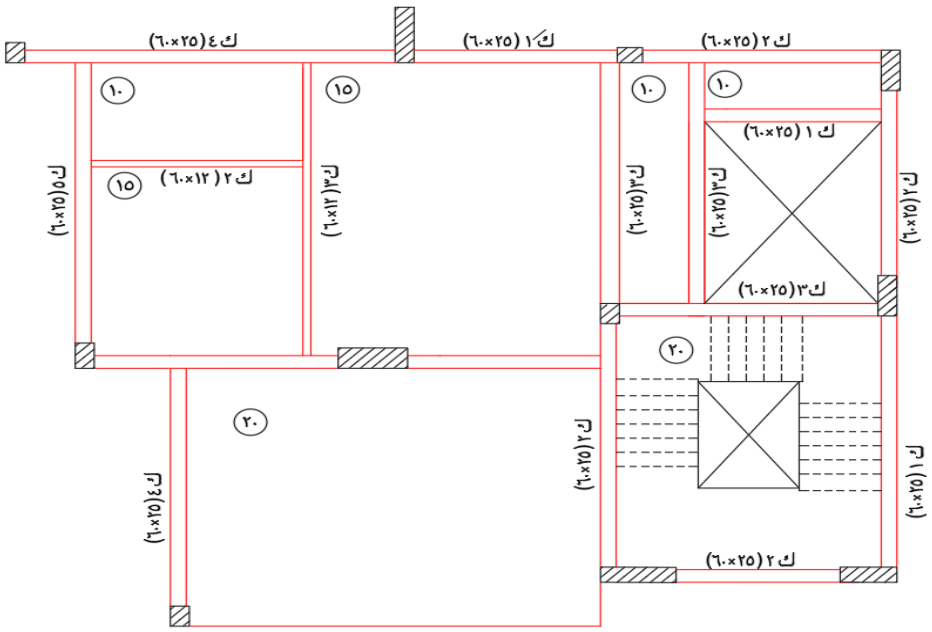
7.1 Design Notes

- The typical floors is designed in solid and flat slab system

Designed on:

- Own wight calculated by sap
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

7.2. Statical system



7.3. Moment of Solid slab

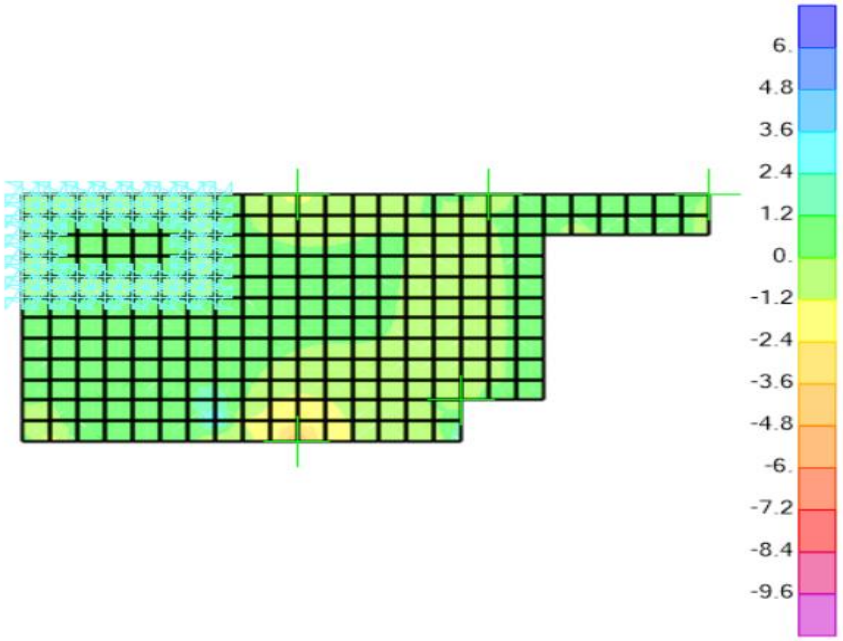


Figure 1.39: M1.1 positive

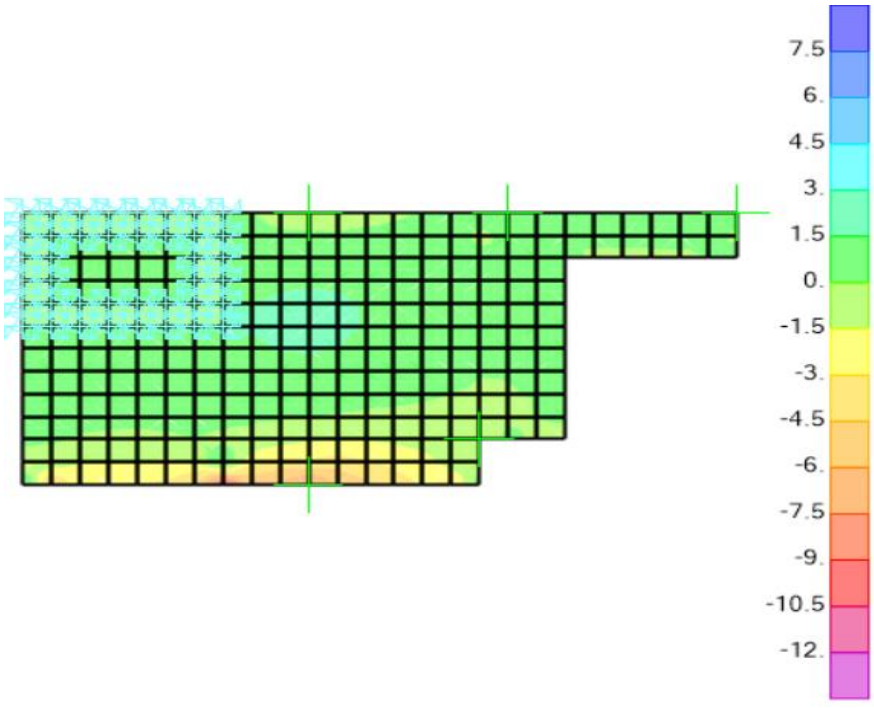


Figure 1.40: M2.2 positive

7.4.Moment of Flat Slab

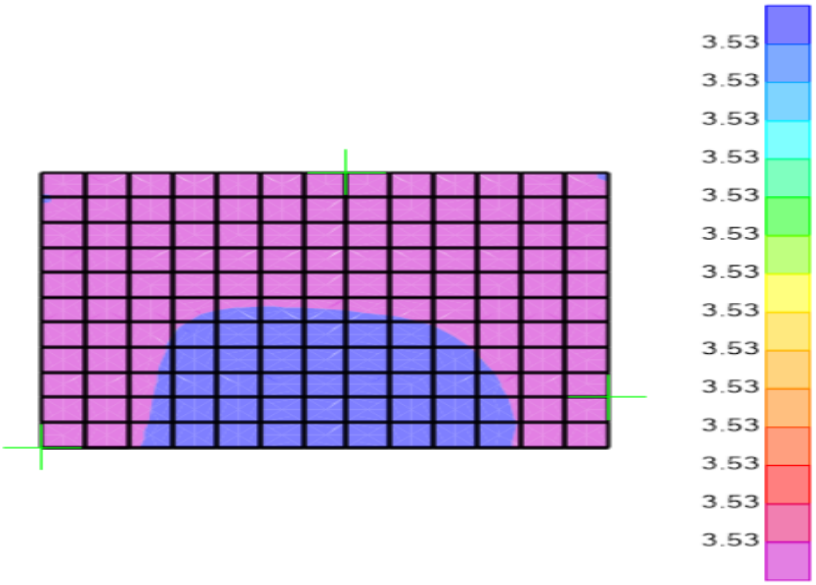


Figure 1.41: M1.1 positive

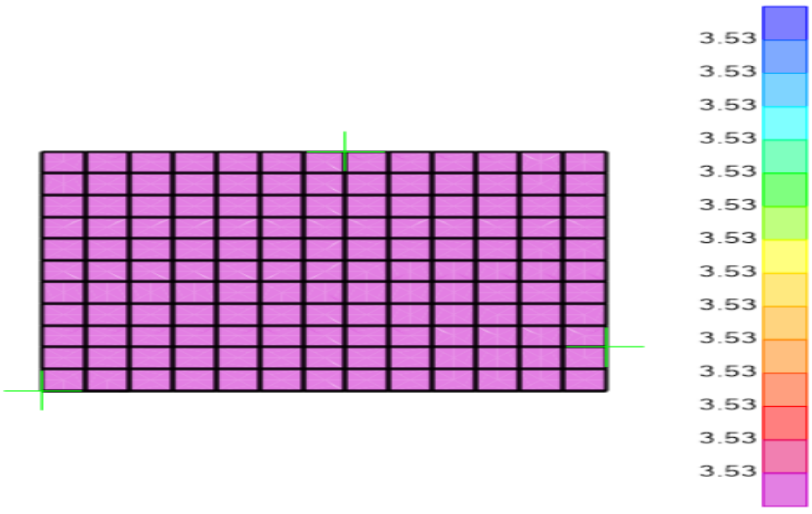


Figure 1.42: M2.2 positive

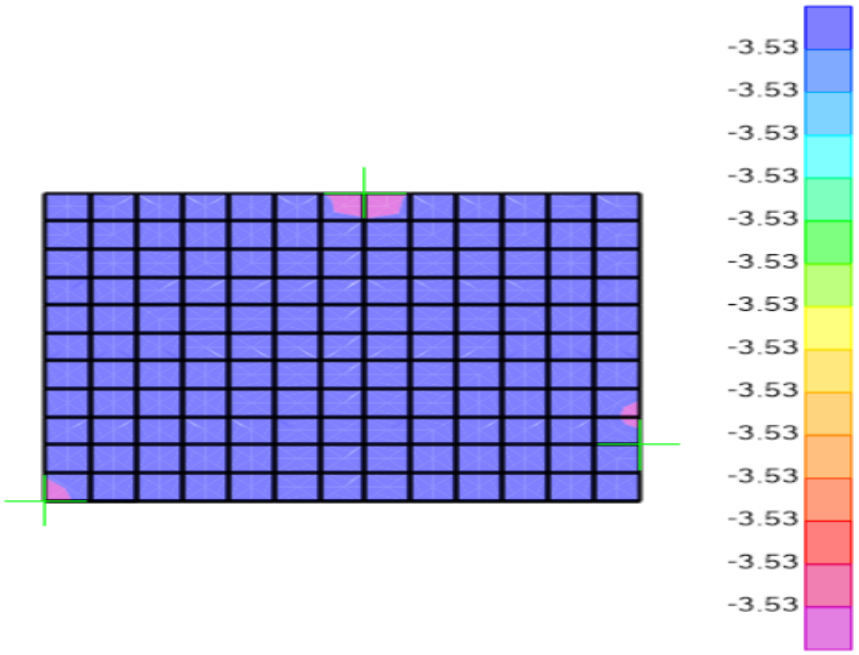


Figure 1.43: M1.1 Negative

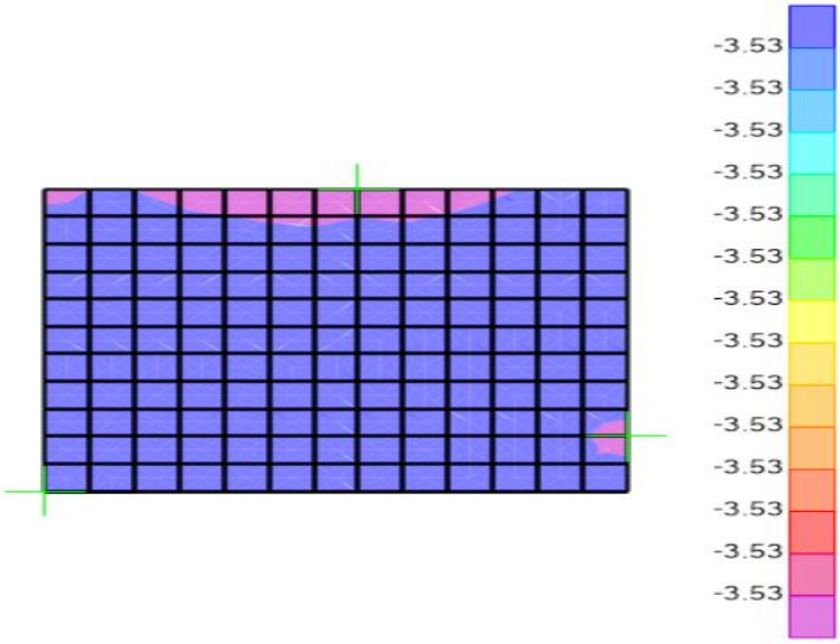


Figure 1.44: M2.2 Negative

7.5. Design of slabs

- *Flat slab (ts = 20 cm) , Solid slab (ts = 15 cm, ts =10cm)*

REINFORCEMENT FOR SOLID SLAB

For slab *ts = 15cm*

Mesh		Ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	150	130	0.826	1	1.475881

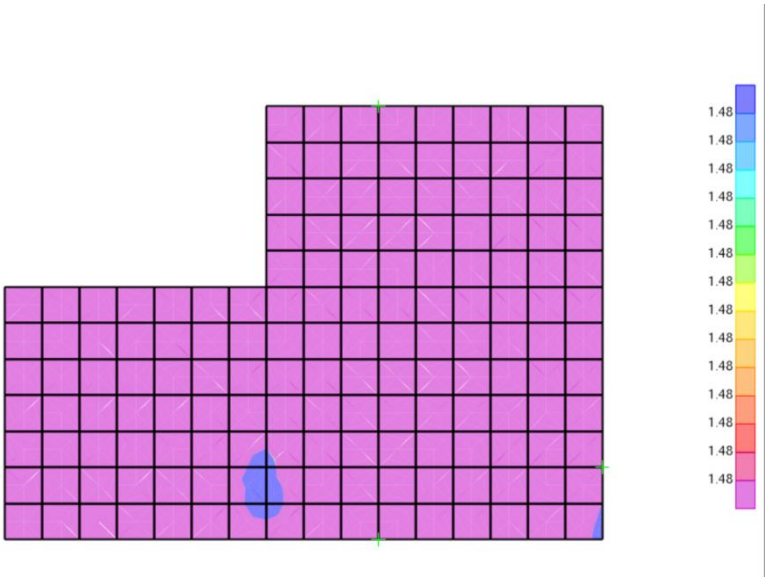


Figure 1.45: M1.1 positive

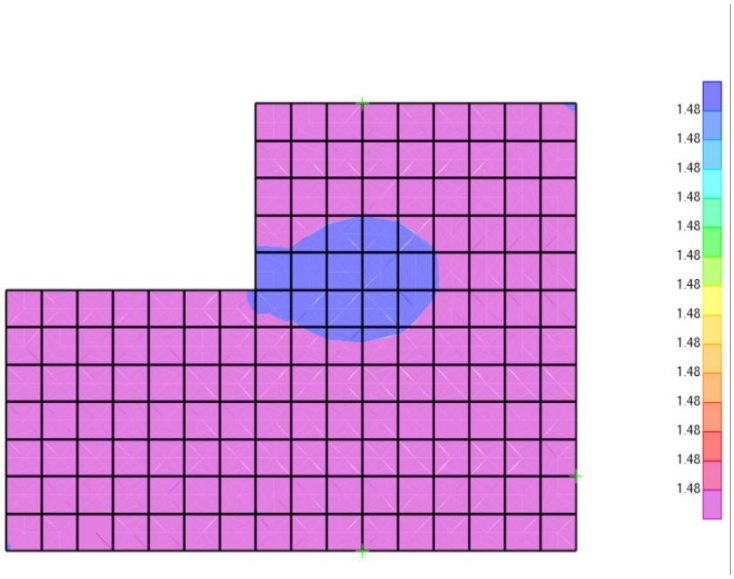


Figure 1.46: M2.2 positive

For slab *ts = 10cm*

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	5	10	392.699	350	100	80	0.826	1	0.9082344

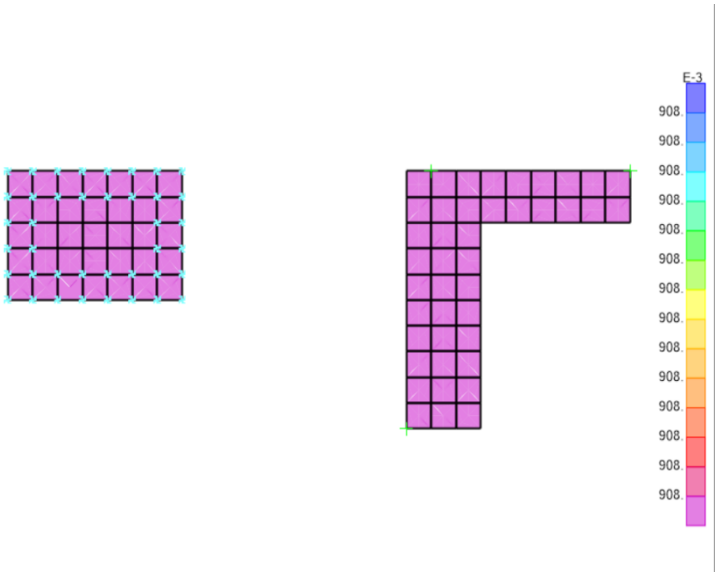


Figure 1.47: M1.1 positive

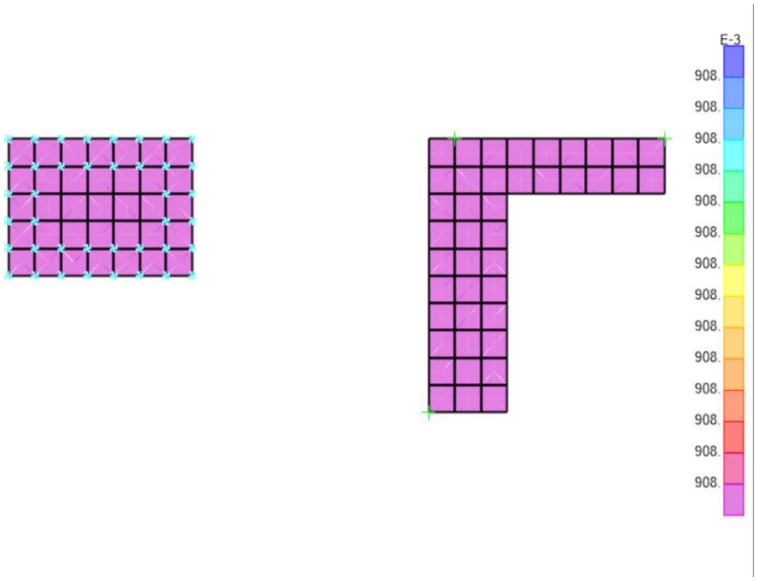


Figure 1.48: M2.2 positive

BOTTOM REINFORCEMENT FOR FLAT SLAB:

Mesh		Ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	200	180	0.826	1	3.5312155

Additional		Ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	200	180	0.826	1	6.2777164

Total	9.81

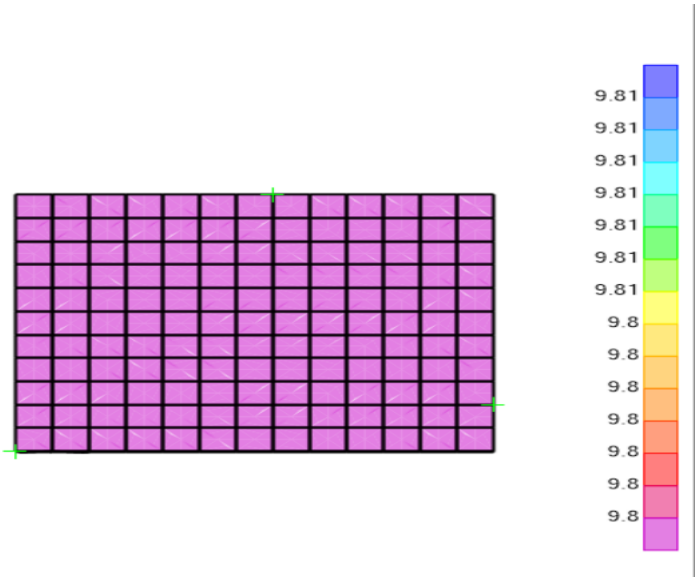


Figure 1.49: M1.1 positive

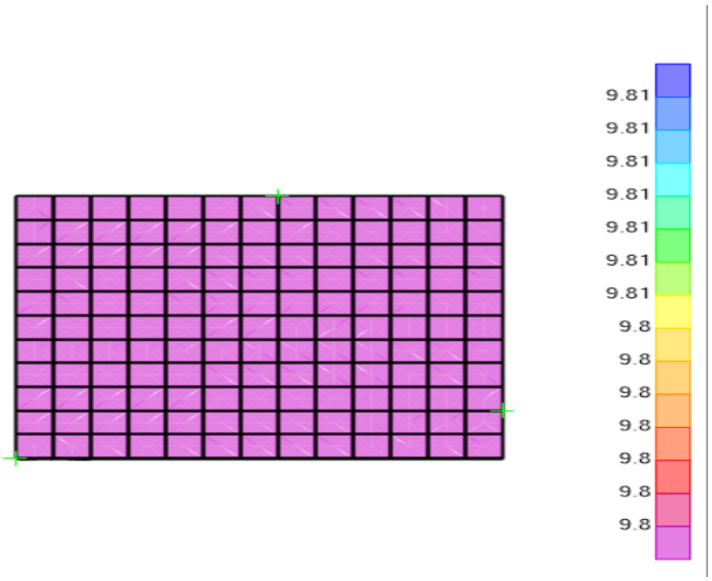


Figure 1.50: M2.2 positive

TOP REINFORCEMENT FOR FLAT SLAB:

Mesh		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	12	678.584	350	200	180	0.826	1	3.5312155

Additional		ø	As	Fy	T	d	J	Factor	Moment
		mm	mm2	N/mm2	mm	mm			Ton.m
	6	16	1206.37	350	200	180	0.826	1	6.2777164

Total	9.81

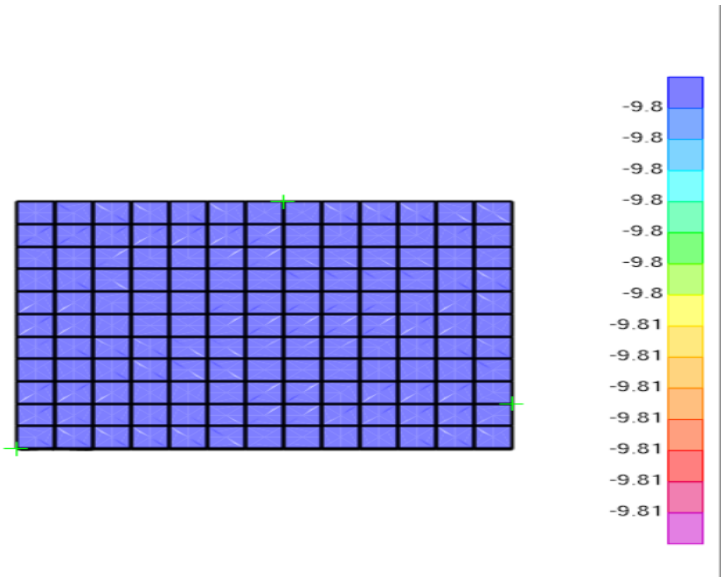


Figure 1.51: M1.1 negative with additional

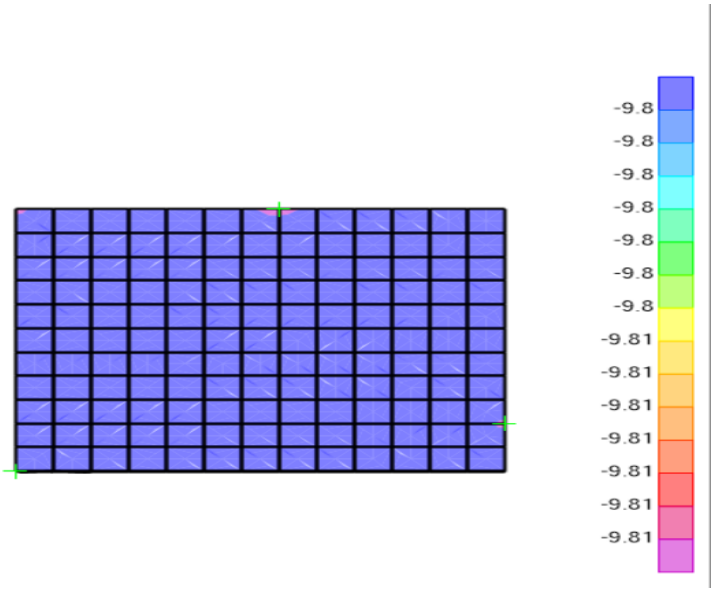
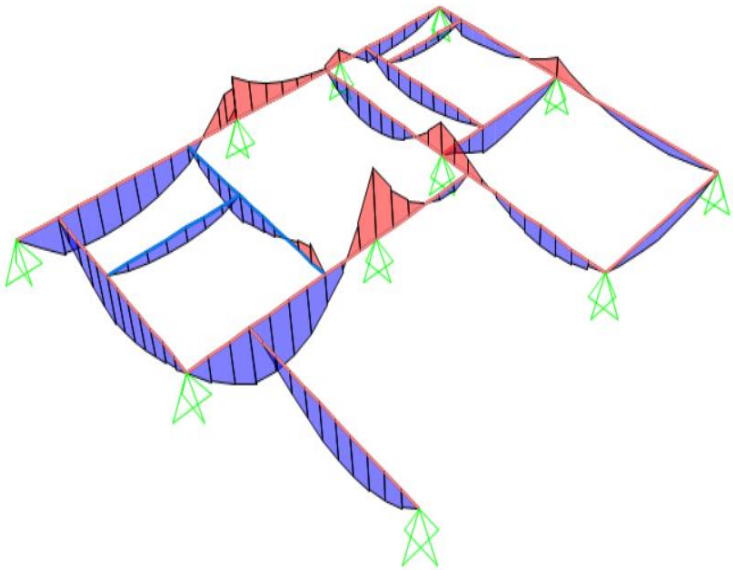


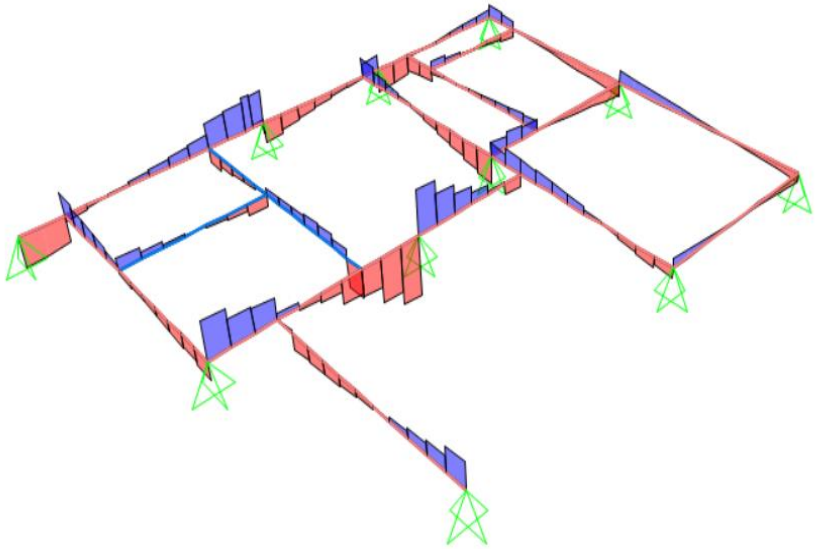
Figure 1.52: M2.2 negative with additional

7.6. Design of beams

Moment of beams



Shear of beams



Design of beam

Main RFT		Ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	360	600	575	0.72	1	5.1
B2	5	12	565.4866777	360	600	575	0.72	1	8.4
B3	4	16	804.2477194	360	600	575	0.72	1	12.0
B4	6	16	1206.371579	360	600	575	0.72	1	18.0
B5	6	18	1526.81403	360	600	575	0.72	1	22.8

Check shear

Concrete F_{cu} =	250	kg/cm^2
Steel F_y =	3500	kg/cm^2

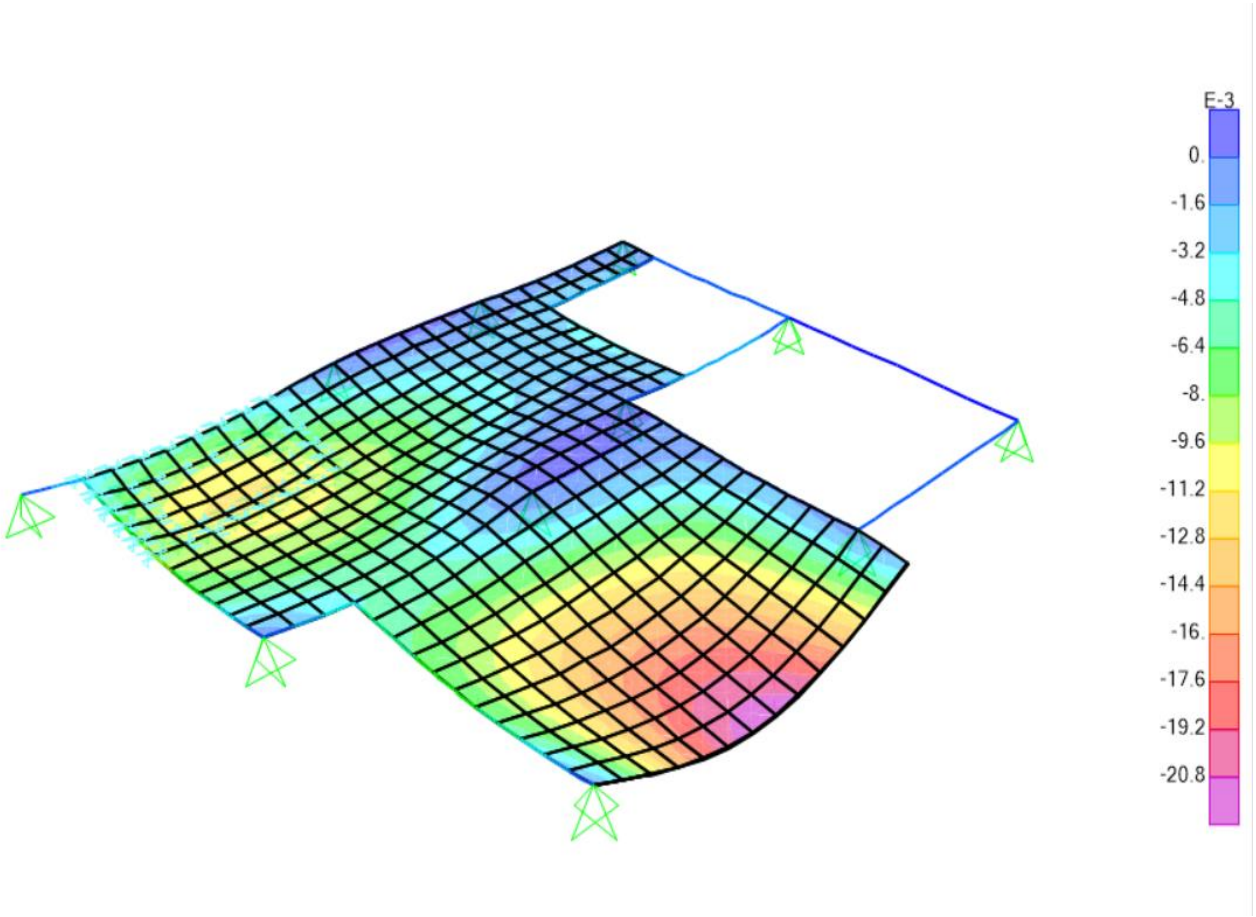
R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
					#DIV/0!	######	######	######	### ϕ 12	#DIV/0!
					#DIV/0!	######	######	######	### ϕ 16	#DIV/0!
1	26	25	25	57.5	2.819	0.723	4.52	17.88	8 ϕ 18	safe

check of deflection



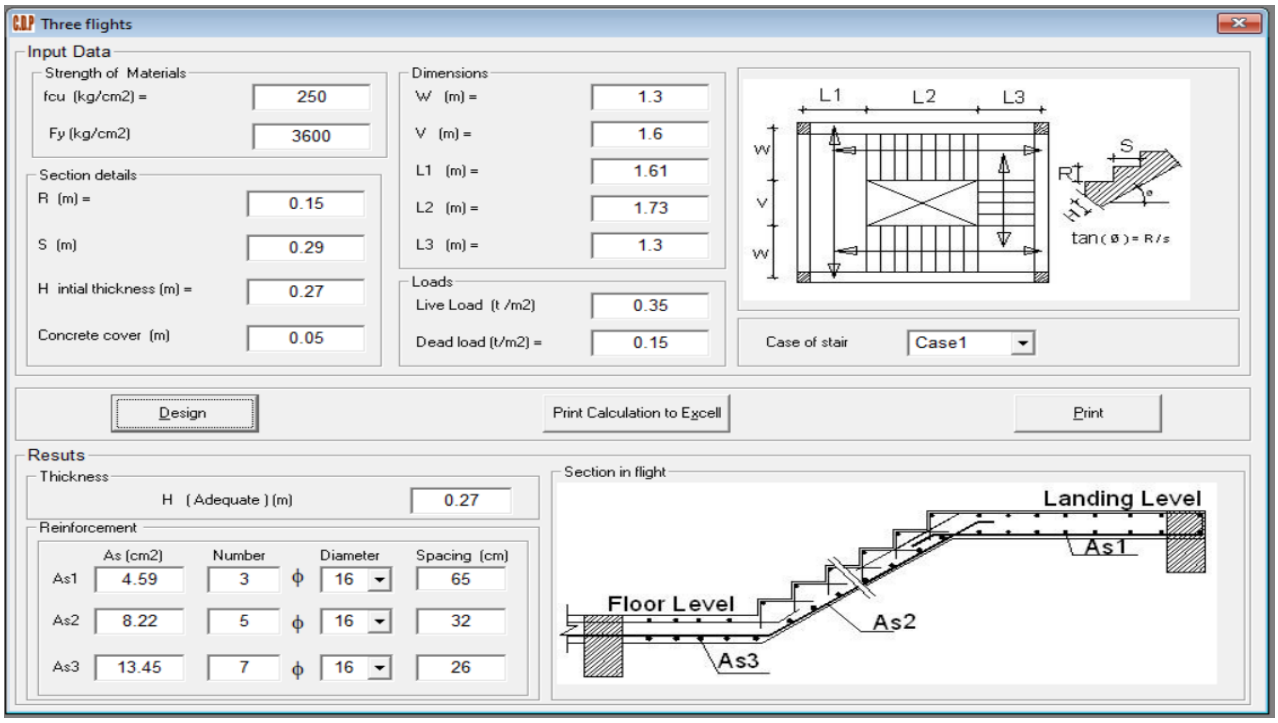
Δ max = 2.2 cm (from SAP)

Δ all = span / 250

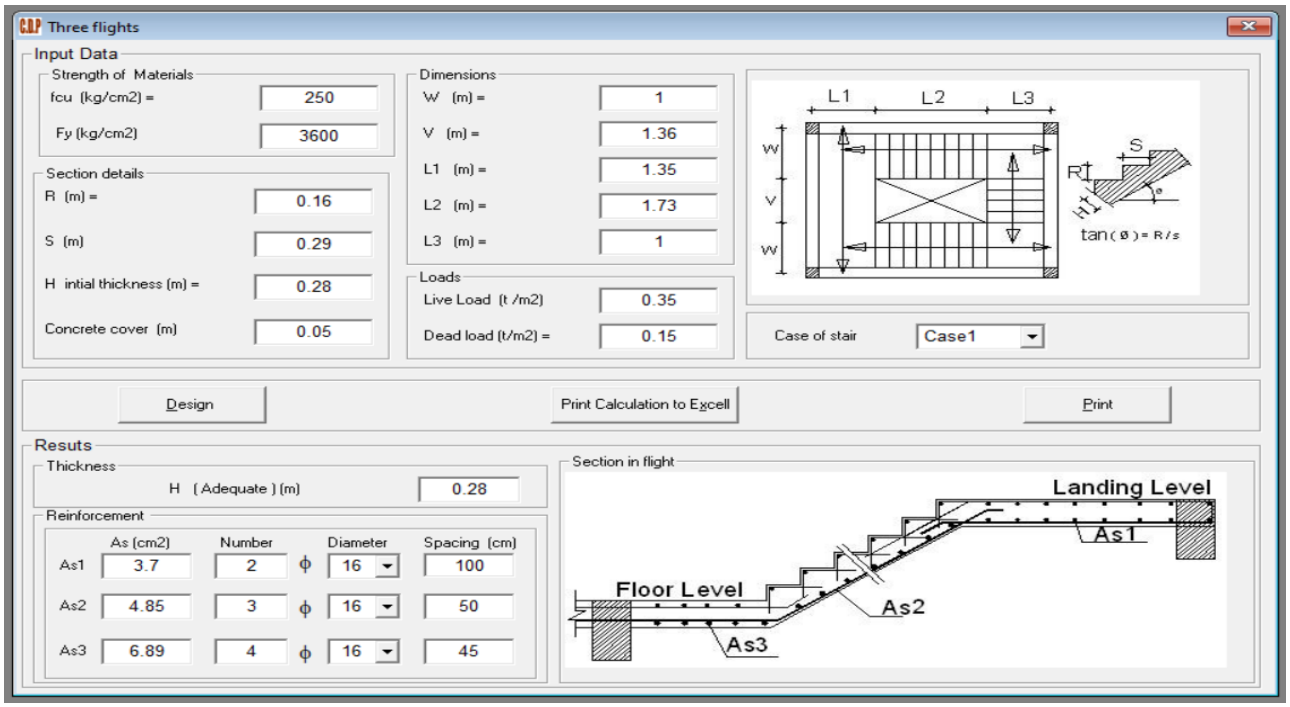
Δ all = 652 / 250 = 2.608cm

SAFE DEFLECTION

8. Design of stairs

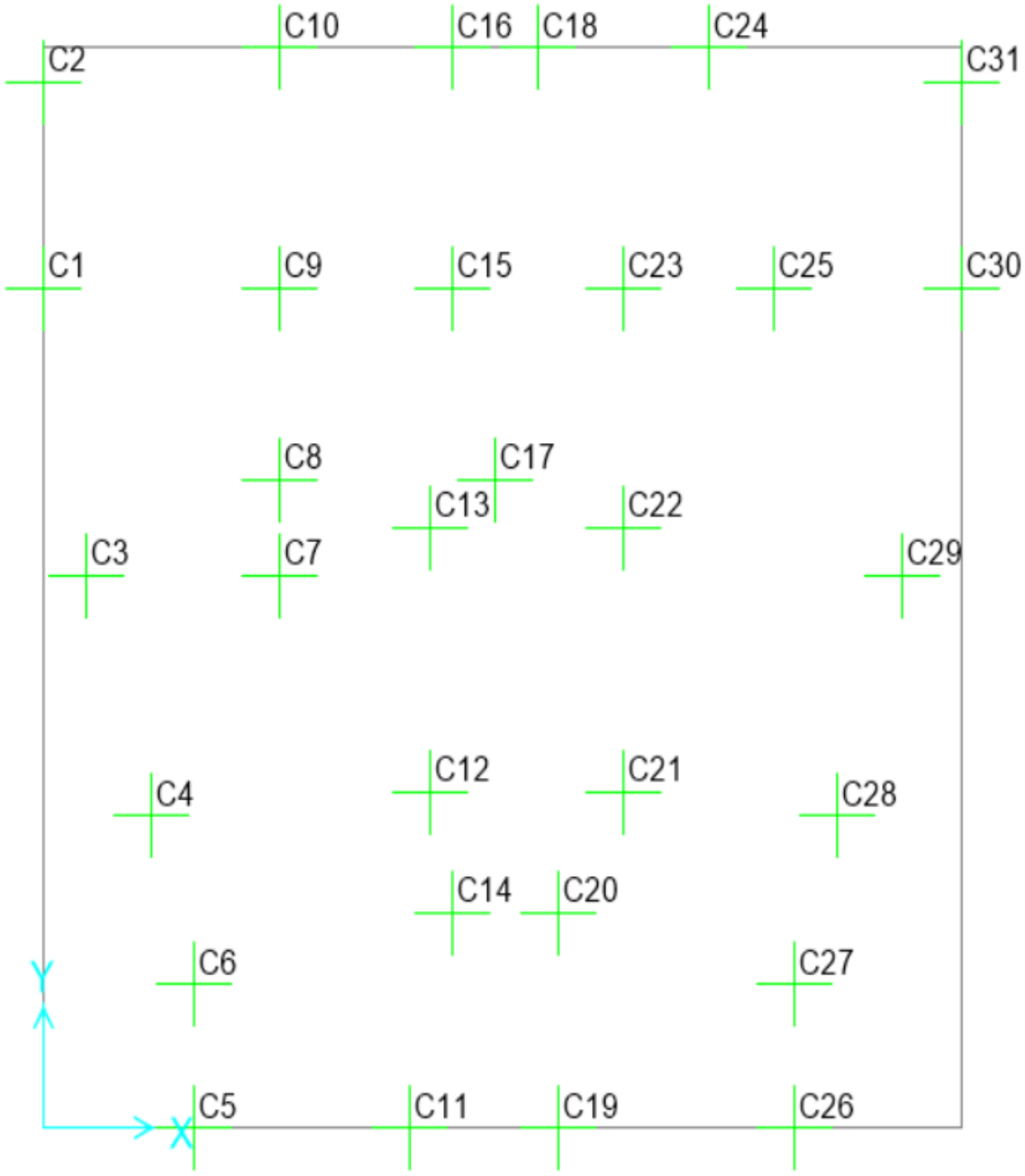


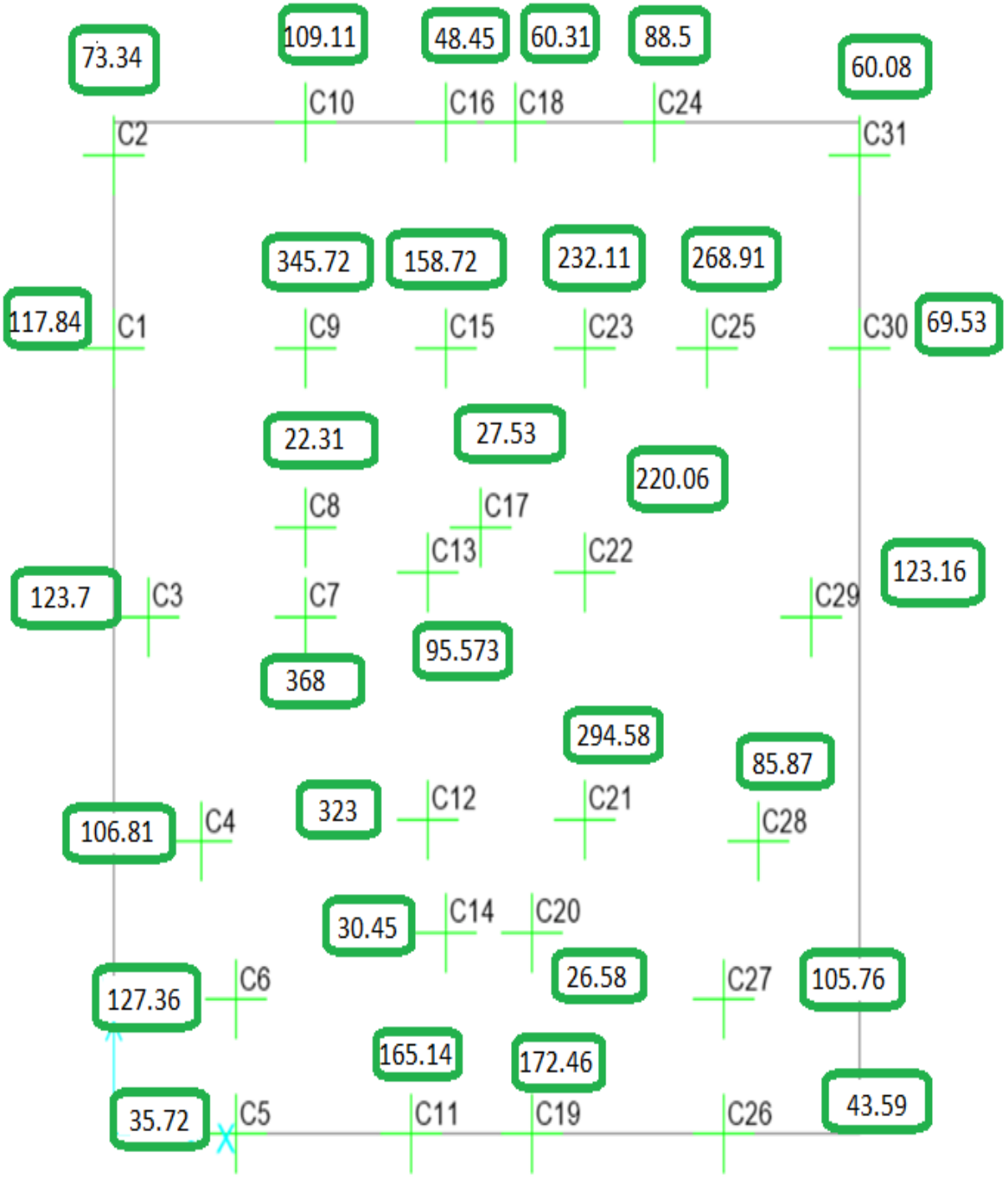
السلم الرئيسي



السلم الداخلي

9. Design of columns




73.34
109.11
48.45
60.31
88.5
60.08
C10
C16
C18
C24
C2
C31
345.72
158.72
232.11
268.91
117.84
C1
C9
C15
C23
C25
C30
69.53
22.31
27.53
220.06
C8
C17
C13
C22
123.7
C3
C7
C29
123.16
95.573
368
294.58
85.87
323
C12
C21
106.81
C4
C28
30.45
C14
C20
26.58
C27
105.76
127.36
C6
165.14
172.46
35.72
C5
C11
C19
C26
43.59

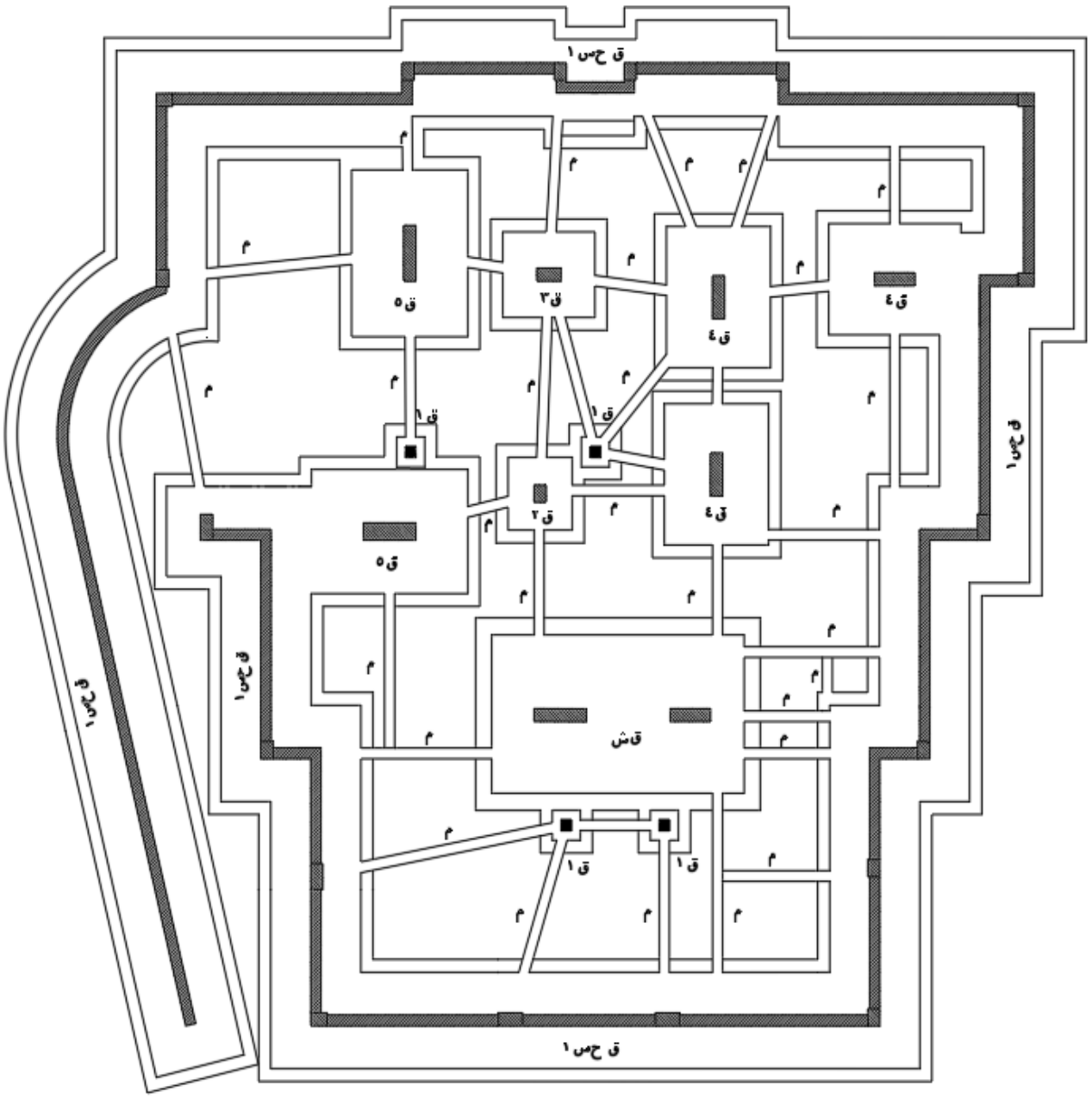
Design Of Short Columns Under Axial Force Only

Fcu=	250	Kg/cm2	umber Of Floors	1	
Fy=	3500	Kg/cm2	μ =	1.0%	

Coulmn	R ton	Total R ton	AC cm2	b cm	t cm	As cm2	Ø	n	RFT	
C8	22.31	24.541	221.19	25	25	6.25	16	4	4Ø16	
C20	26.58	29.238	263.52	25	25	6.25	16	4	4Ø16	
c17	27.53	39.292	354.14	25	25	6.25	16	4	4Ø16	ق1
C14	30.45	33.495	301.89	25	25	6.25	16	4	4Ø16	
c5	35.72	30.283	272.94	30	40	12	16	6	6Ø16	
C26	43.59	47.949	432.17	30	40	12	16	6	6Ø16	
C16	48.45	53.295	480.35	30	40	12	16	6	6Ø16	
C31	60.08	66.088	595.66	30	40	12	16	6	6Ø16	
C18	60.31	66.341	597.94	30	40	12	16	6	6Ø16	
C30	69.53	76.483	689.35	30	40	12	16	6	6Ø16	
C2	72.34	79.574	717.21	30	40	12	16	6	6Ø16	ق2
C28	85.87	94.457	851.35	30	40	12	16	6	6Ø16	
C24	88.5	97.35	877.42	30	40	12	16	6	6Ø16	
C13	95.573	105.1303	947.55	30	40	12	16	6	6Ø16	
C27	105.76	116.336	1048.5	30	40	12	16	6	6Ø16	
C4	106.81	117.491	1059	30	40	12	16	6	6Ø16	
C10	109.11	120.021	1081.8	30	40	12	16	6	6Ø16	
C1	117.84	129.624	1168.3	30	40	12	16	6	6Ø16	
C29	123.16	135.476	1221.1	30	60	18	16	10	10Ø16	
C3	123.7	136.07	1226.4	30	60	18	16	10	10Ø16	
C6	127.36	140.096	1262.7	30	60	18	16	10	10Ø16	
C15	158.72	174.592	1573.6	30	60	18	16	10	10Ø16	ق3
C11	165.14	181.654	1637.3	30	60	18	16	10	10Ø16	
C19	172.46	189.706	1709.8	30	60	18	16	10	10Ø16	
C22	220.06	242.066	2181.8	30	100	30	16	16	16Ø16	
C23	232.11	255.321	2301.2	30	100	30	16	16	16Ø16	ق4
C25	268.91	295.801	2666.1	30	100	30	16	16	16Ø16	
C21	294.58	324.038	2920.6	30	100	30	16	16	16Ø16	
C12	323	355.3	3202.3	30	130	39	16	20	20Ø16	
C9	345.72	380.292	3427.6	30	130	39	16	20	20Ø16	ق5
C7	368	404.8	3648.5	30	130	39	16	20	20Ø16	

10. Design of footing

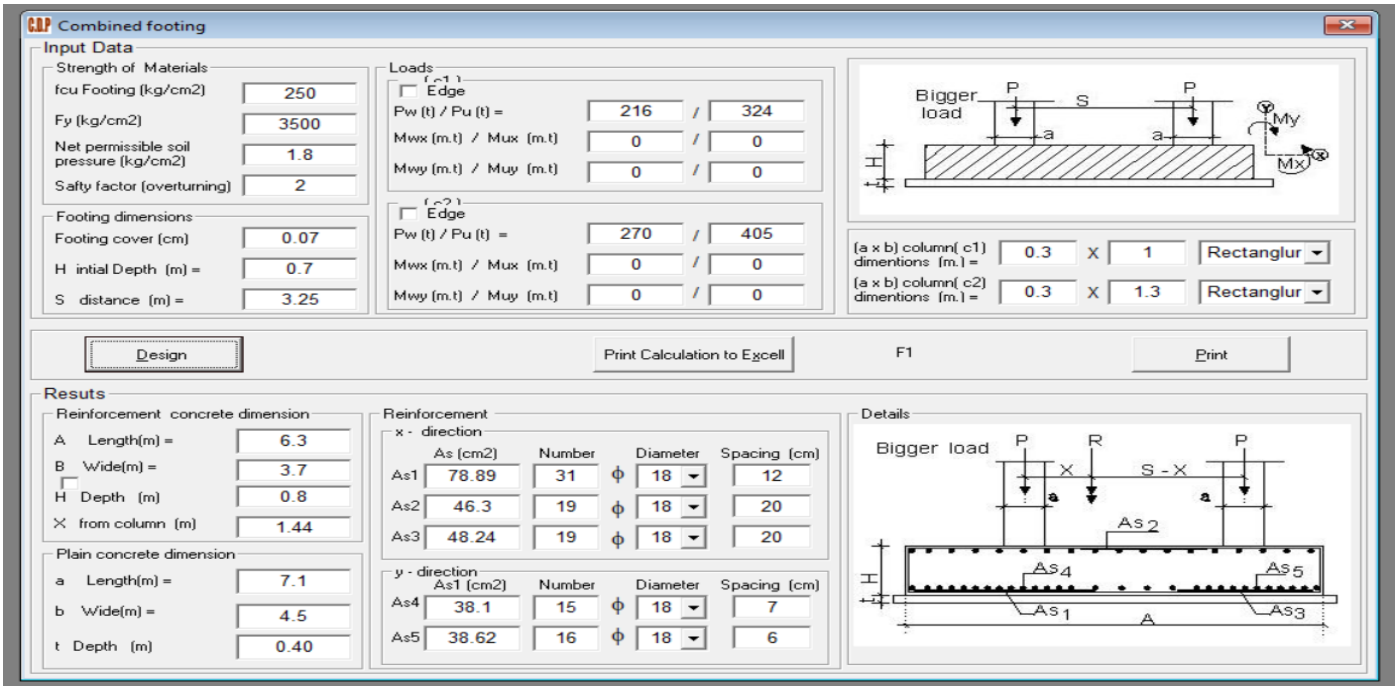
Statical system



Concrete	F_{cu} =	250	kg/cm²
Steel	F_y =	3500	kg/cm²
Bearing capacity q_{all} =		1.80	kg/cm²

	Input
	OutPut
	Equations

Footing	R	Coulmn Reaction	Coulmn Dim.		Dim. Of P.C			Dim. Of R.C			Shear Stress		Punching Shear		RFT							
																Long Direction			Short Direction			
	Ult (Ton)	Working (Ton)	b (cm)	t (cm)	B (cm)	L (cm)	T (cm)	B (cm)	L (cm)	T (cm)	Kg/cm2	Notes	Kg/cm2	Notes	As/m	As min	No.	ø	Total No.	No.	ø	Total No.
F1	130	86.67	30	40	220	230	30	160	170	70	2.4632	safe	3.205	safe	5.372912	9.75	9	12	16	9	12	17
F2	190	126.67	30	60	260	290	30	200	230	70	3.3997	safe	4.9645	safe	7.670053	9.75	9	12	20	9	12	22
F3	324	216.00	30	100	320	390	30	260	330	70	4.851	safe	7.8714	safe	12.99261	9.75	7	16	20	7	16	25
F4	405	270.00	30	130	350	450	30	290	390	70	5.4264	safe	9.0202	safe	15.84823	9.75	8	16	25	8	16	33
F5	39	26.00	25	25	130	130	30	70	70	60	-0.5788	safe	-0.606	safe	1.206851	8.25	8	12	7	8	12	7



11. Design of Retaining walls

input
output

Fcu	250	Kg/m2
Fy	3600	Kg/m2
qall	18	ton/m2
Soil denisty	1.8	ton
friction angle Ø	30	°
Ka	0.3333	
Kp	3	
μ	0.364	

Check sliding

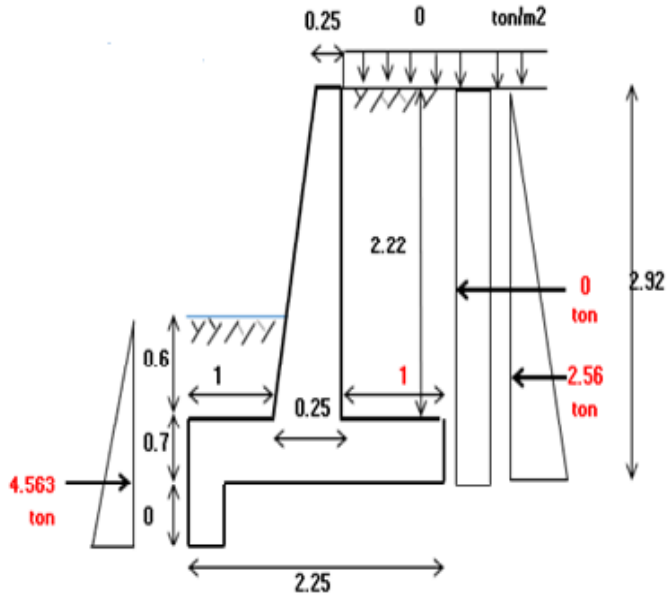
stability force	8.5015	ton	
sliding force	2.5579	ton	
F.O.S	3.3236	>	1.5
	safe		

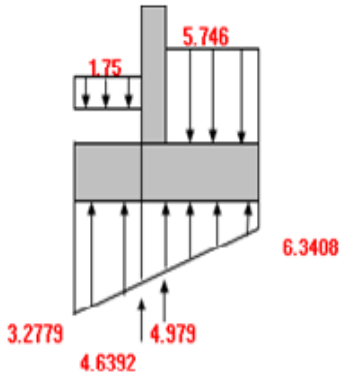
Check over turning

M overturning	2.4897	ton.m	
M stability	15.956	ton.m	
F.O.S	6.4086	>	1.5
	safe		

Check soil failure

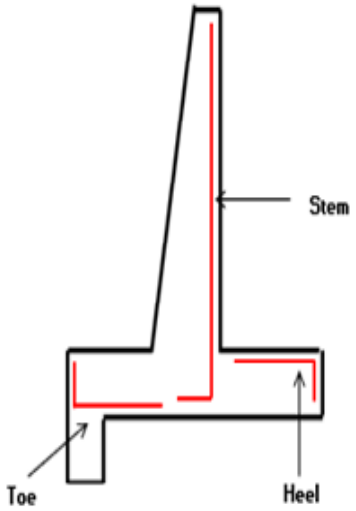
e	-0.119	
q toe	3.2779	safe
q Heel	6.3408	safe





Design of sections

section	check shear			Design of Flexure							
	qsh	qcu	Notes	Mu	C1	j	As	As min	No.	Ø	
stem	0.131424	0.6532	safe	1.75	6.80226	0.782	345.46	720	4	16	at right
toe	0.100531173	0.6532	safe	-1.6	25.018	0.826	84.624	1050	6	16	At bottom
Heel	0.002180512	0.6532	safe	0.25	62.9758	0.826	13.355	1050	6	16	At Top



UNIT 2 / HIGHRISE BUILDING

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2.11	Design of shear walls & cores	155-159
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2.13	Design of Retaining walls	178

UNIT 2

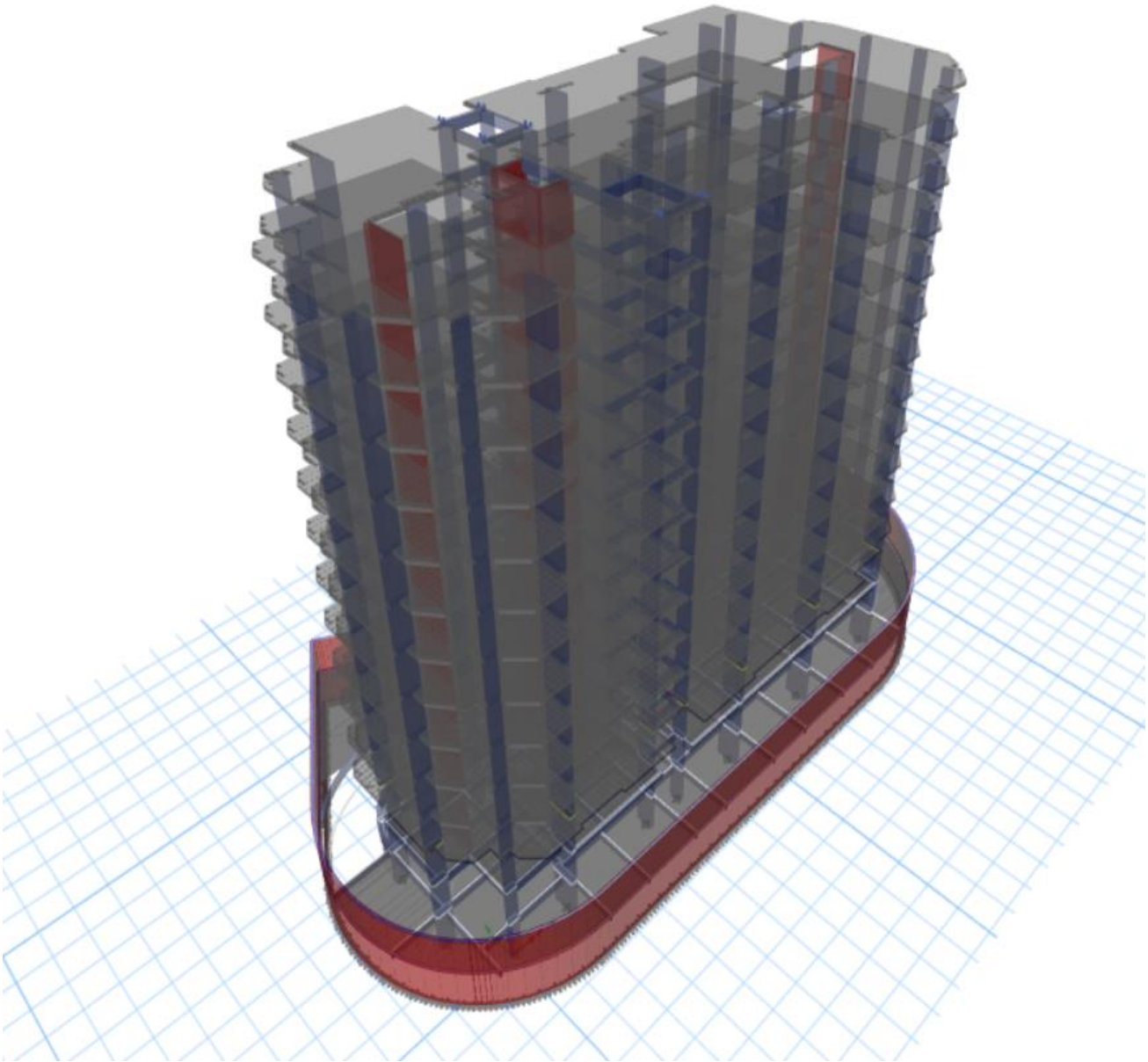
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2.3.2	The architecture plan of the ground floor	
2.3.3	The architecture plan of the basement floor one	
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2.4.2	Statical system	
2.4.3	Design of slabs	
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2.11.2	Design of cores	
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UNIT 2

3D MODEL



2.1. Project description

- The first unit is a Highrise building
- Building consists of 14 floors
- 2Basement, ground, 11 typical floors
- Basement (garage), ground (commercial), typical(residential)
- Building area is 1009.5 m^2
- The height of the floor is 3 m, except for the basement is 3m
- Total height of building is 42m
- Location of the project is in Beni Suef, Zone Two, Soil type (C)

Design Codes

- Egyptian code for design concrete structure (ECP 203-2018).
- Egyptian code for calculating loads and forces in construction and building works ECP(201-2018).

2.2.the programs used



SAFE 2016



ETABS 2016

POWERPOINT



EGYPTIAN CODE CONCRETE (C.D.P)

EXCEL



AUTOCAD 2020

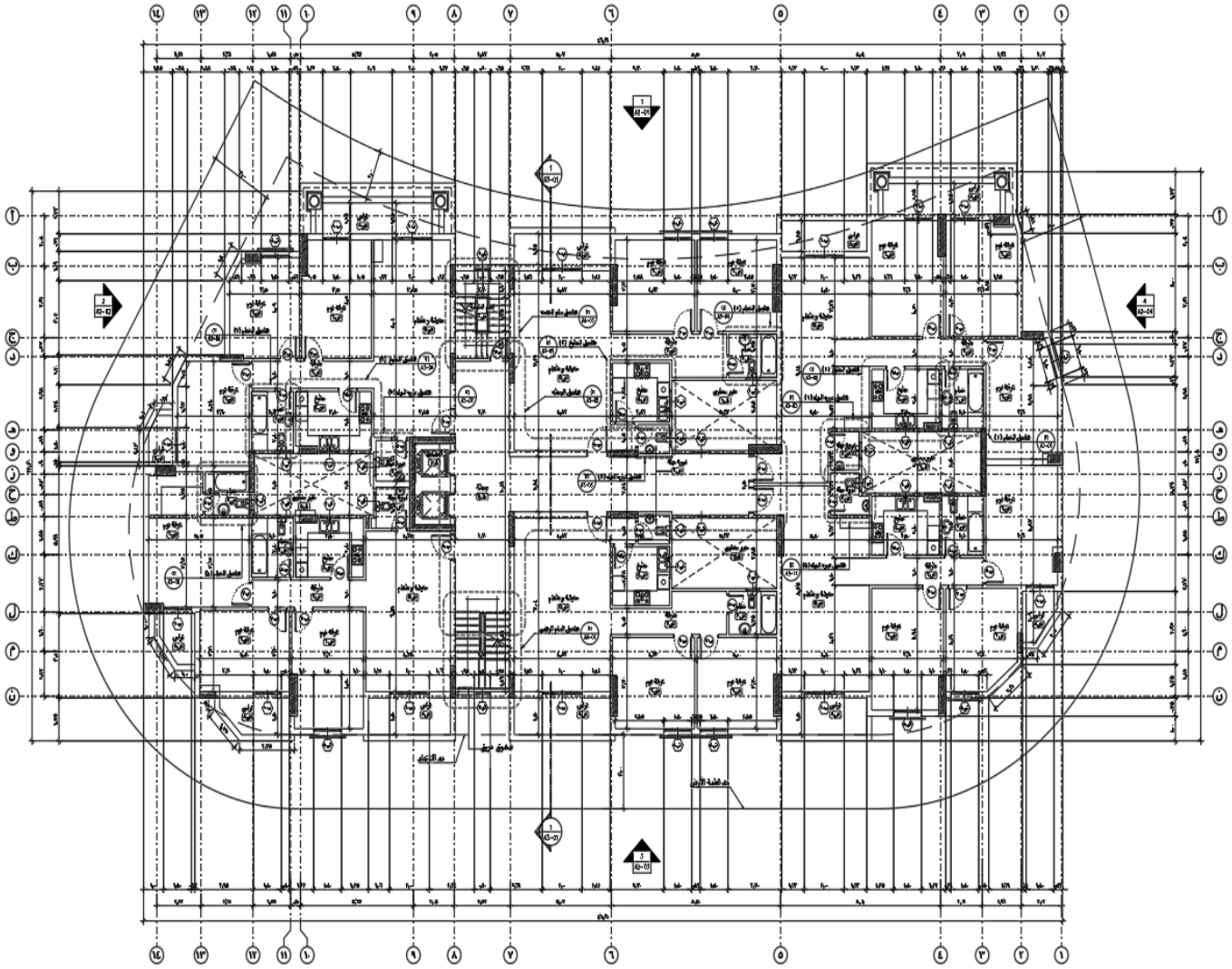


SpColumn

WORD

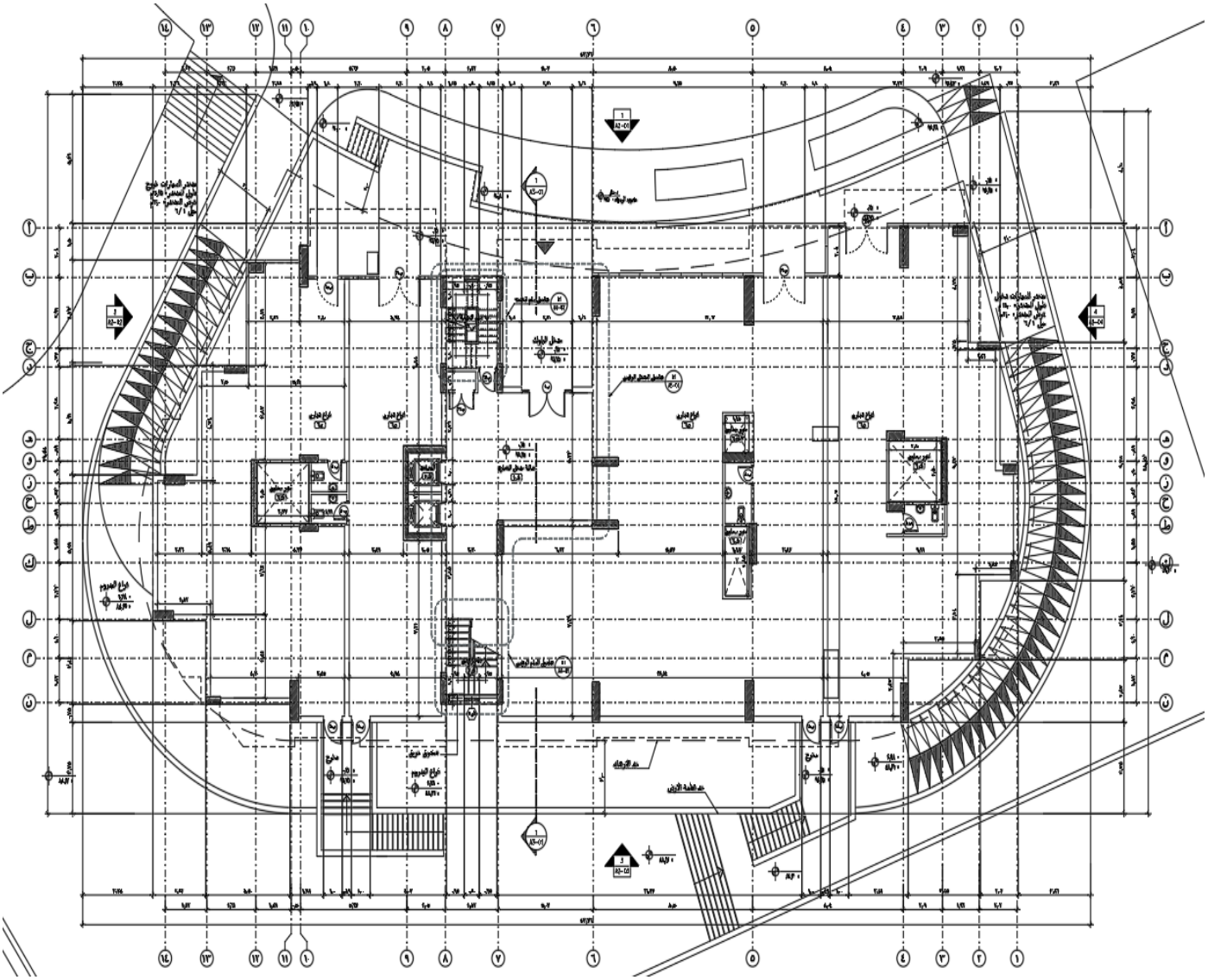
2.3 The Architecture plans

2.3.1 The architecture plan of the typical floor



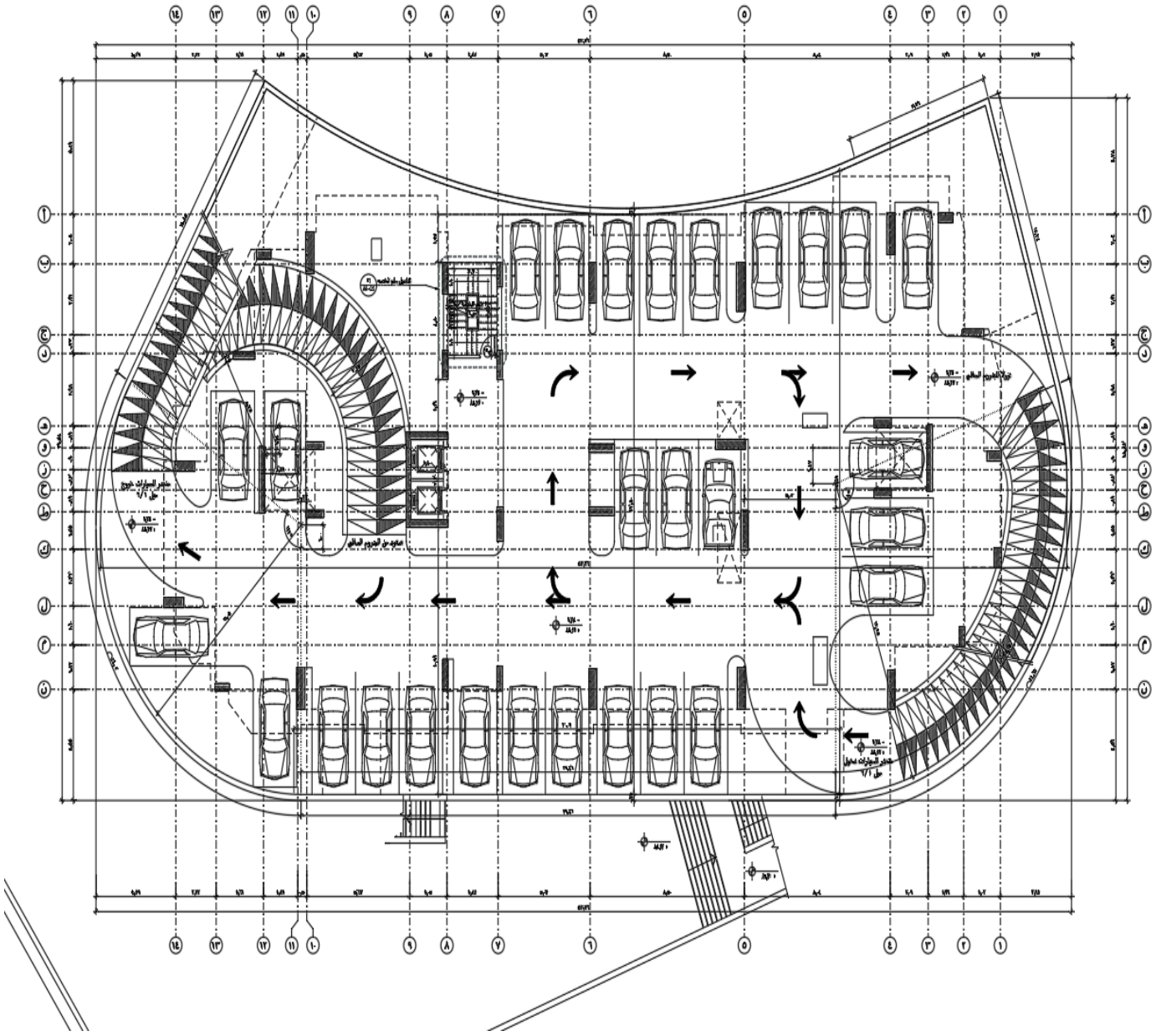
مسقط افقي للدور المتكرر

2.3.2 The architecture plan of the ground floor



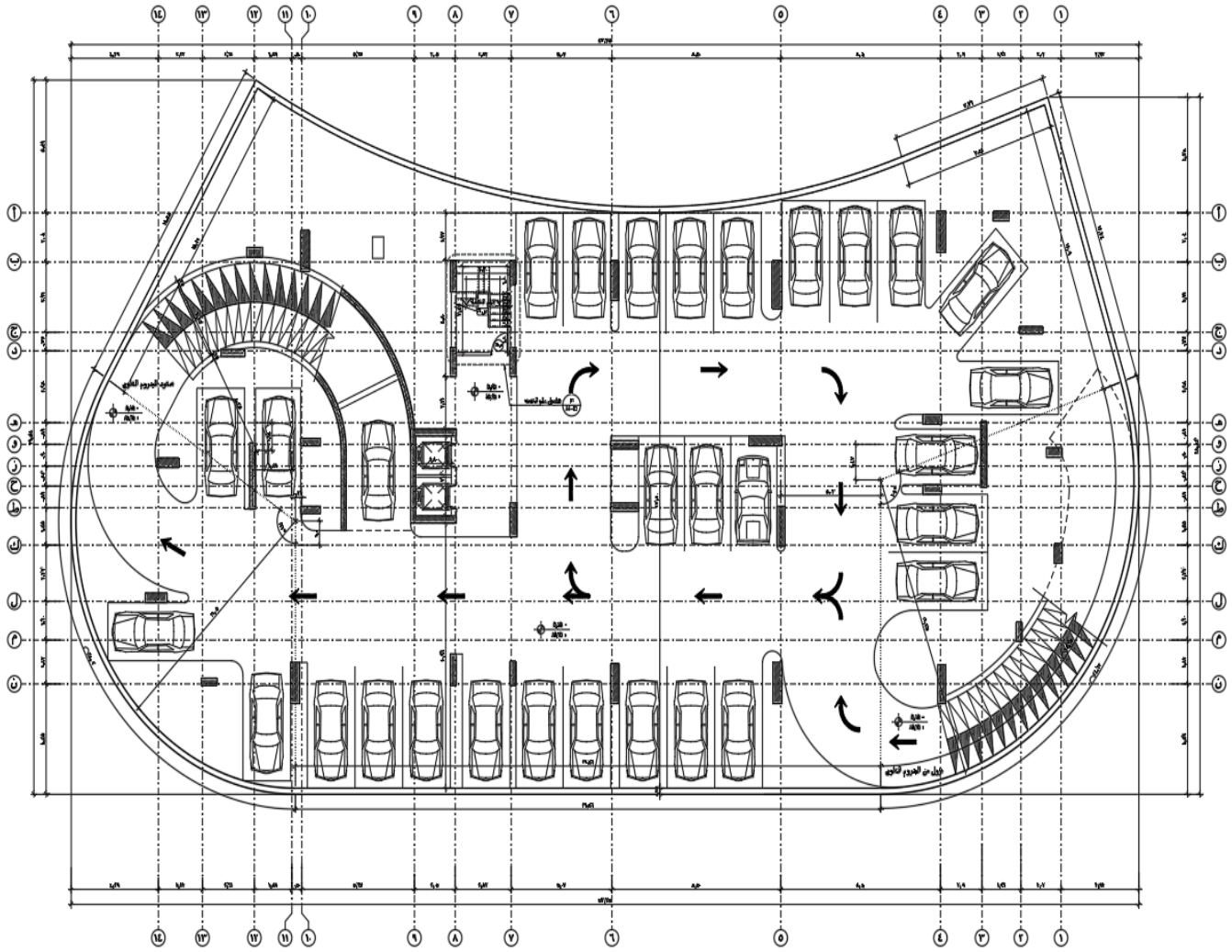
مسقط افقي للدور الارضي

2.3.3 The architecture plan of the basement floor one



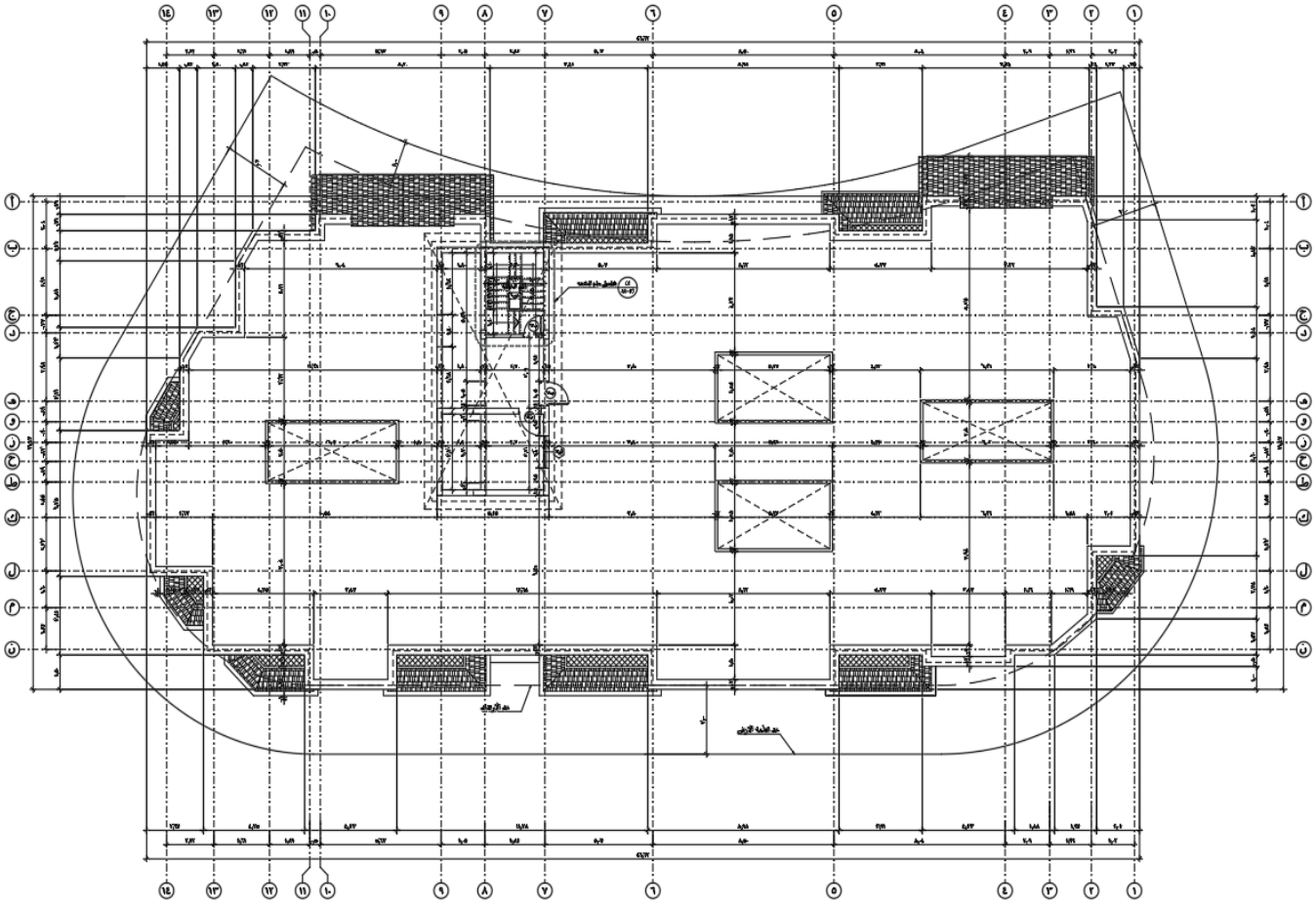
مسقط افقي للدور البدروم الأول(العلوي)

2.3.4 The architecture plan of the basement floor two



مسقط افقي للدور البدروم الثاني(السفلي)

2.3.5 The architecture plan of the Roof floor



مسقط افقي للدور السطح

2.4.1. Design of Lower basement floor

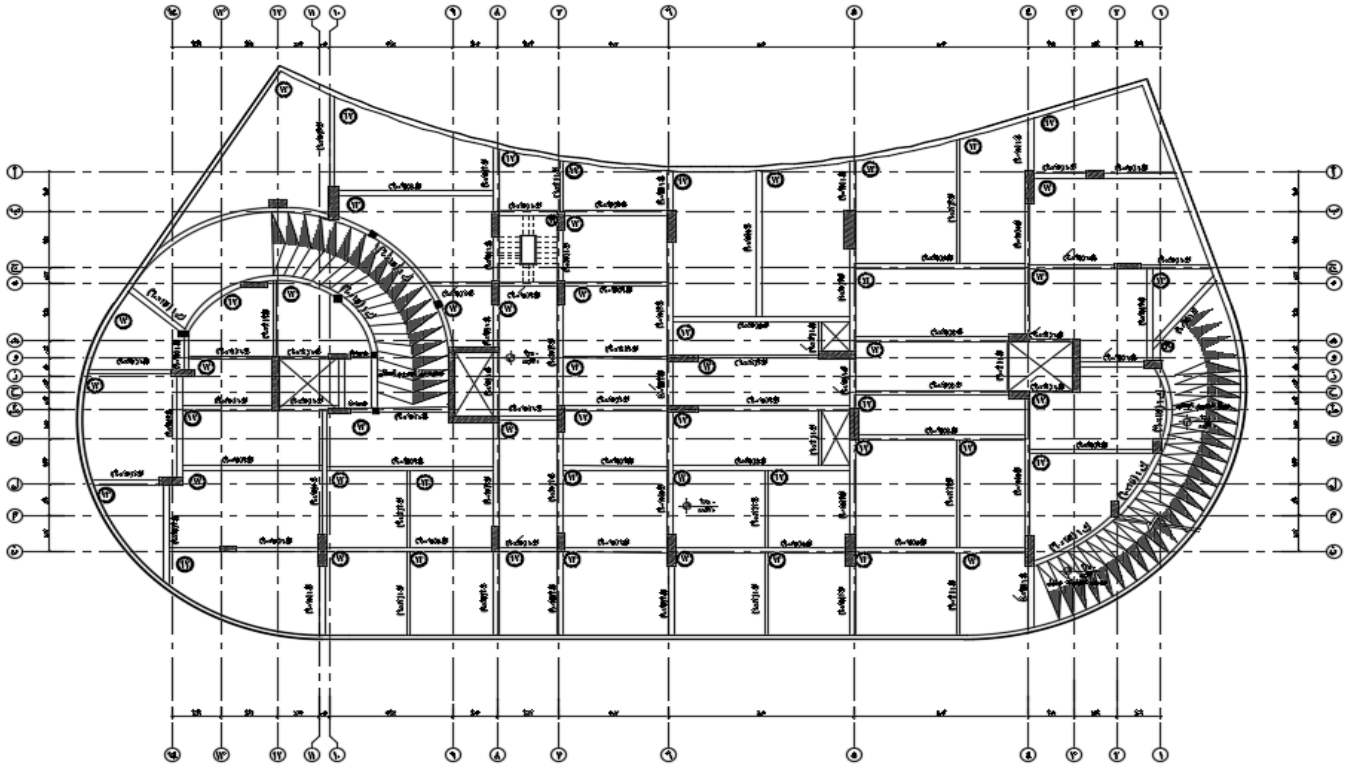
2.4.1. Design Notes

- The roof is designed in solid slab system

Designed on:

- Own wight calculated by sap
- Live load = 500 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 400 kg/cm²)
- Steel characteristics strength (Fy = 3600 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

2.4.2. Statical system



2.4.3. Moment of slabs

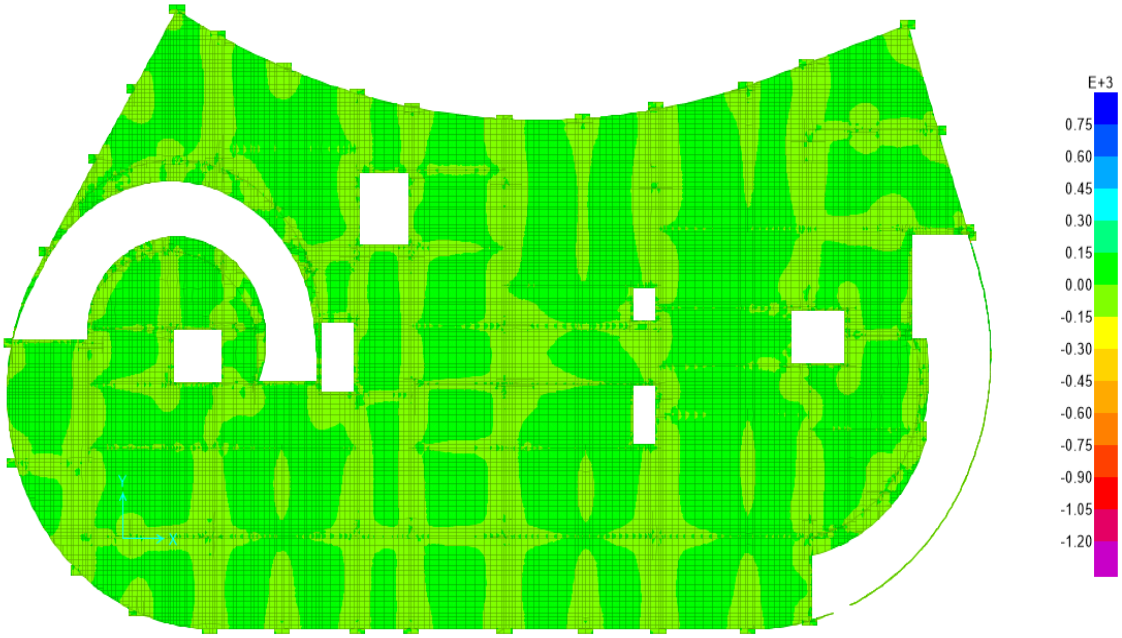


Figure 2.1: M1.1 positive

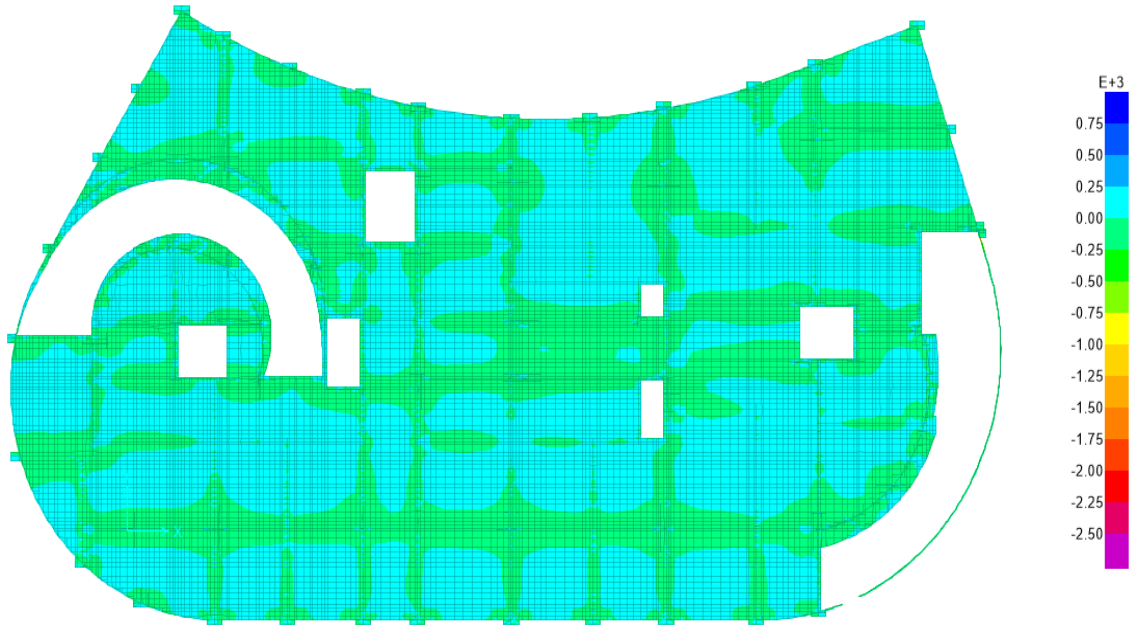


Figure 2.2: M2.2 positive

2.4.4. Design of slabs

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529

- *Solid slab (ts = 12cm)*

For slab *ts = 12cm*

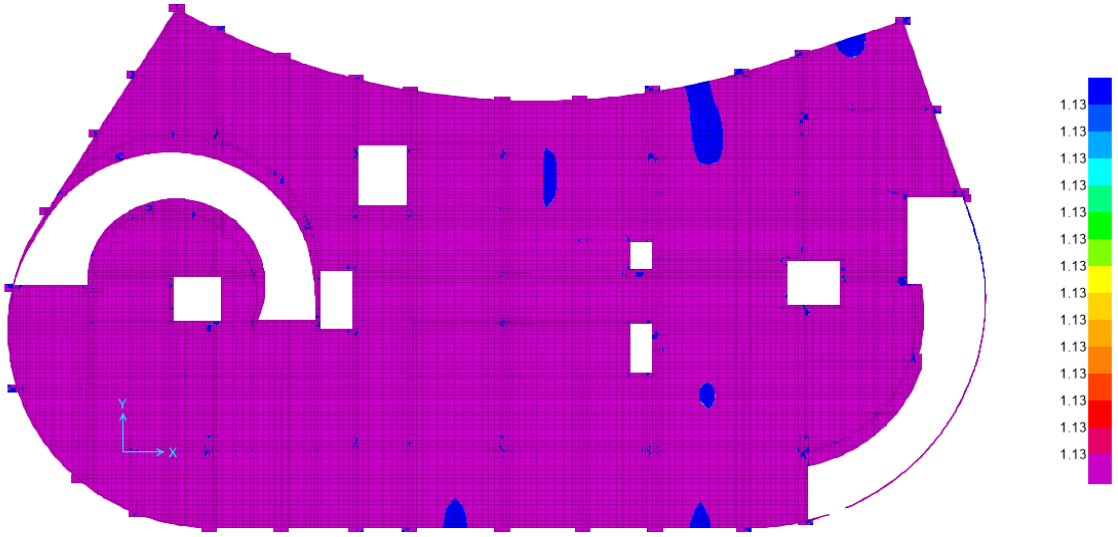


Figure 2.3: M1.1 positive

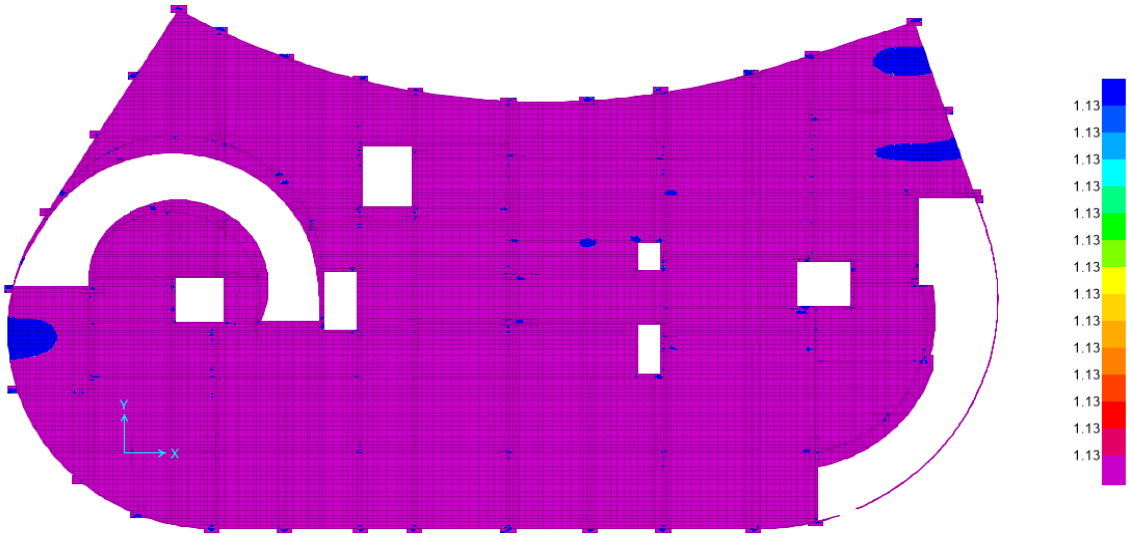


Figure 2.4: M2.2 positive

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	10	628.319	350	120	100	0.826	1.81647

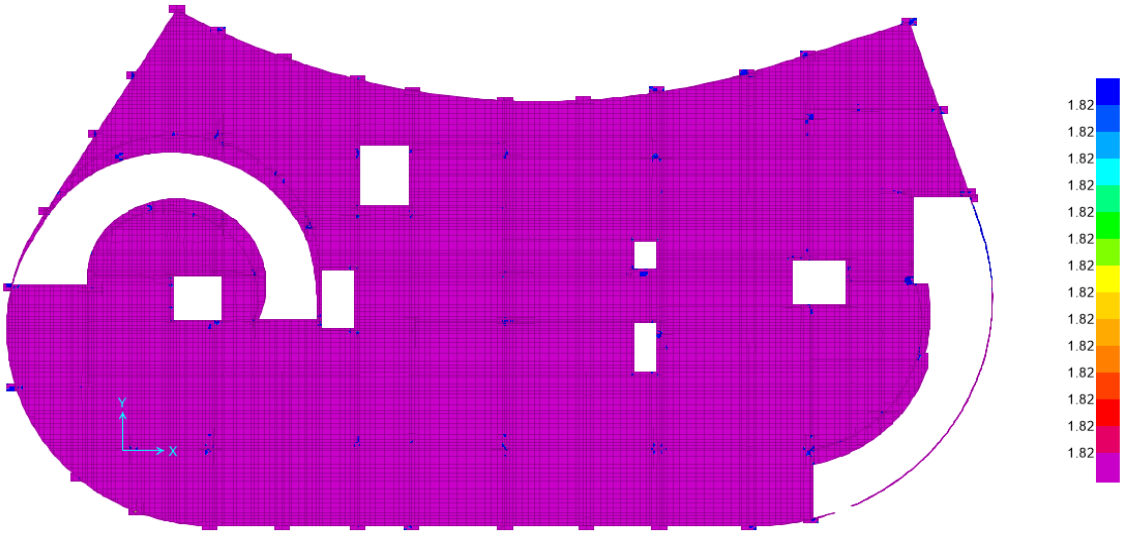


Figure 2.5: M1.1 positive

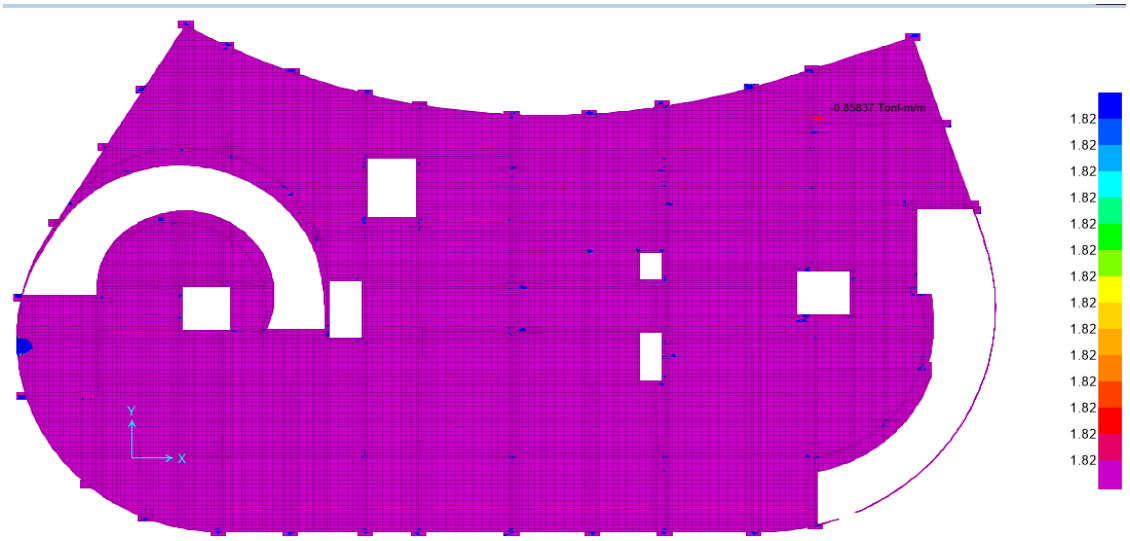
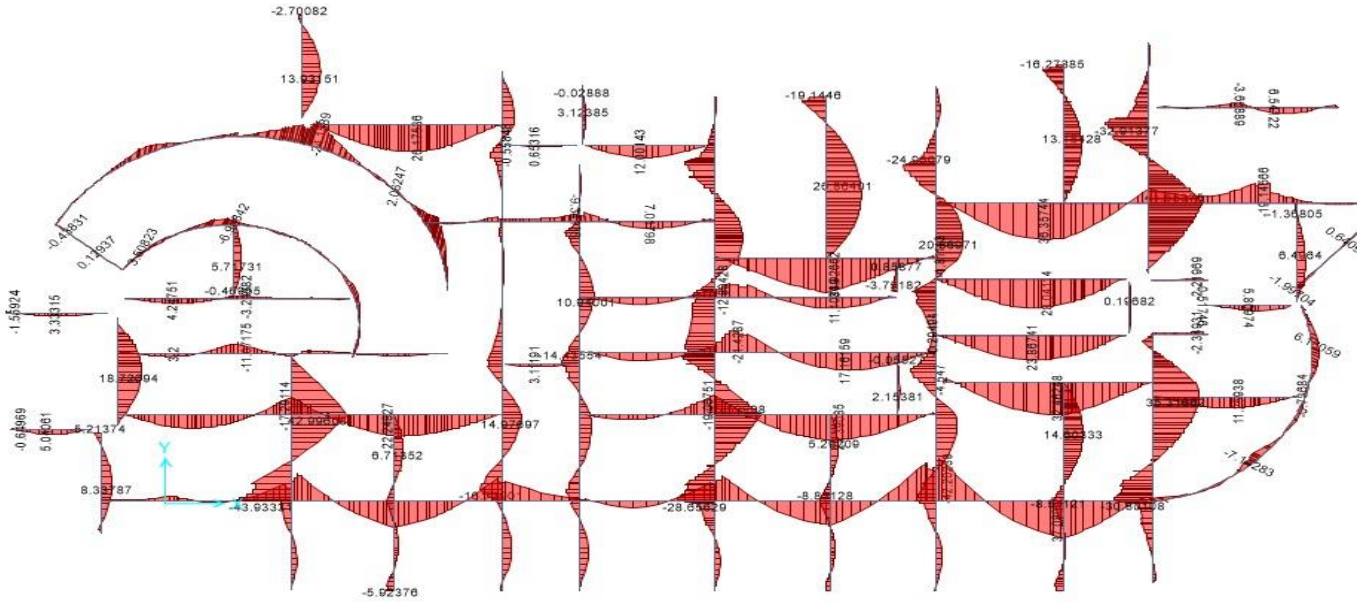


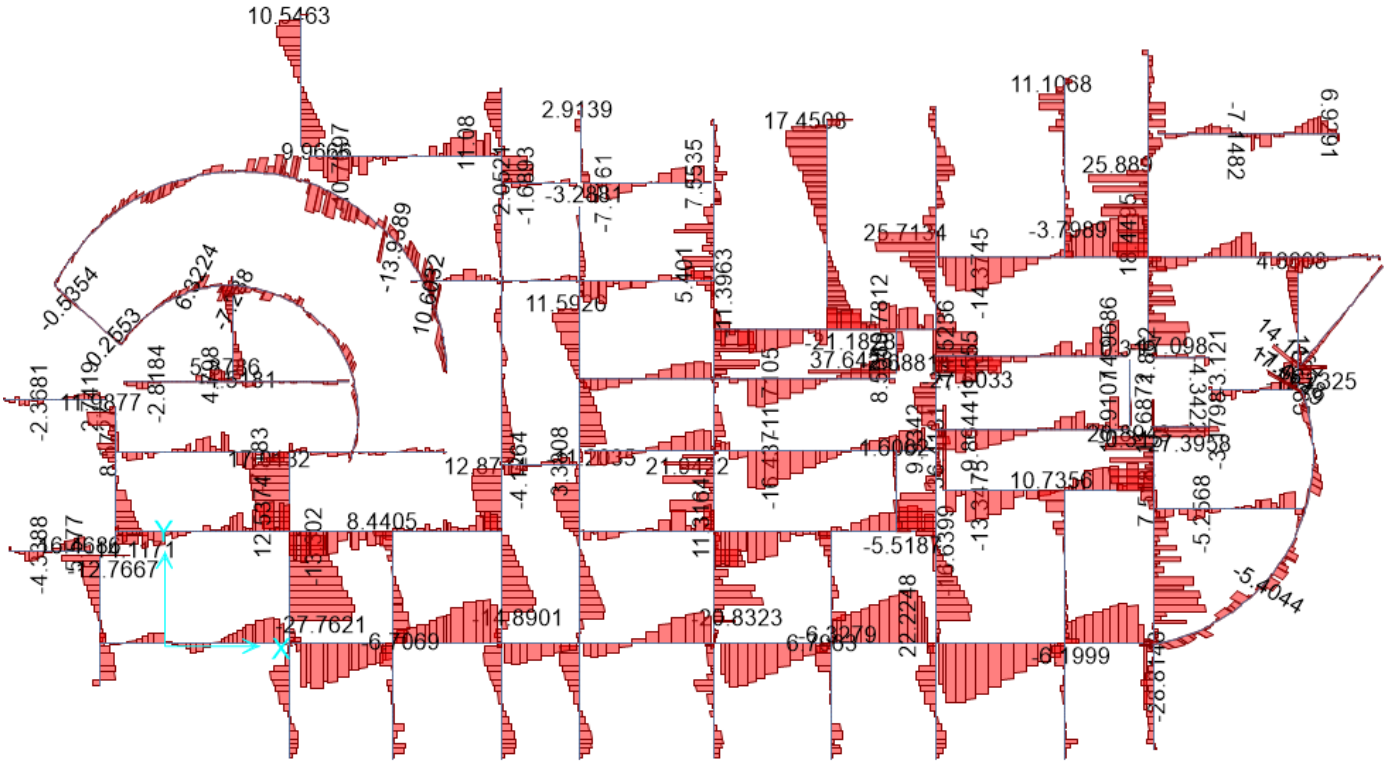
Figure 2.6: M2.2 positive

2.4.5 Design of beams

Moment of beams



Shear of beams



check concrete dimension

Concrete F_{cu} =	400	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	46	25	25	60	2.798	0.720	4.71	30.44	9 ϕ 22	safe
	22	12	12	60	2.803	0.720	2.26	14.54	4 ϕ 22	safe

Design of beam

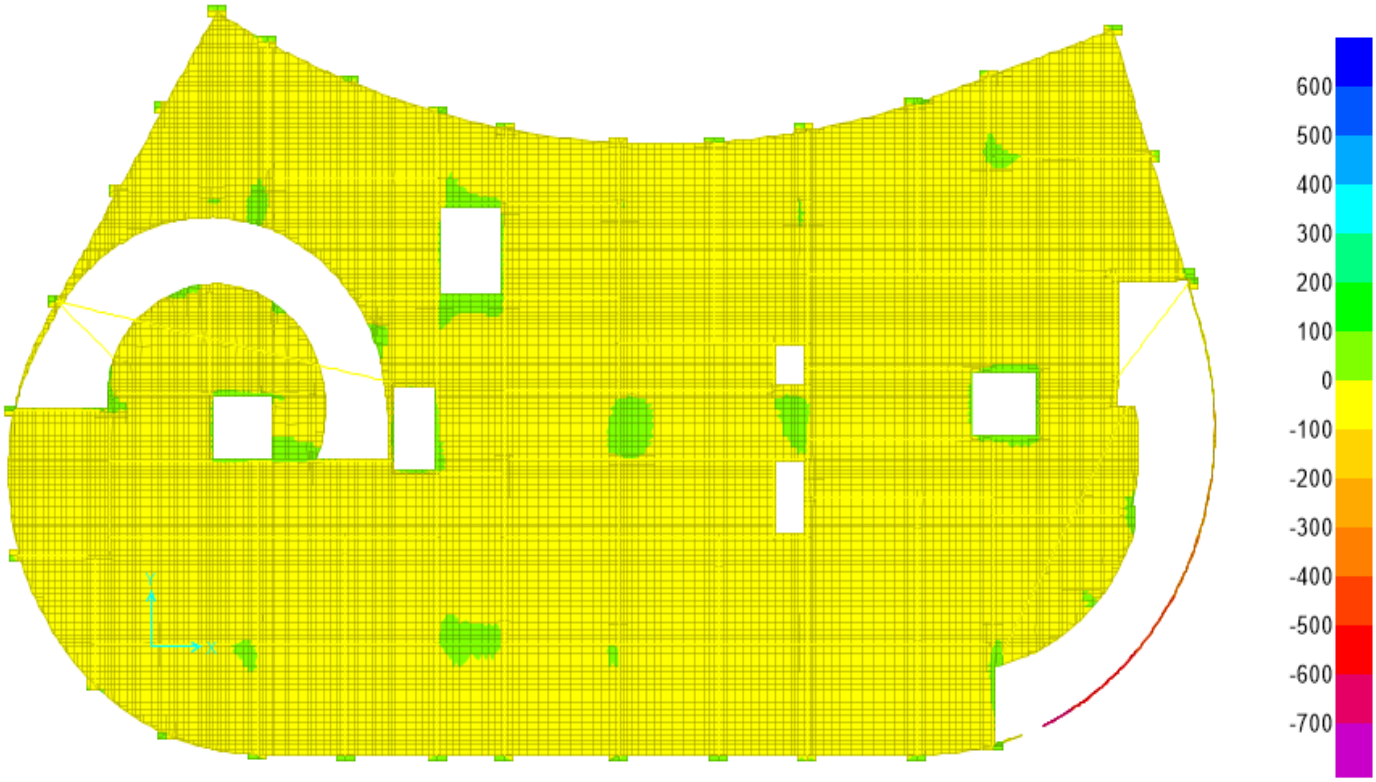
Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	350	600	575	0.72	0.9	4.4
B2	4	16	804.2477194	350	600	575	0.72	0.9	10.5
B3	8	16	1608.495439	350	600	575	0.72	0.9	21.0
B4	10	18	2544.69005	350	600	575	0.72	0.9	33.2
B5	12	18	3053.62806	350	600	575	0.72	0.9	39.8

Check shear

Concrete F_{cu} =	400	kg/cm^2
Concrete q_{all} =	12.247	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	55	25	60	*36.67*	*0.251*	2	*5* ϕ 8	***safe***
	26	12	60	*36.11*	*0.118*	2	*5* ϕ 8	***safe***

check of deflection



Δ max = 0.05 cm

Δ all = span / 250

Δ all=225 / 250 = 0.9cm

SAFE DEFLECTION

2.5.1. Design of The upper basement floor

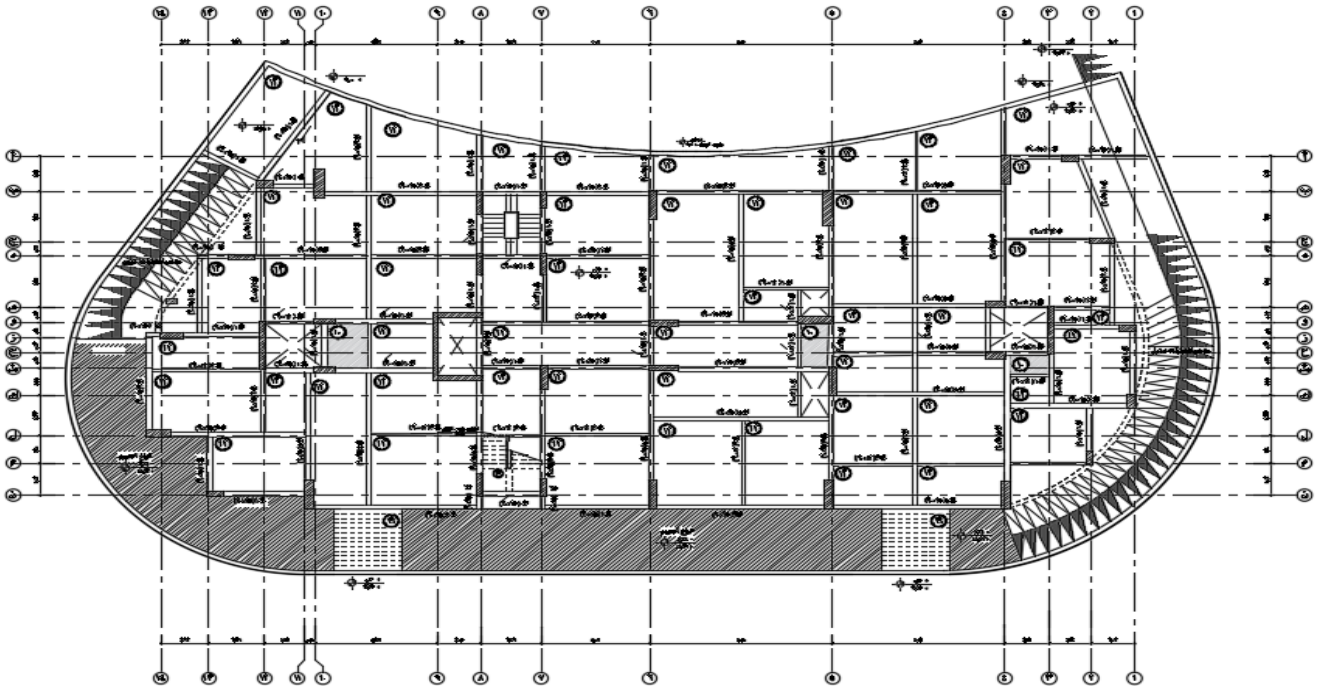
2.5.1. Design Notes

- The roof is designed in solid slab system

Designed on:

- Own wight calculated by sap
- Live load = 500 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 400 kg/cm²)
- Steel characteristics strength (Fy = 3600 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

2.5.2. Statical system



2.5.3. Moment of slabs

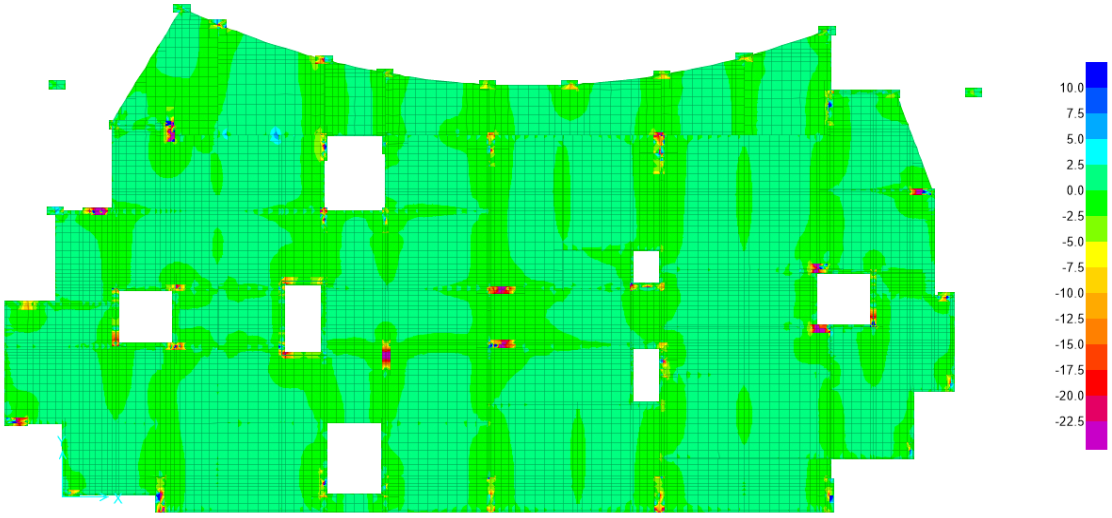


Figure 2.7: M1.1 positive

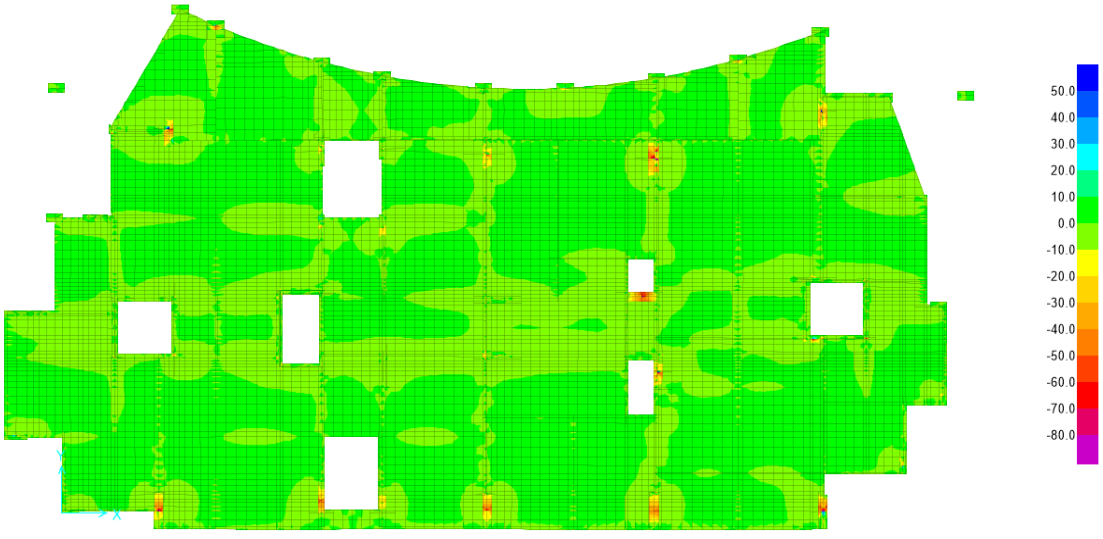


Figure 2.8: M2.2 positive

2.5.4. Design of slabs

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529

- *Solid slab (ts = 12cm)*

For slab *ts = 12cm*

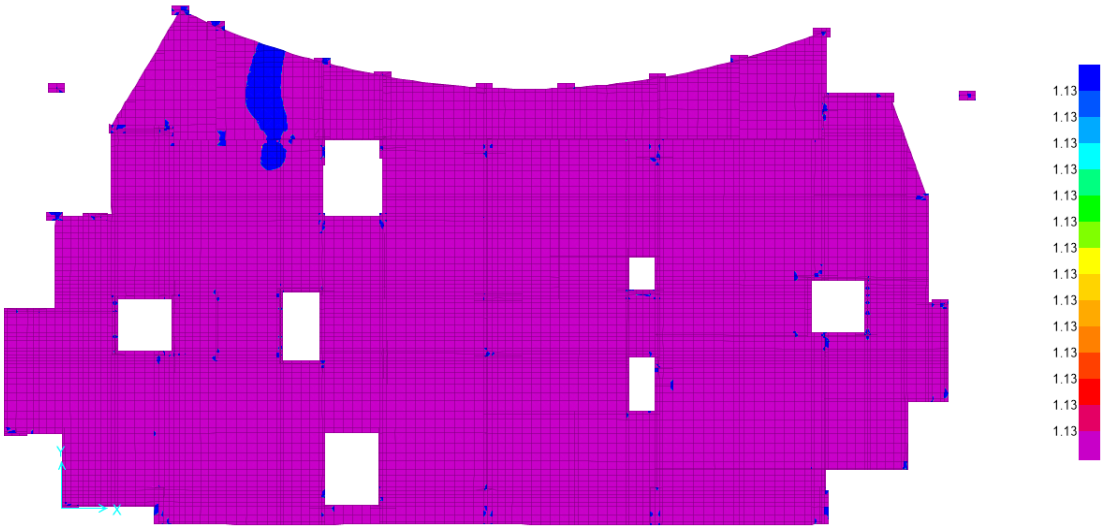


Figure 2.9: M1.1 positive

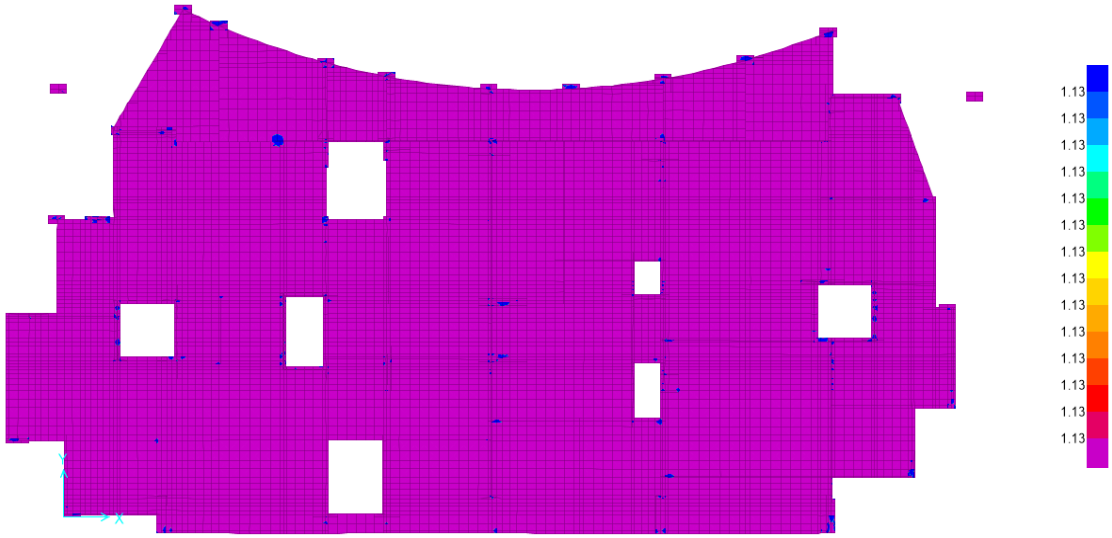


Figure 2.10: M2.2 positive

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	10	628.319	350	120	100	0.826	1.81647

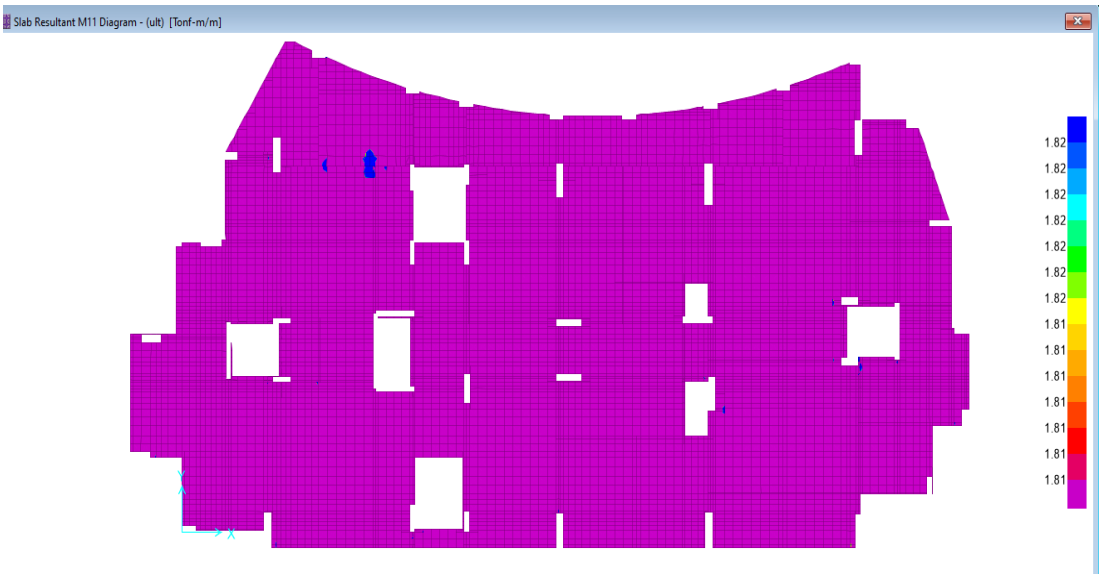
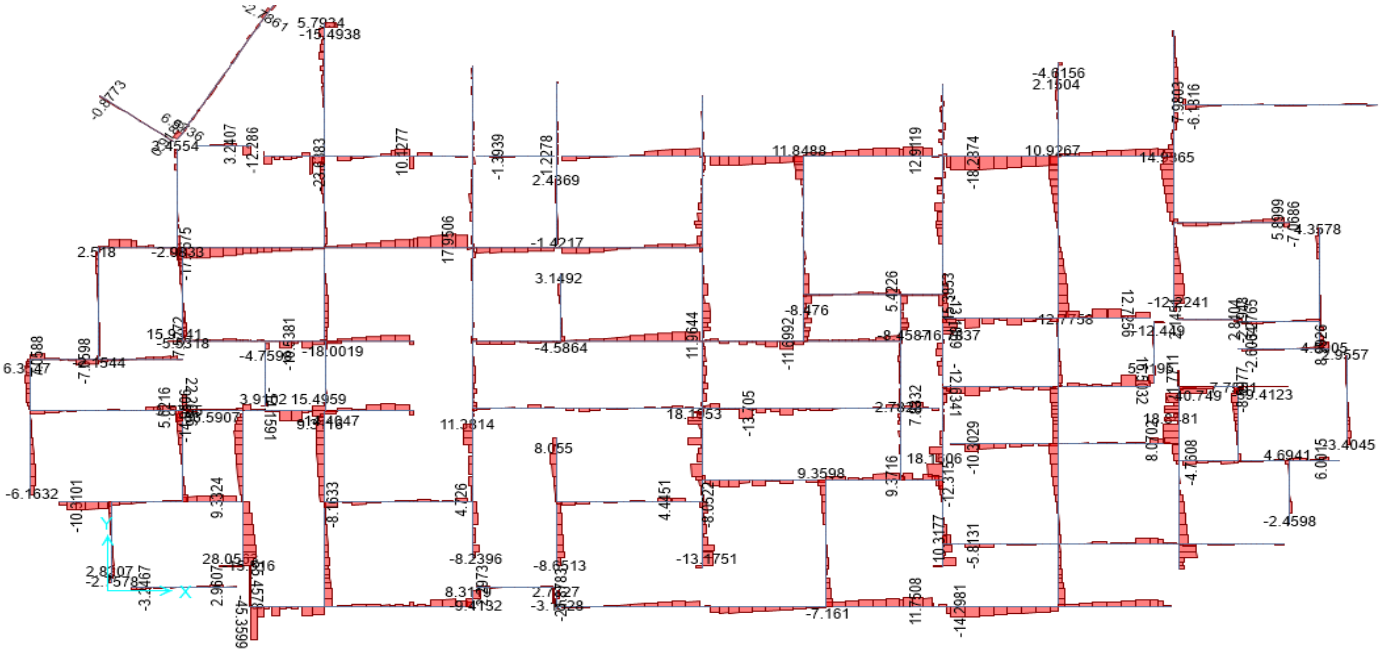


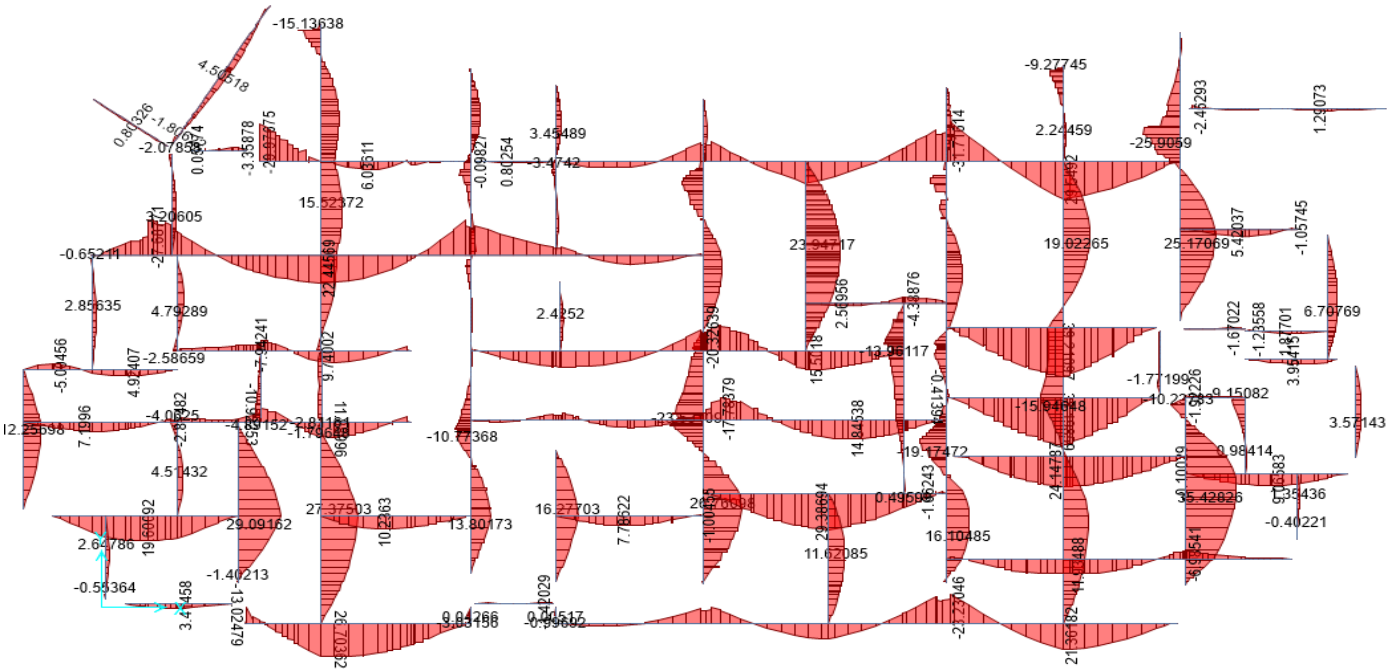
Figure 2.11: M1.1 positive

2.5.5 Design of beams

Moment of beams



Shear of beams



check concrete dimension

Concrete F_{cu} =	400	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	46	25	25	60	2.798	0.720	4.71	30.44	9 ϕ 22	safe
	22	12	12	60	2.803	0.720	2.26	14.54	4 ϕ 22	safe

Design of beam

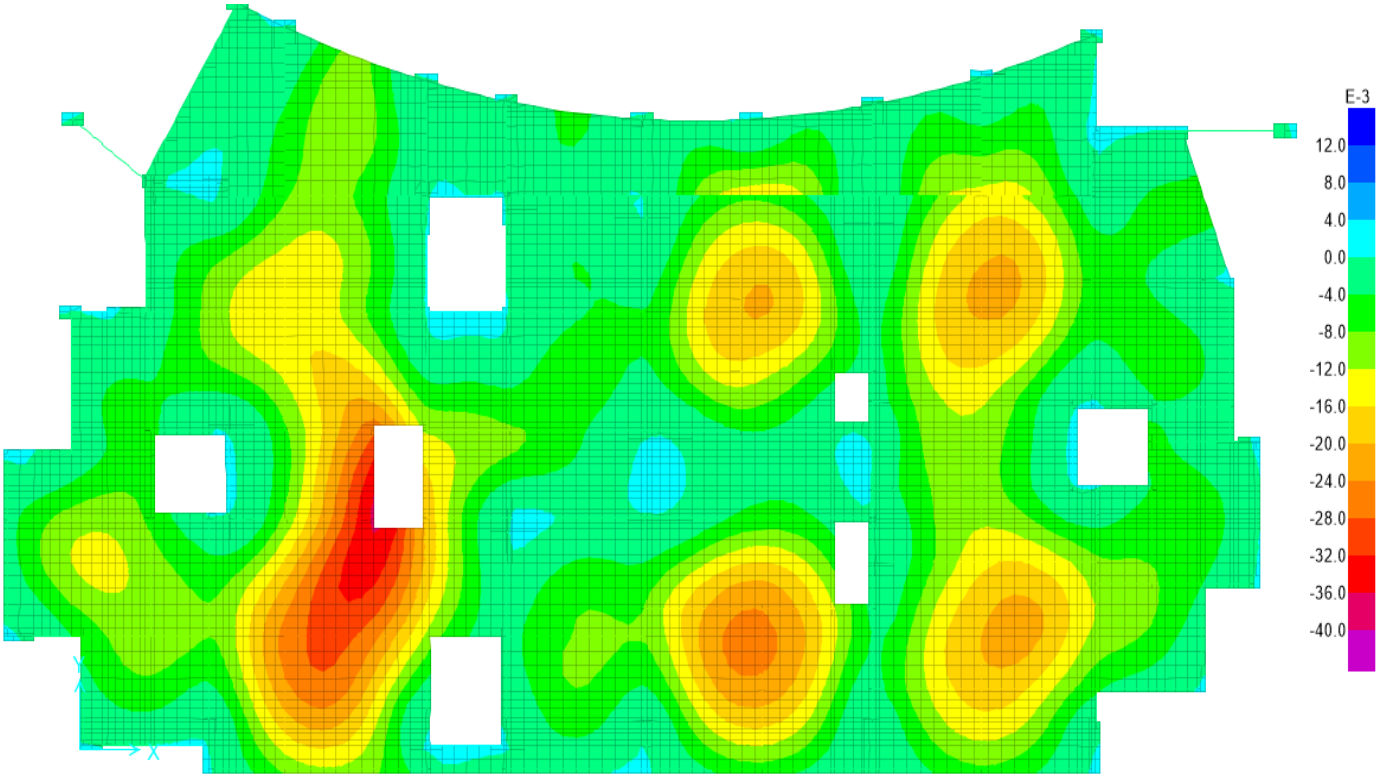
Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	3	12	339.2920066	350	600	575	0.72	0.9	4.4
B2	4	16	804.2477194	350	600	575	0.72	0.9	10.5
B3	8	16	1608.495439	350	600	575	0.72	0.9	21.0
B4	10	18	2544.69005	350	600	575	0.72	0.9	33.2
B5	12	18	3053.62806	350	600	575	0.72	0.9	39.8

Check shear

Concrete F_{cu} =	400	kg/cm^2
Concrete q_{all} =	12.247	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	55	25	60	*36.67*	*0.251*	2	*5* ϕ 8	***safe***
	26	12	60	*36.11*	*0.118*	2	*5* ϕ 8	***safe***

check of deflection



Δ max = cm

Δ all = span / 250

Δ all = / 250 = 0.9 cm

SAFE DEFLECTION

2.6.1. Design of the ground floors

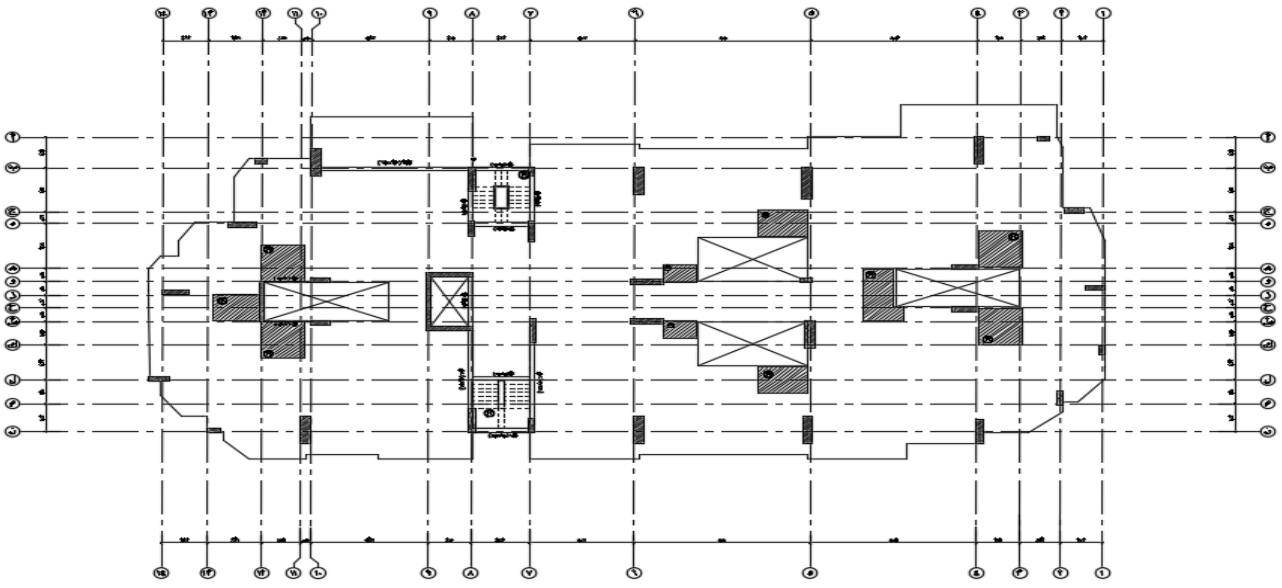
2.6.1.Design notes

- The typical floor is designed in flat slab system

Designed on:

- Own wight calculated by safe
- Live load = 300 kg/cm²
- Walls load on Beams = 0.5 T/m
- Walls on flat slab = 0.5 T/m²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 400 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)
- Brick weight = 1.8 t/m³

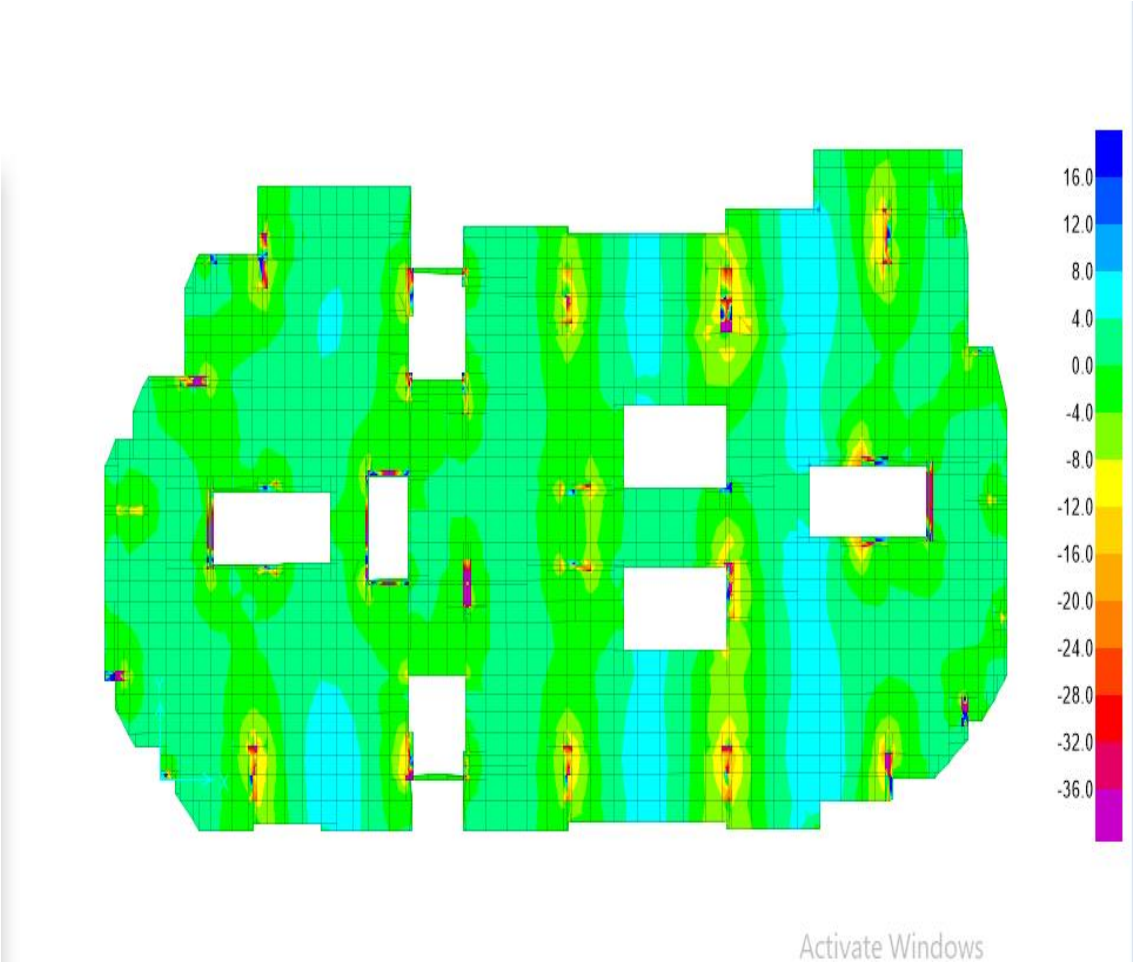
2.6.2 Statical system



2.6.3 Design of slabs

- Take Ts = 25 cm

Moment of X direction



Check Positive Moment in X Direction

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

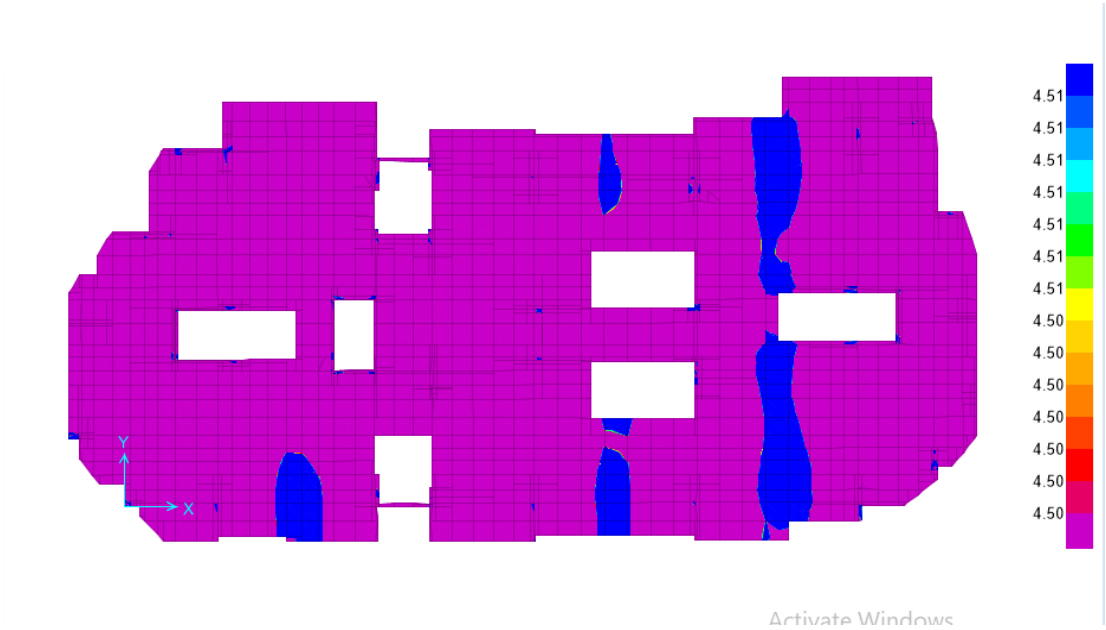


Figure 2.12: M1.1 positive

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

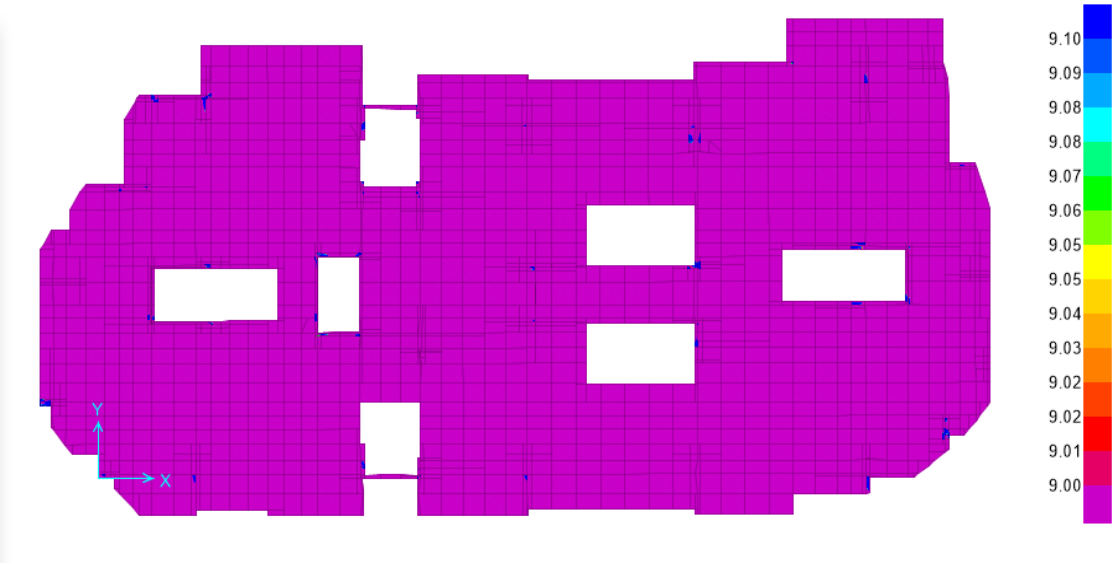


Figure 2.13: M1.1 positive with additional

Check Negative Moment in X Direction

	input
	output

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

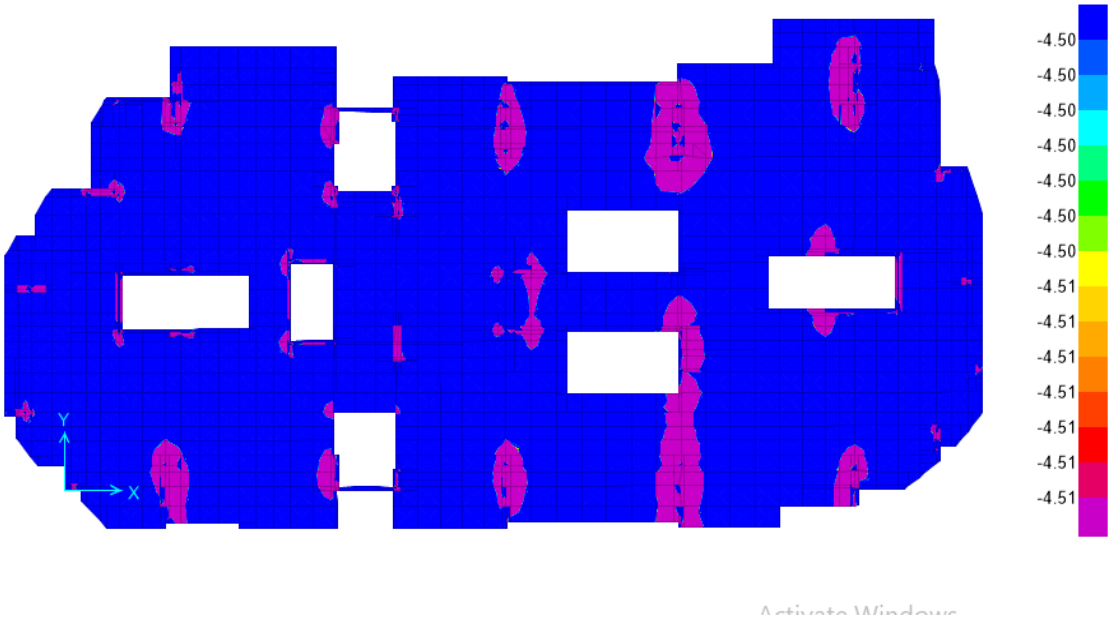


Figure 2.14: M1.1 negative

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

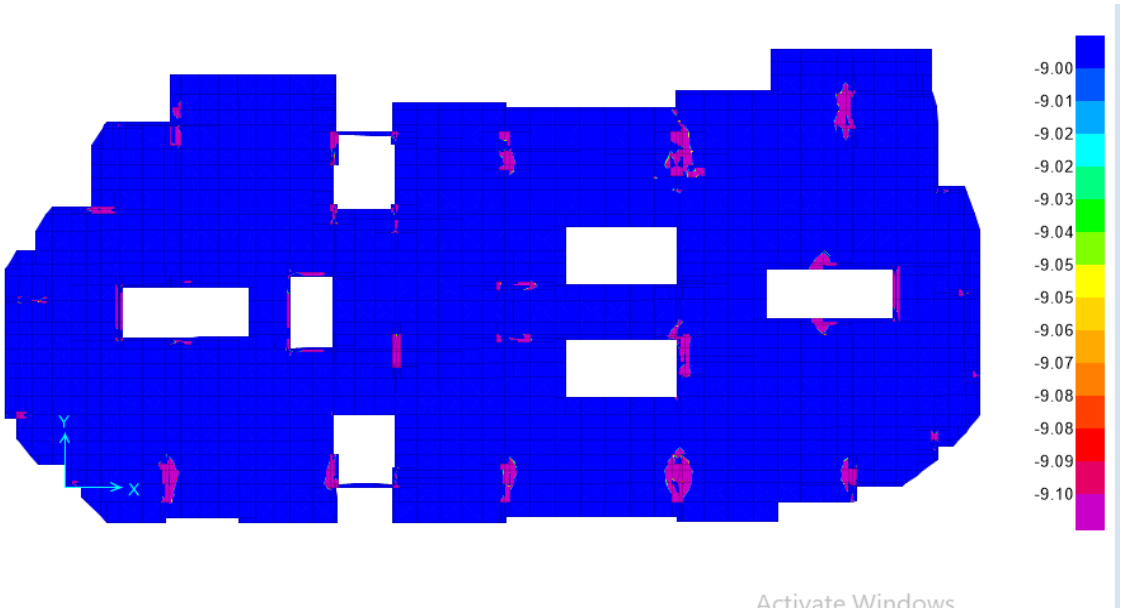
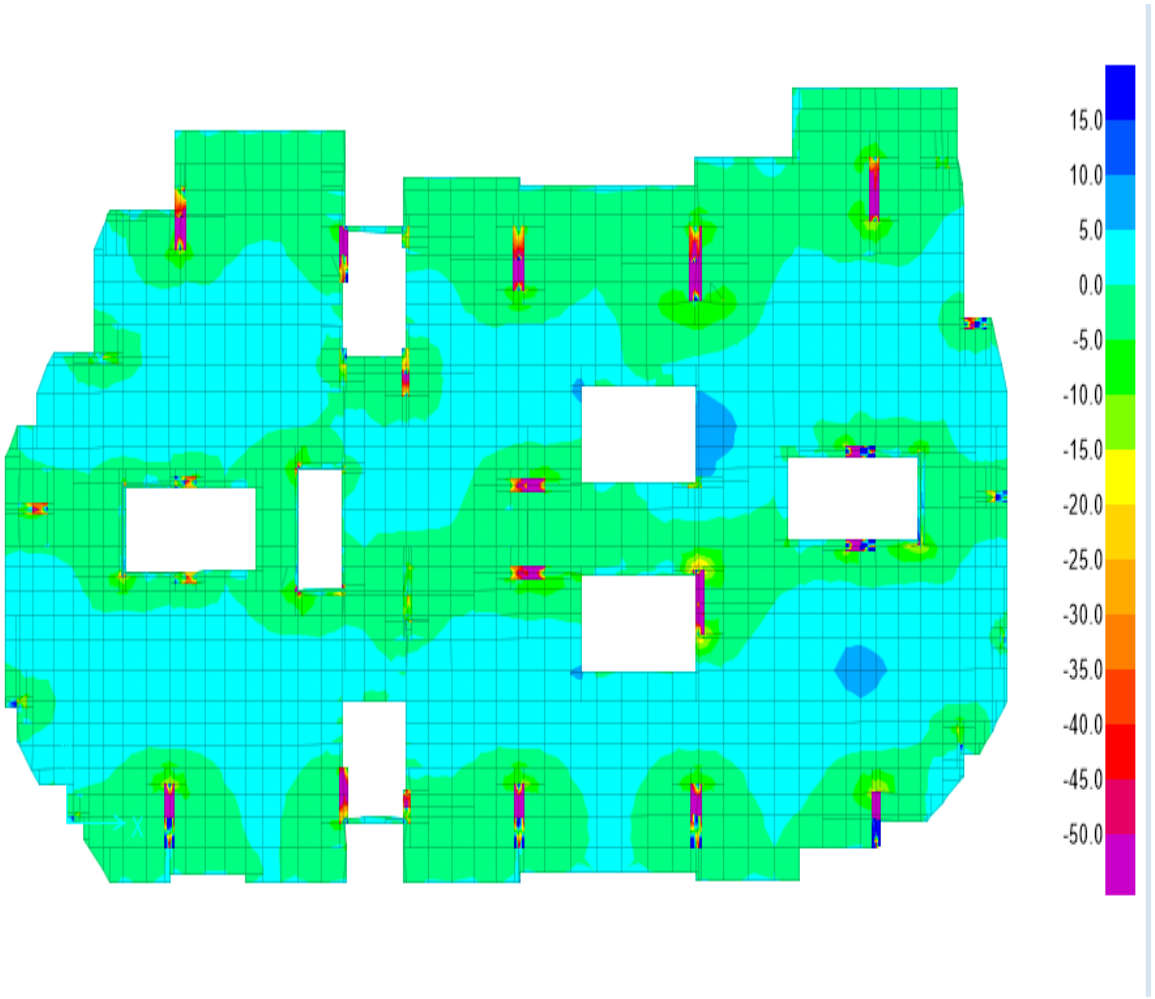


Figure 2.15: M1.1 negative with additional

Moment of Y direction



Check Positive Moment in Y Direction

	input
	output

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

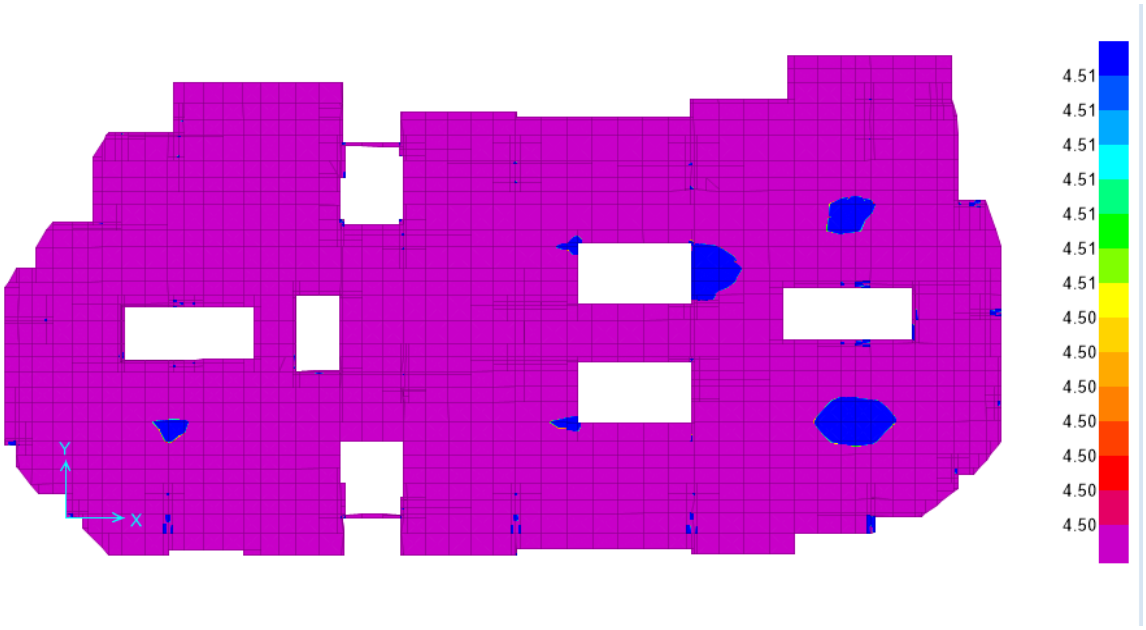


Figure 2.16: M2.2 positive

Additional	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

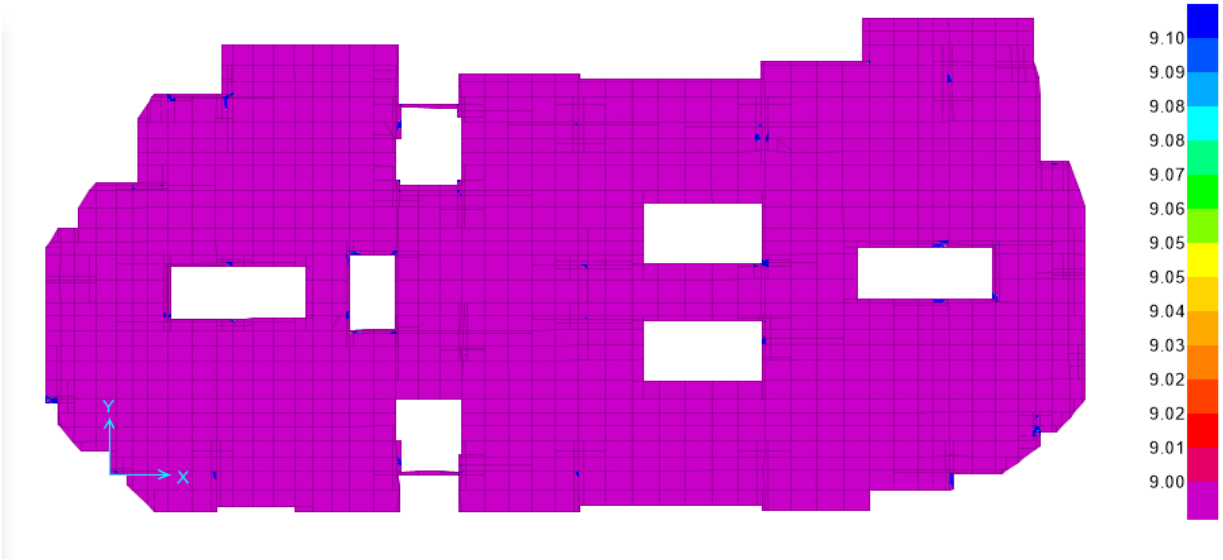
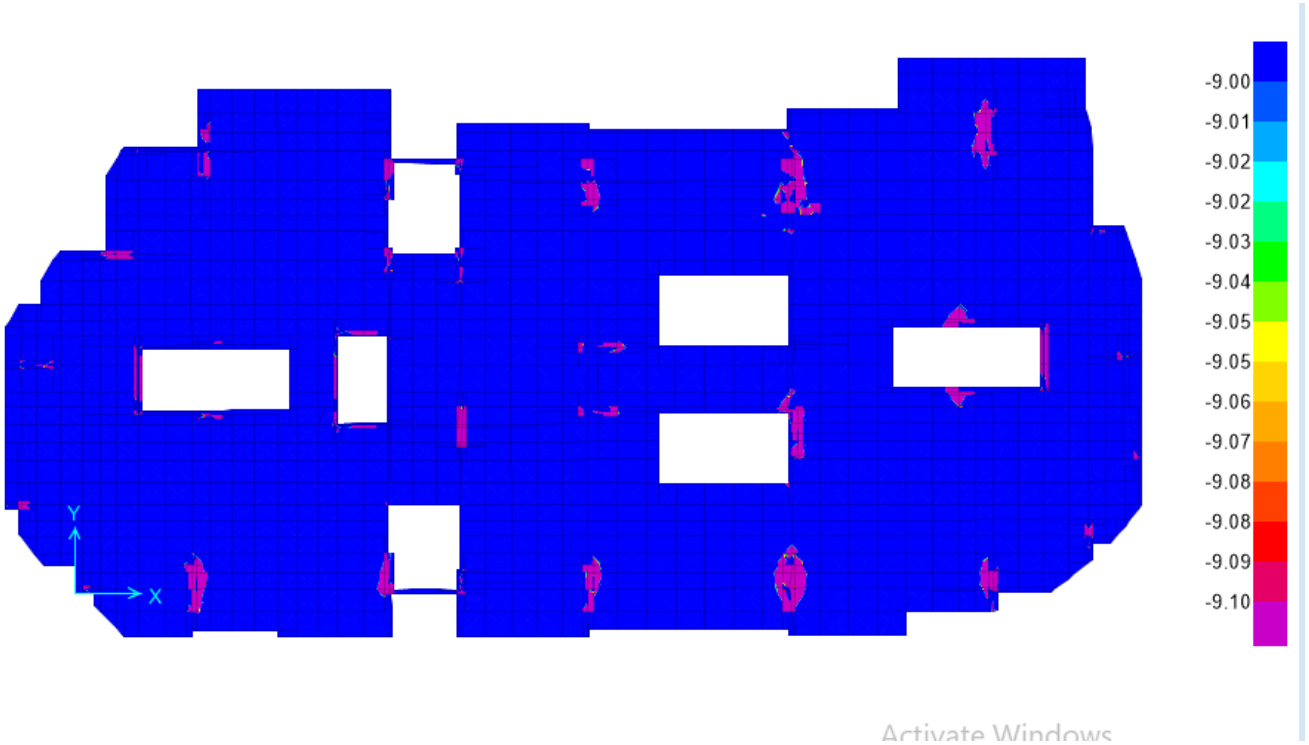


Figure 2.17: M2.2 positive with additional

Check Negative Moment in Y Direction

	input
	output

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211



Activate Windows

Figure 2.18: M2.2 negative

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

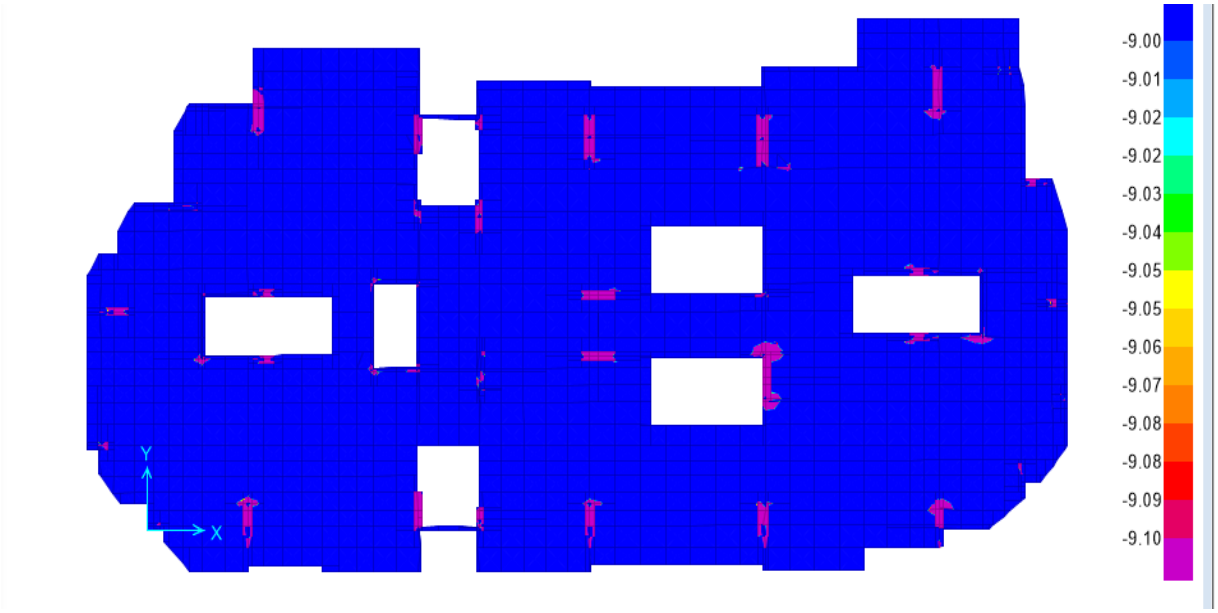
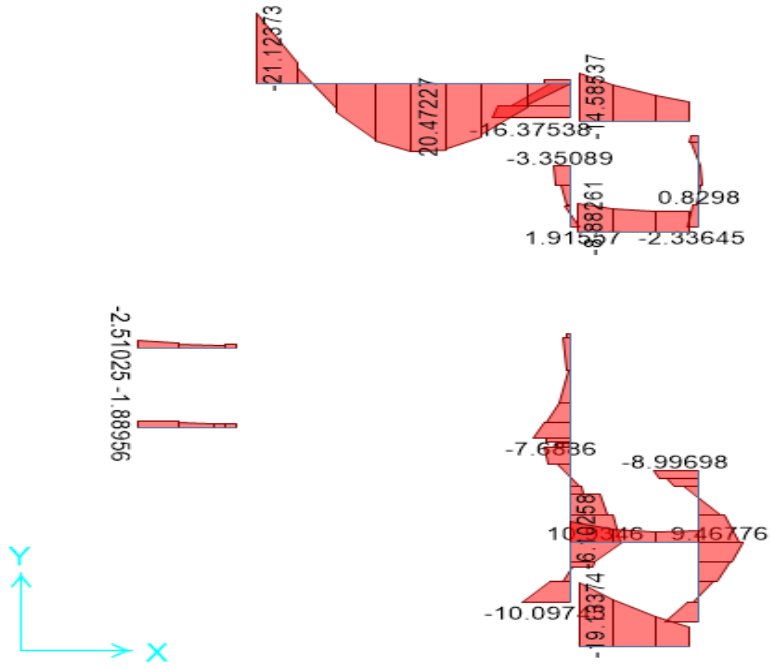


Figure 2.19: M2.2 negative with additional

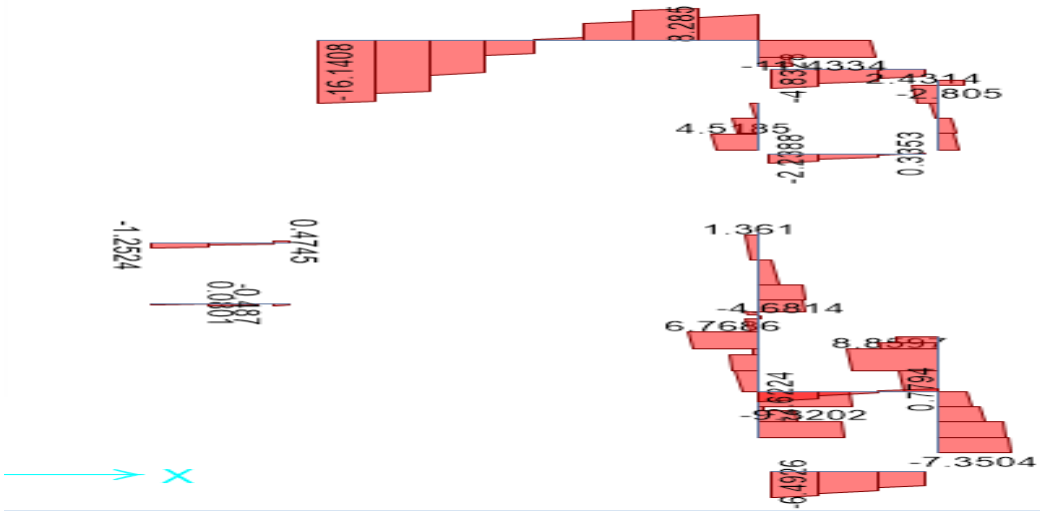
2.6.4Design of beams

Moment of beams



Activa

Shear of beams



check concrete dimension

Concrete F_{cu} =	400	kg/cm^2	R = RECTANGULAR SEC.
Steel F_y =	3500	kg/cm^2	L = L SEC.
			T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	21	25	25	70	4.830	0.826	5.50	10.38	3 ϕ 22	safe

Cmin	2.78

Design of beam

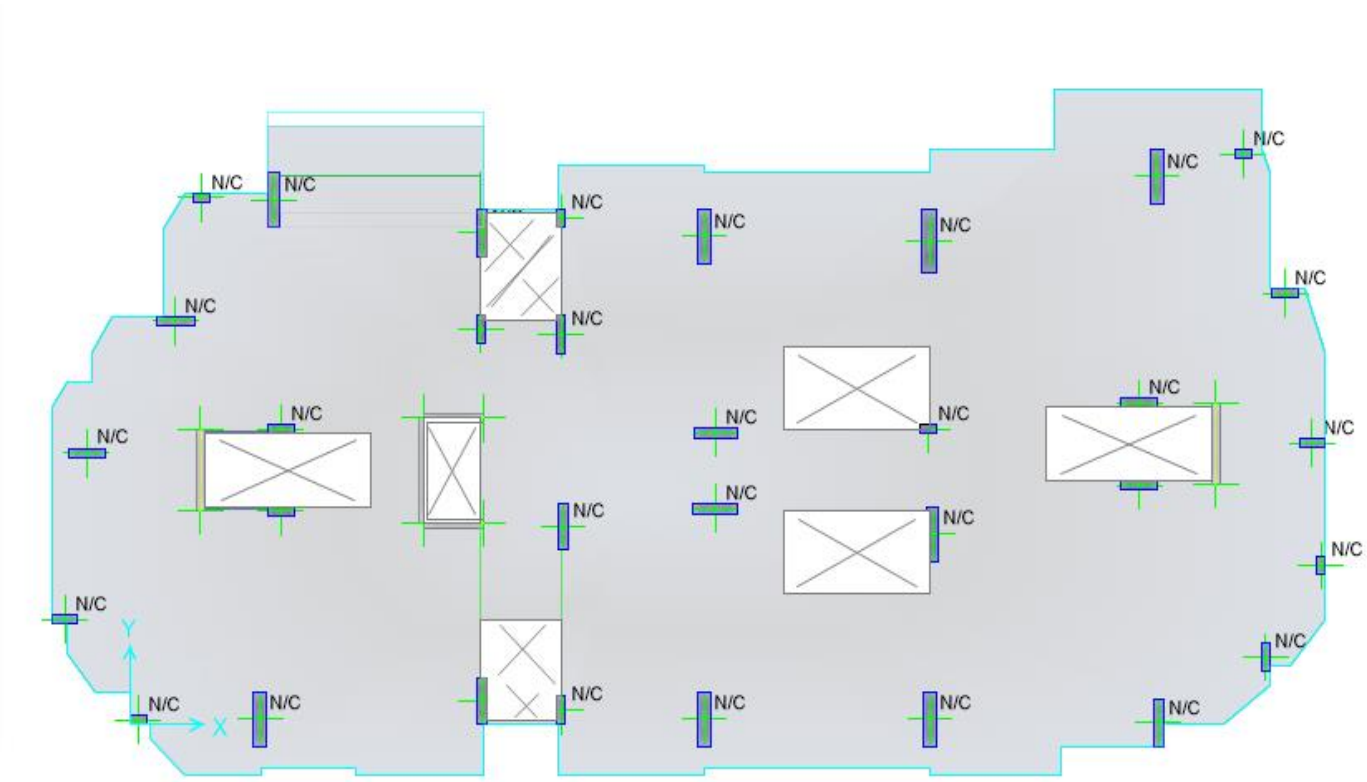
Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	5	12	565.4866777	350	750	725	0.72	0.9	9.3
B2	7	16	1407.433509	350	750	725	0.72	0.9	23.1

check shear

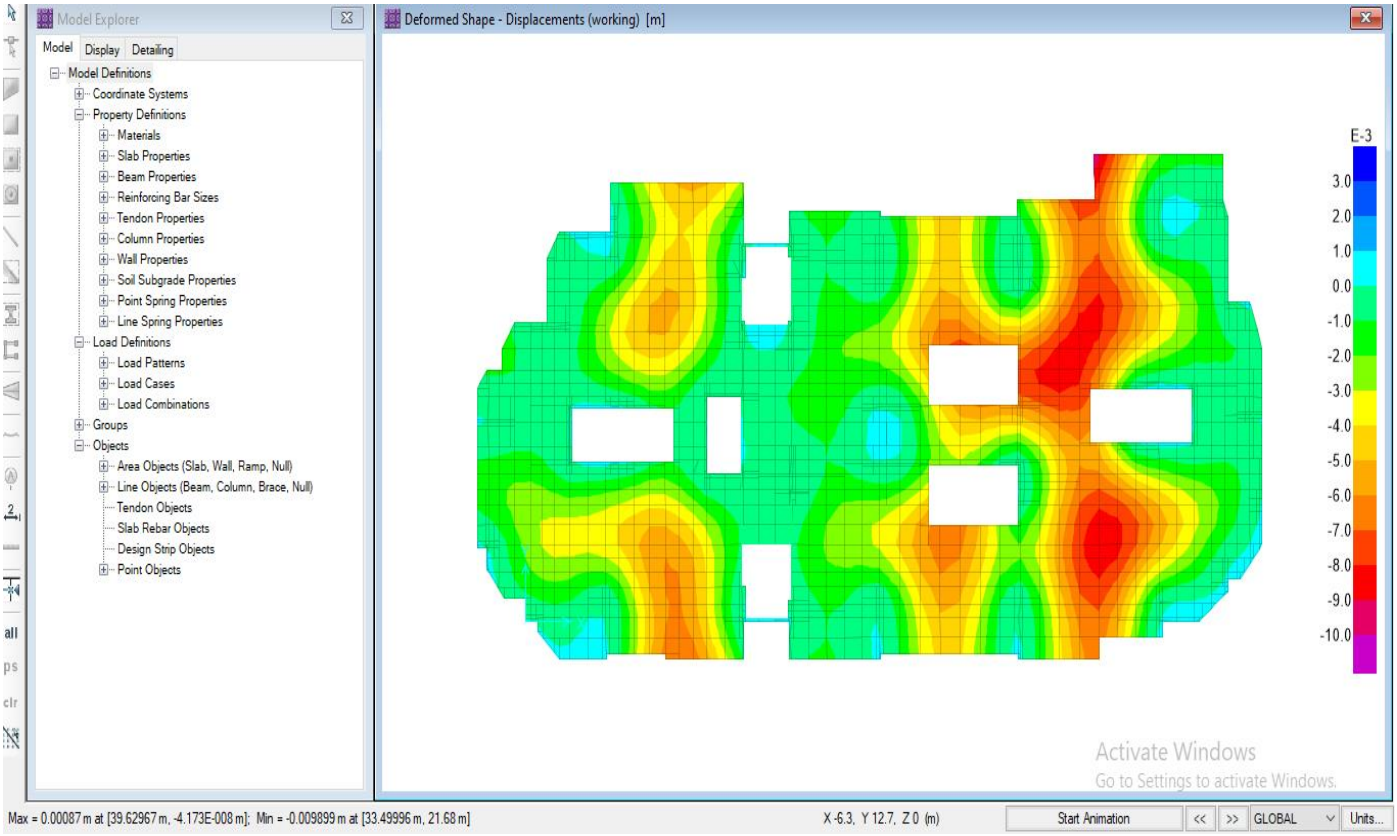
Concrete F_{cu} =	400	kg/cm²
Concrete q_{all} =	12.247	kg/cm²
Stirrups F_y =	3500	kg/cm²

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm²)	As / S	no. of bran.	Stirrups	Notes
	21	25	75	11.20	0.042	2	5 ϕ 8	safe

check punching



check deflection



Δ max = 1 cm

Δ all = span / 250

Δ all = 1000 / 250 =

4cm SAFE DEFLECTION

2.7. 1.Design of the typical floors

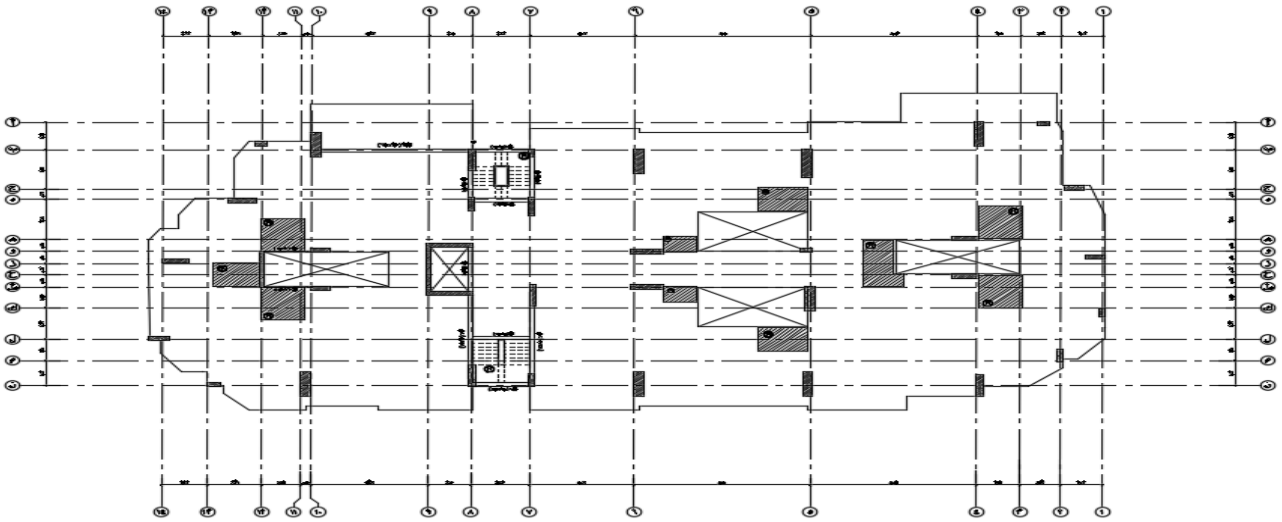
2.7.1Design notes

- The typical floor is designed in flat slab system

Designed on:

- Own wight calculated by safe
- Live load = 300 kg/cm²
- Walls load on Beams = 0.5 T/m
- Walls on flat slab = 0.5 T/m²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 400 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)
- Brick weight = 1.8 t/m³

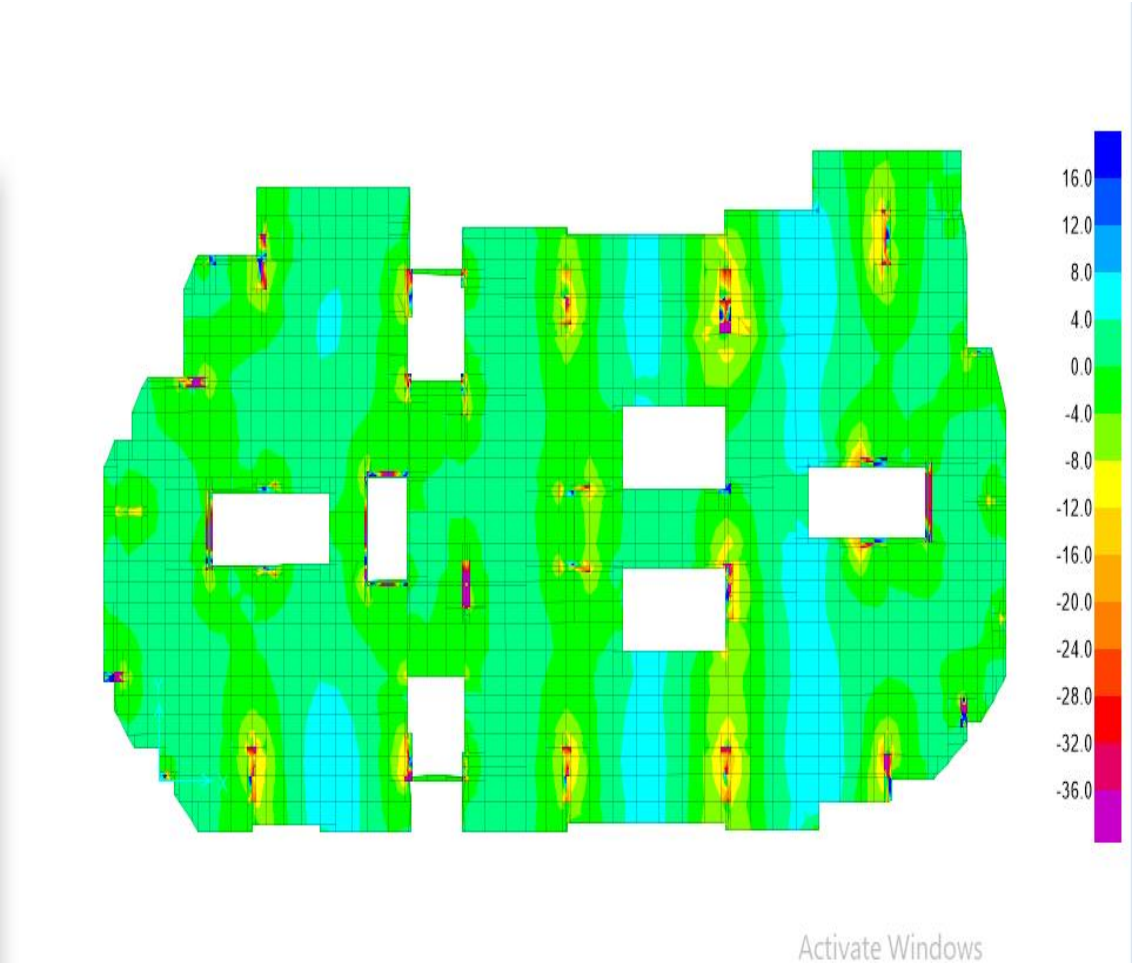
2.7.2 Statical system



2.7.3 Design of slabs

- Take Ts = 25 cm

Moment of X direction



Check Positive Moment in X Direction

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

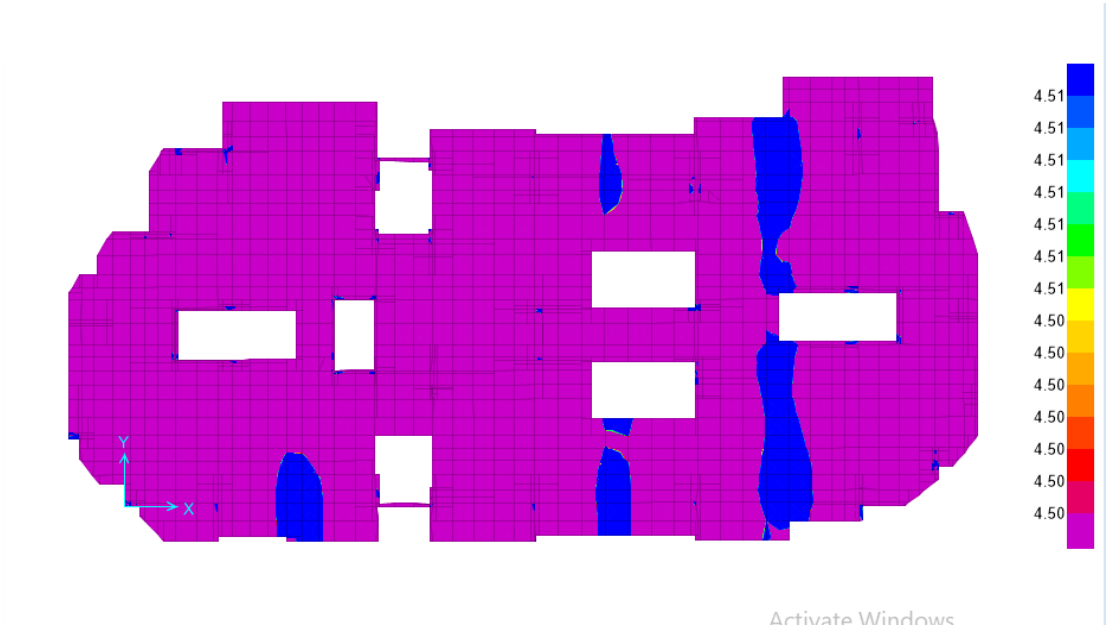


Figure 2.20: M1.1 positive

Additional	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211
						Total		9.02

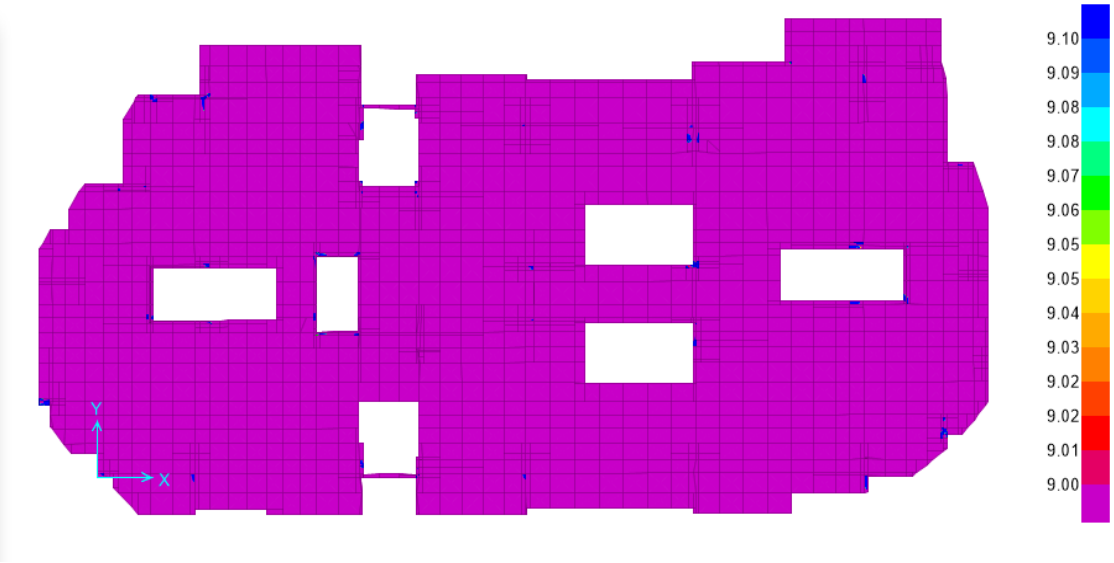
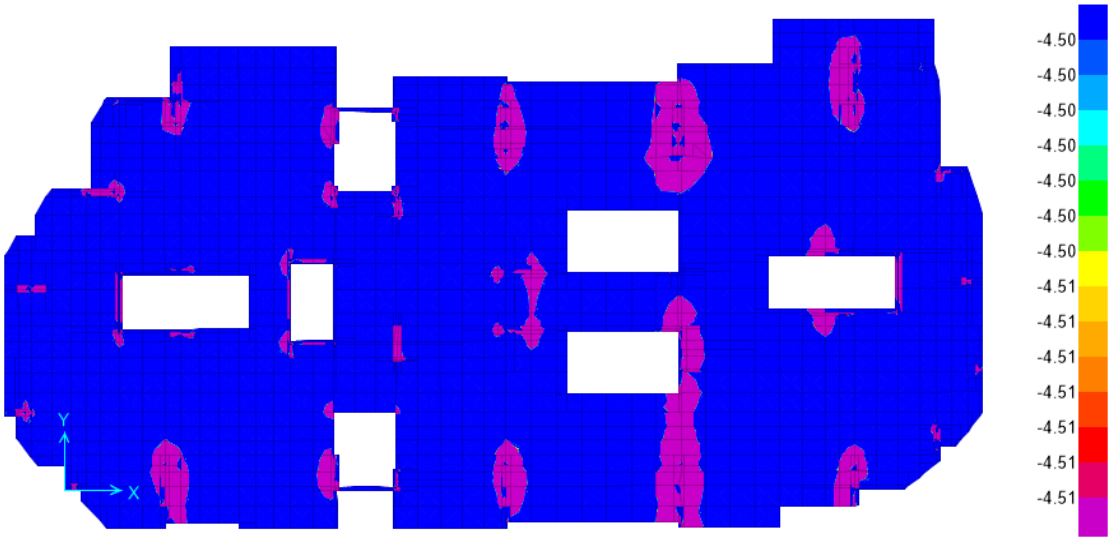


Figure 2.21: M1.1 positive with additional

Check Negative Moment in X Direction

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211



Activate Windows

Figure 2.22: M1.1 positive

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

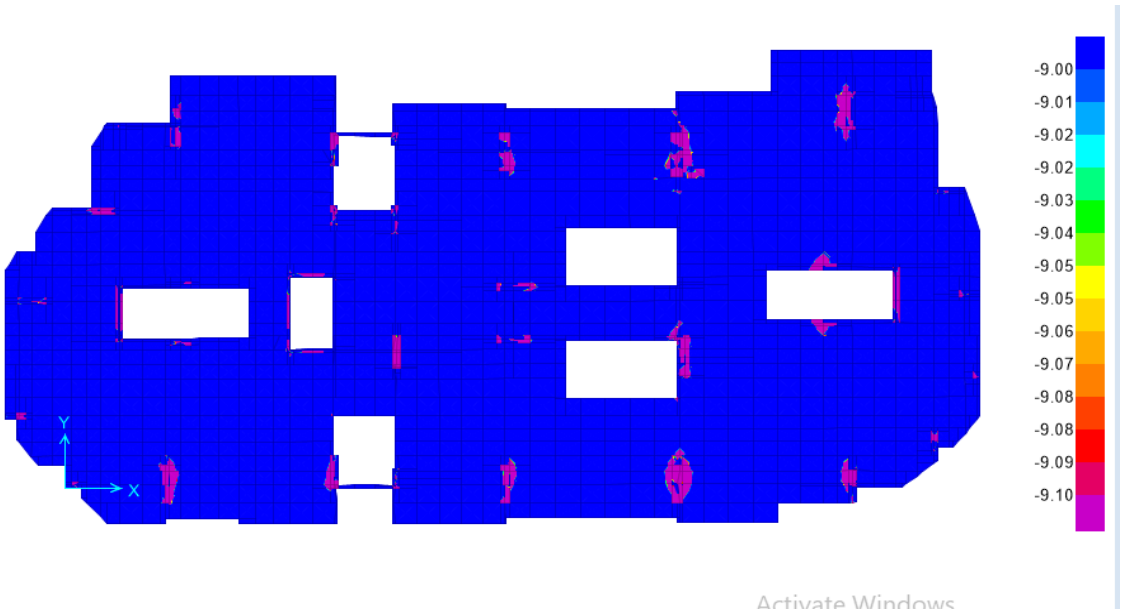
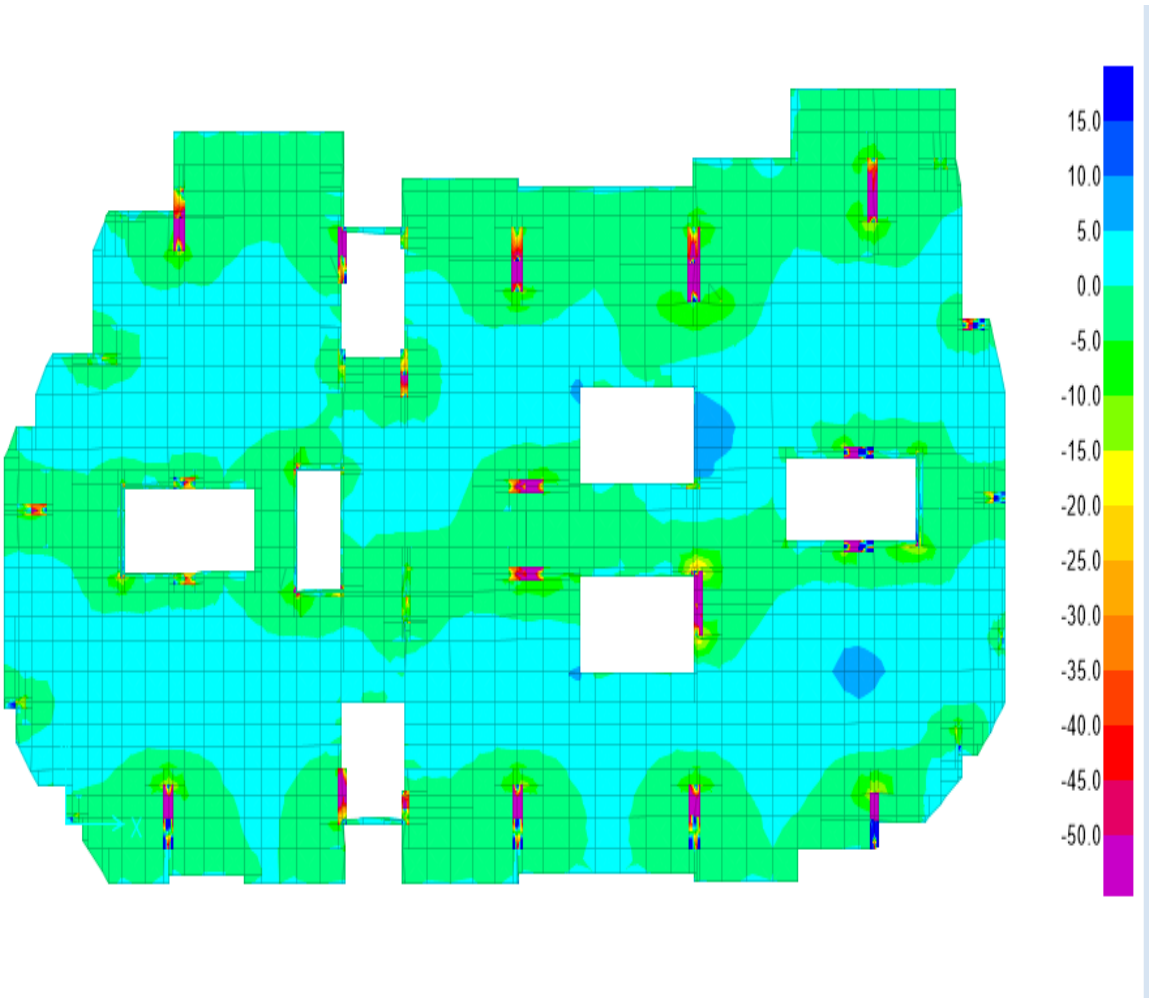


Figure 2.23: M1.1 positive with additional

Moment of Y direction



Check Positive Moment in Y Direction

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

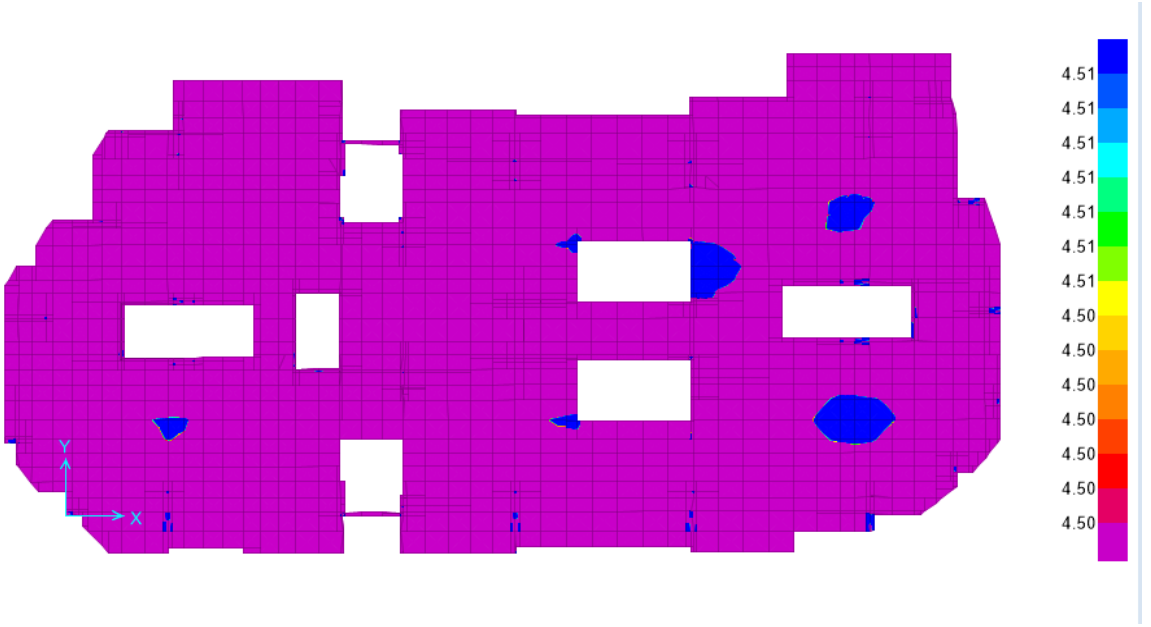


Figure 2.24: M2.2 positive

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211

Total	9.02

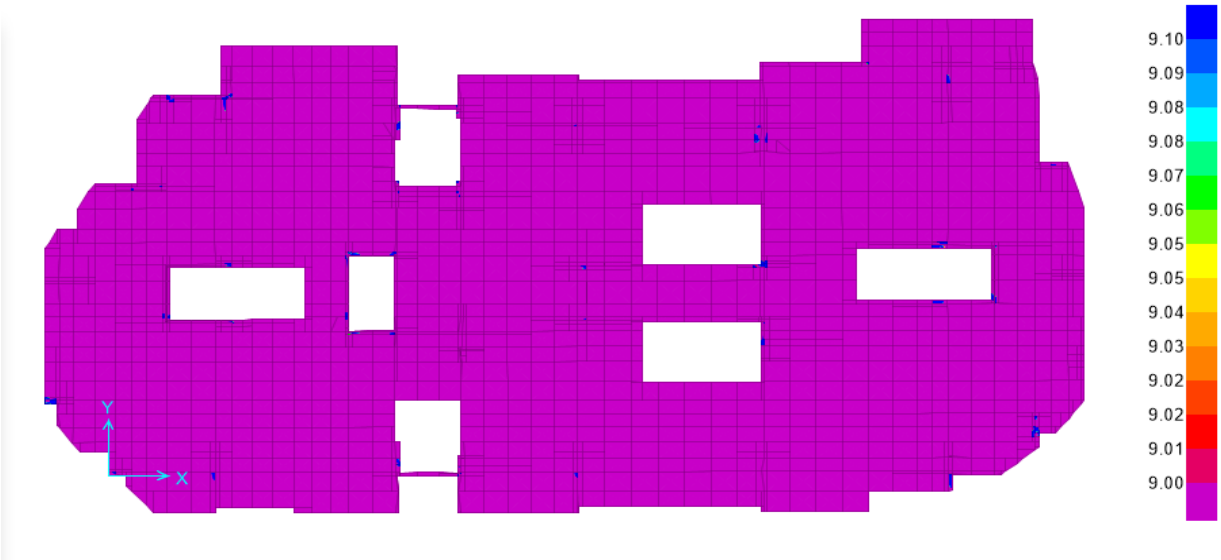


Figure 2.25: M2.2 positive with additional

Check Negative Moment in Y Direction

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	12	678.584	350	250	230	0.826	4.51211

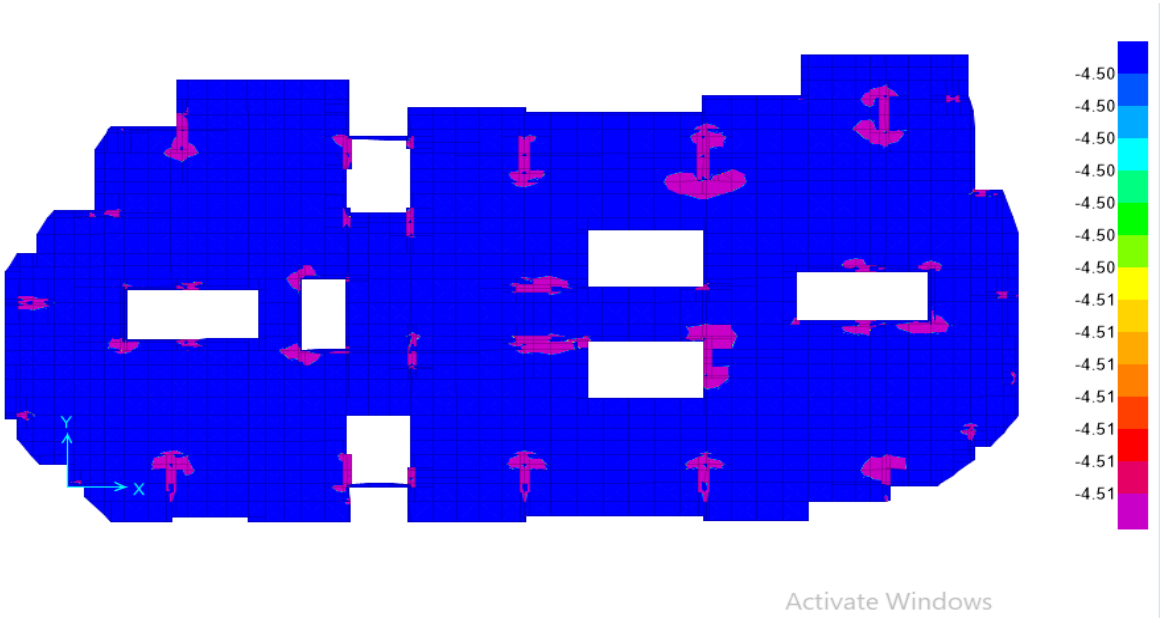


Figure 2.26: M2.2 negative

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	3	12	678.584	350	250	230	0.826	4.51211
						Total		9.02

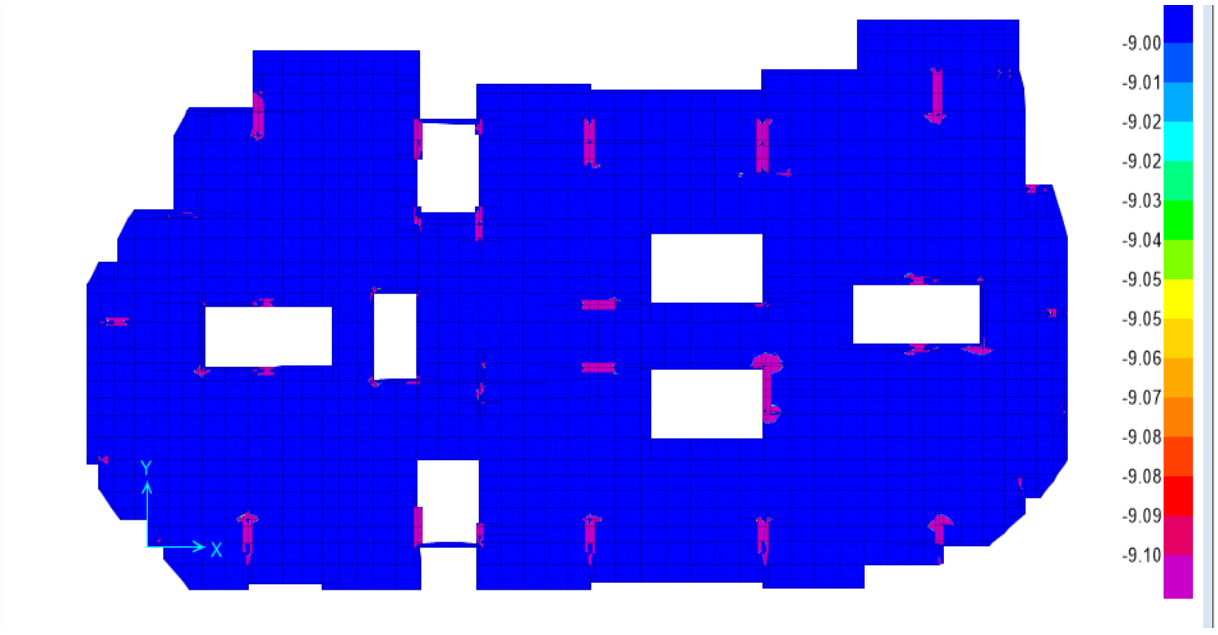
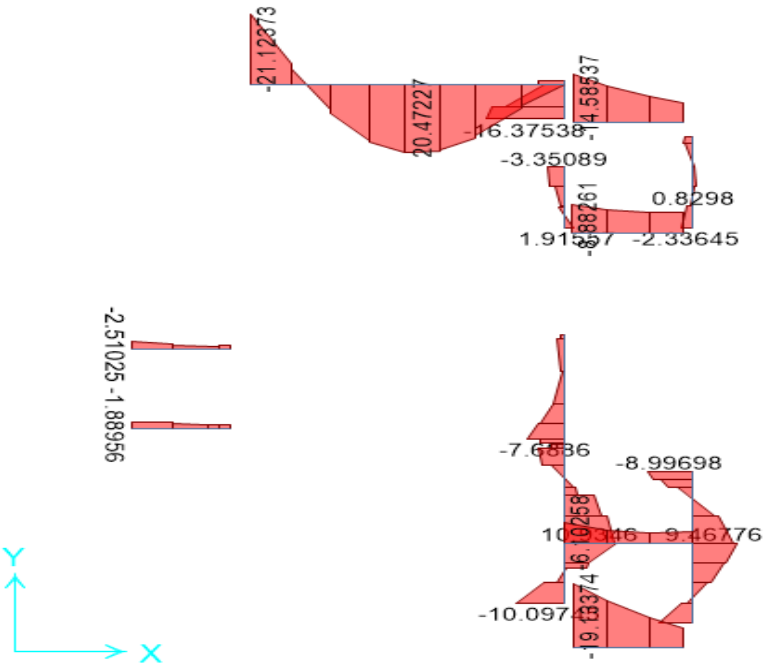


Figure 2.27: M2.2 negative with additional

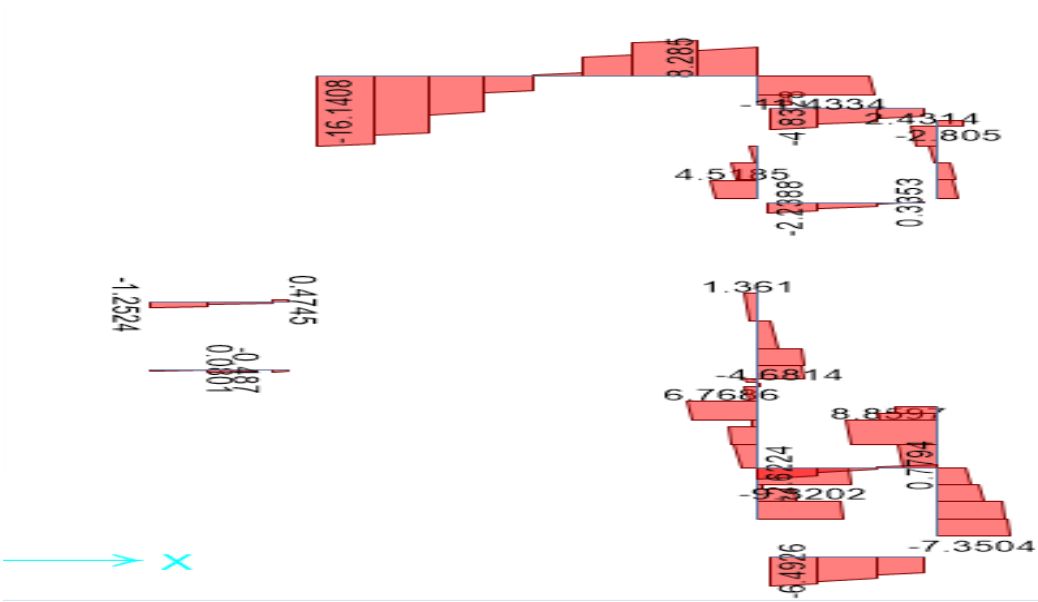
2.7.4.Design of beams

Moment of beams



Activa

Shear of beam



check concrete dimension

Concrete F_{cu} =	400	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.		Notes
	21	25	25	70	4.830	0.826	5.50	10.38	3 ϕ	22	safe

Cmin	2.78

Design of beam

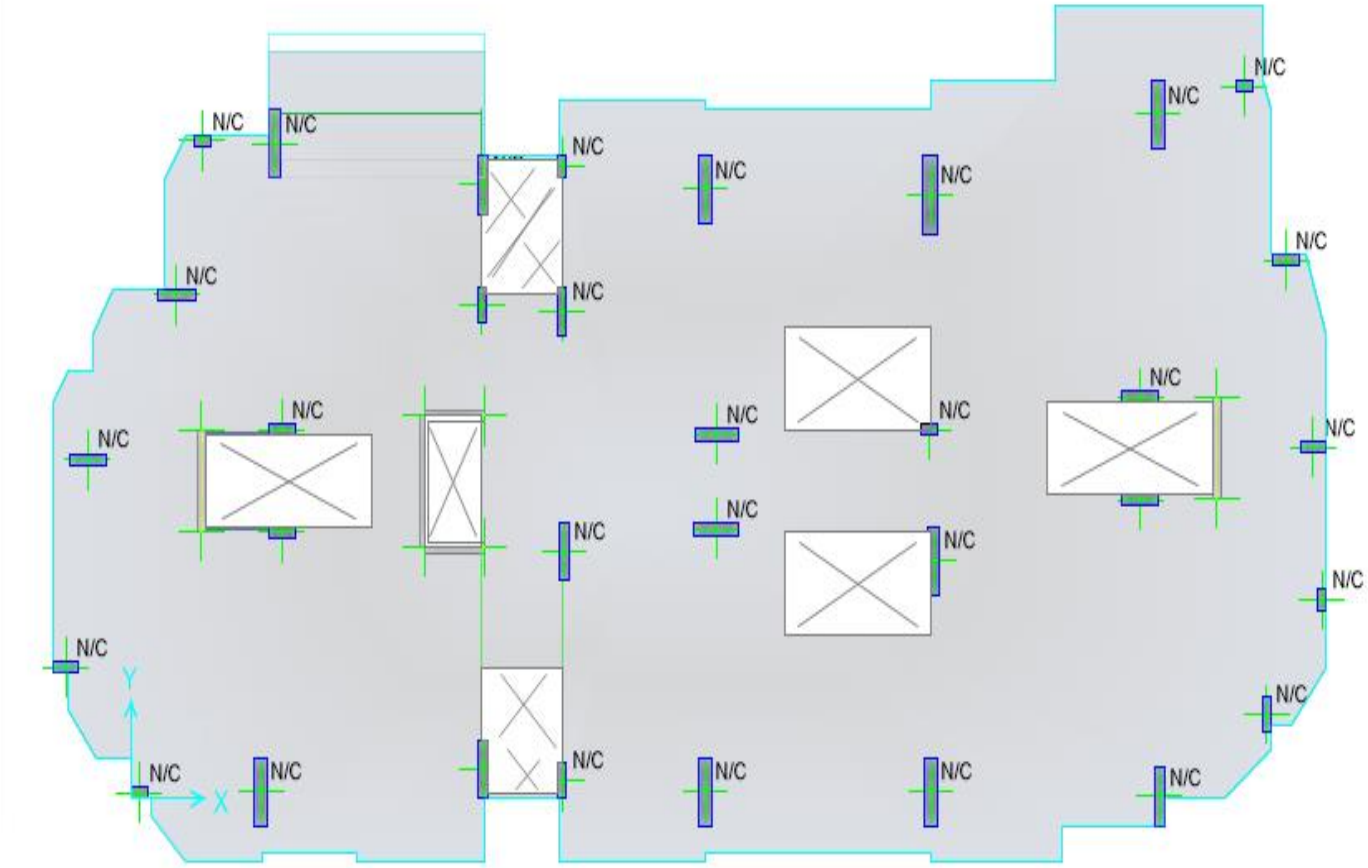
Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	5	12	565.4866777	350	750	725	0.72	0.9	9.3
B2	7	16	1407.433509	350	750	725	0.72	0.9	23.1

check shear

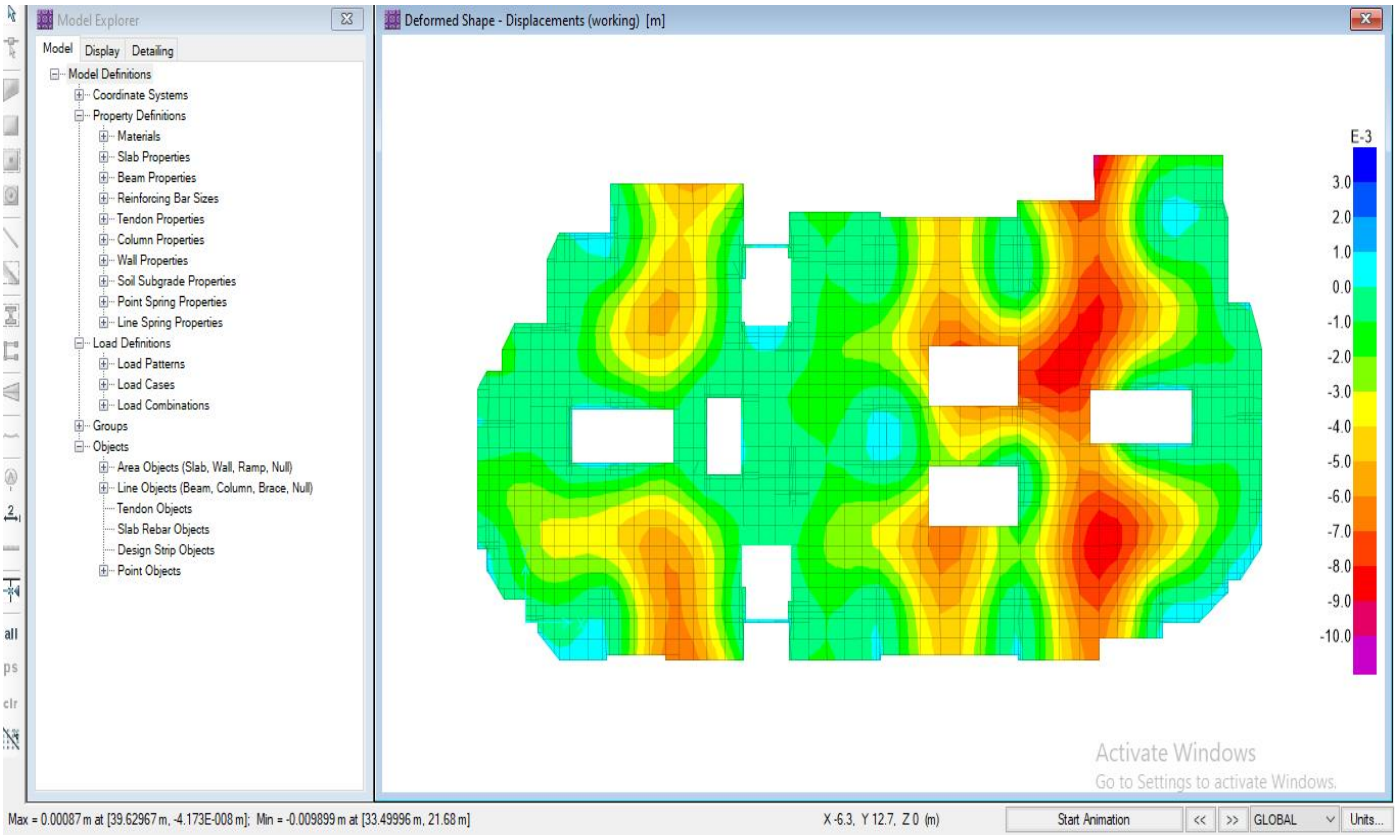
Concrete F_{cu} =	400	kg/cm²
Concrete q_{all} =	12.247	kg/cm²
Stirrups F_y =	3500	kg/cm²

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm²)	As / S	no. of bran.	Stirrups	Notes
	21	25	75	11.20	0.042	2	5 ϕ 8	safe

check punching



check deflection



Δ max = 1cm

Δ all = span / 250

Δ all = 1000/ 250 = 4 cm SAFE DEFLECTION

2.8. Design of the roof floors

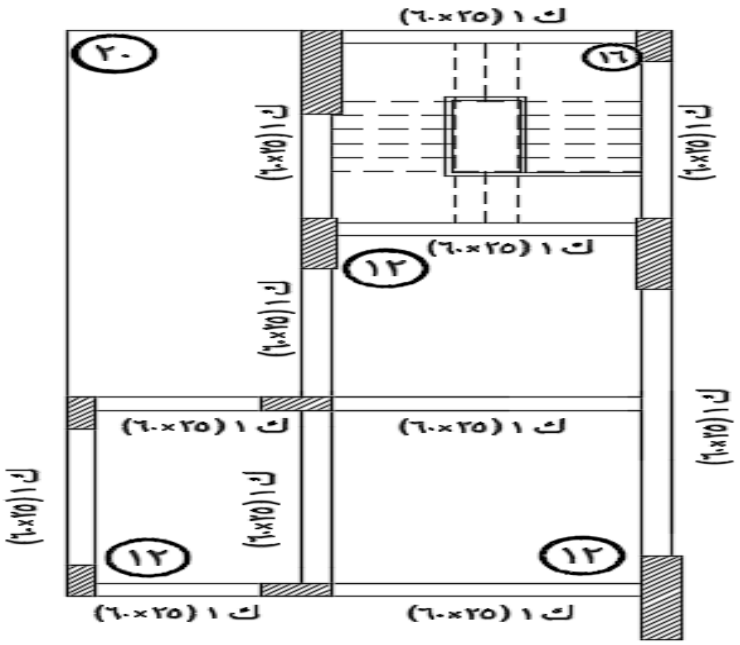
2.8.1 Design Notes

- The typical floors is designed in solid and flat slab system

Designed on:

- Own wight calculated by sap
- Live load = 200 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 400 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2400 kg/cm²)

2.8.2. Statical system



2.8.3. Moment of Solid slab

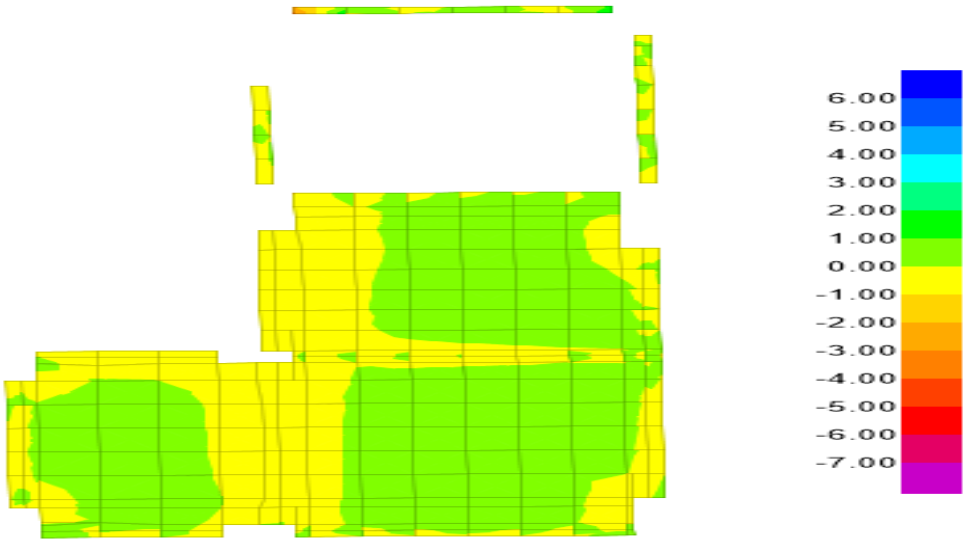


Figure 2.28.: M1.1 positive

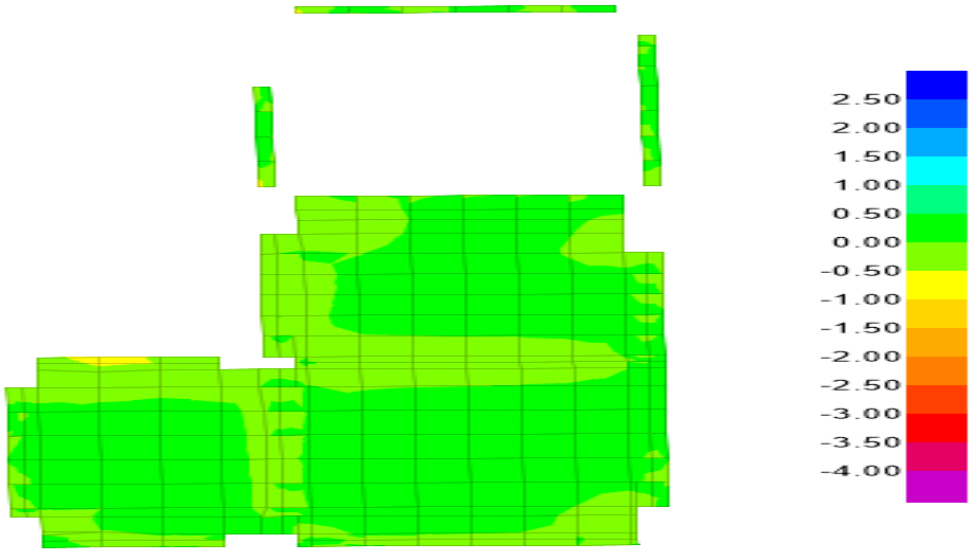


Figure 2.29: M2.2 positive

2.8.4.Moment of Flat Slab

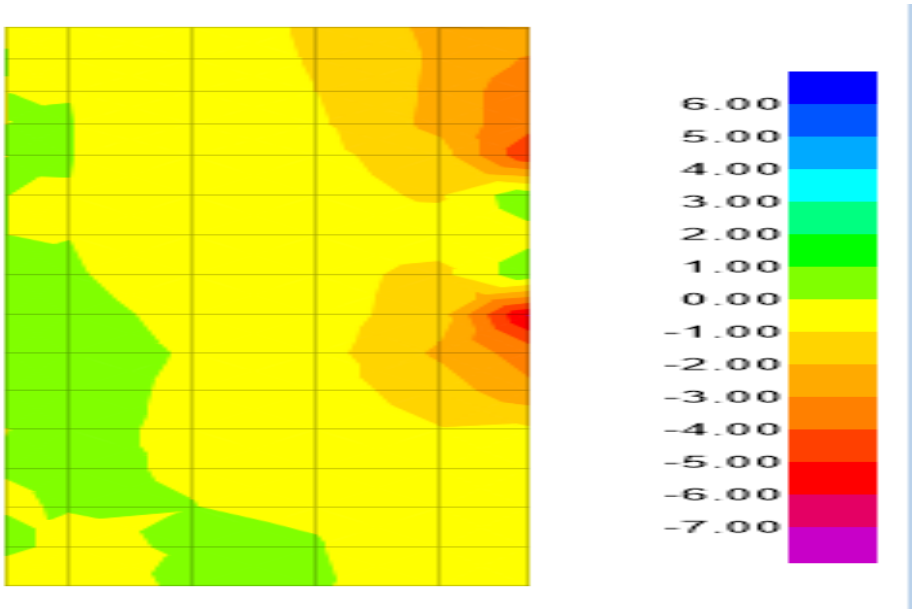


Figure 2.30: M1.1 positive

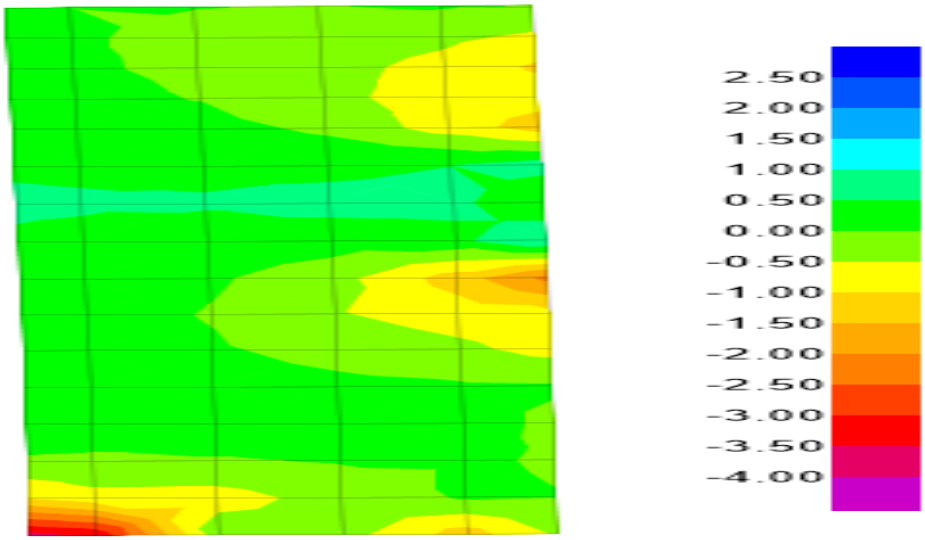


Figure 2.31: M2.2 positive

2.8.5. Design of slabs

- *Flat slab (ts = 16 cm) , Solid slab (ts =12cm)*

REINFORCEMENT FOR SOLID SLAB

For slab *ts = 12cm*

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529



Figure 2.32: M1.1

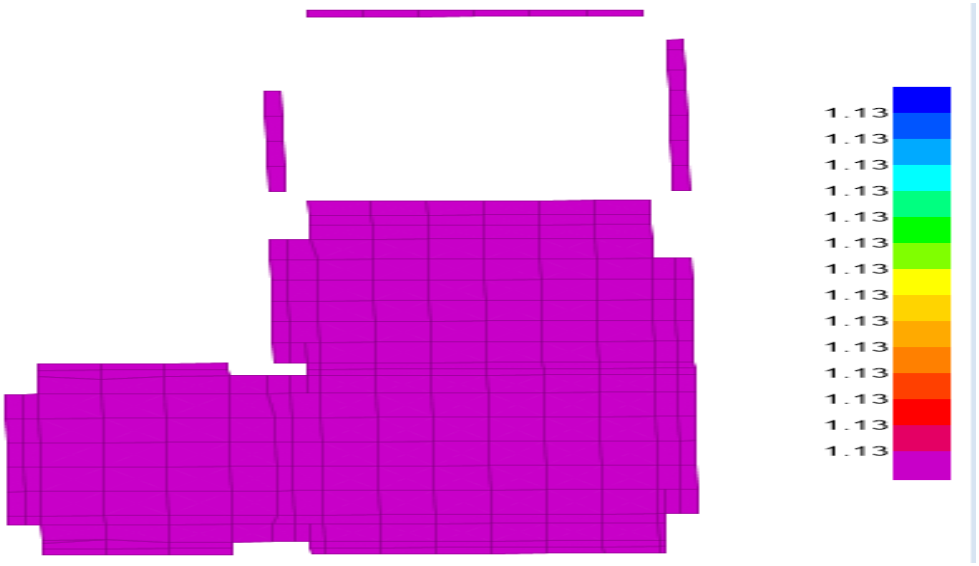


Figure 2.33: M2.2

BOTTOM REINFORCEMENT FOR FLAT SLAB:

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	160	140	0.826	1.58941



Figure 2.34: M1.1 positive



Figure 2.35: M2.2 positive

TOP REINFORCEMENT FOR FLAT SLAB:

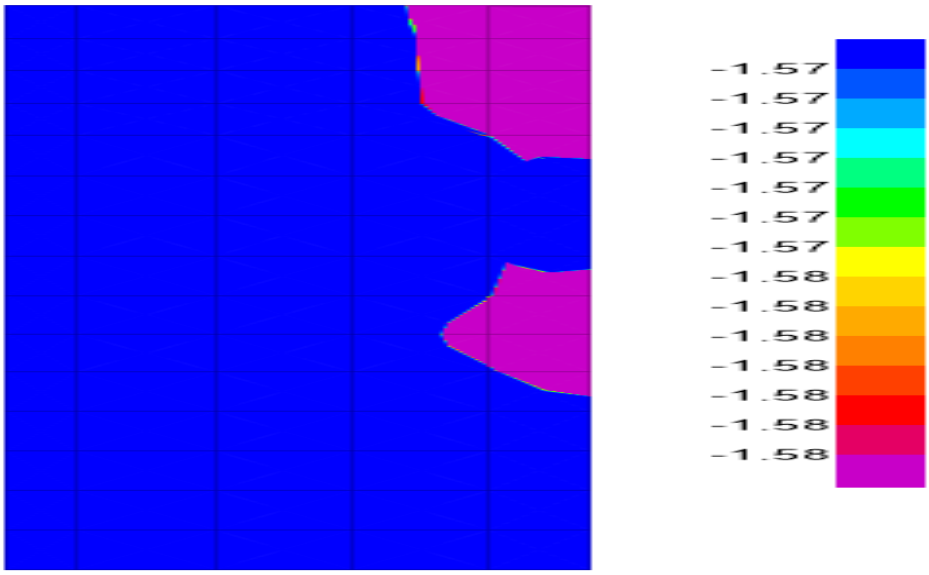


Figure 2.36: M1.1 negative additional

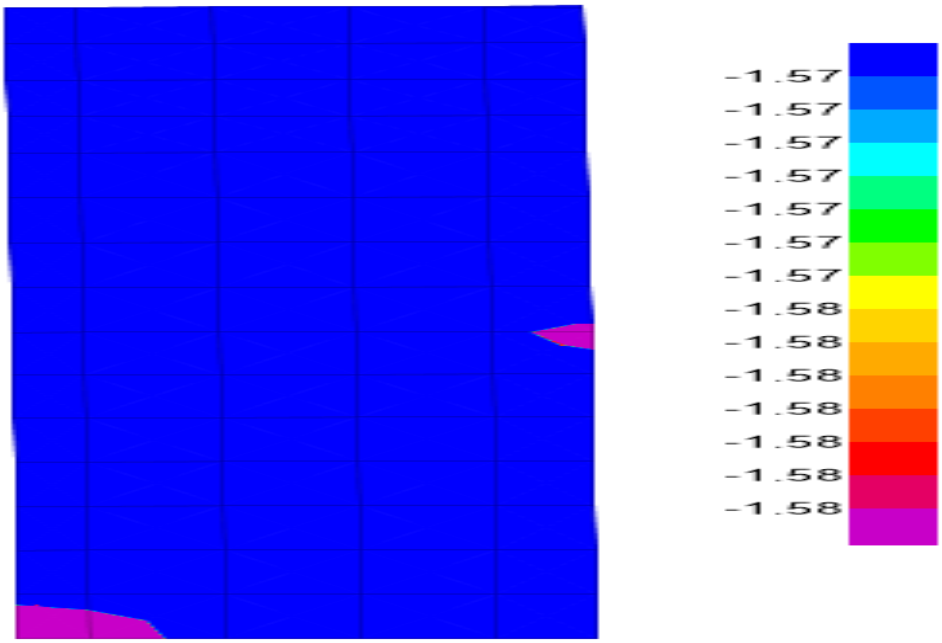


Figure 2.37: M2.2 negative additional

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	160	140	0.826	1.58941

Additional	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	4	10	314.159	350	160	140	0.826	1.27153

Total	2.86

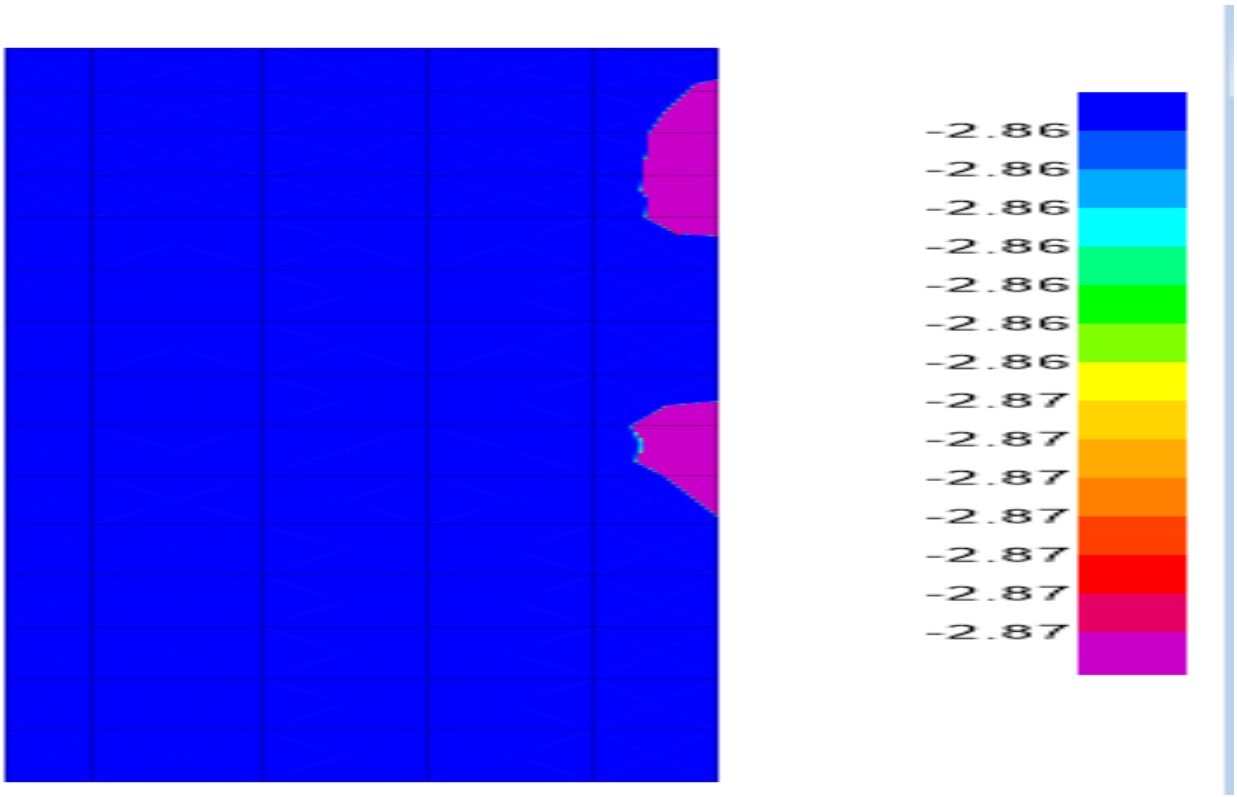
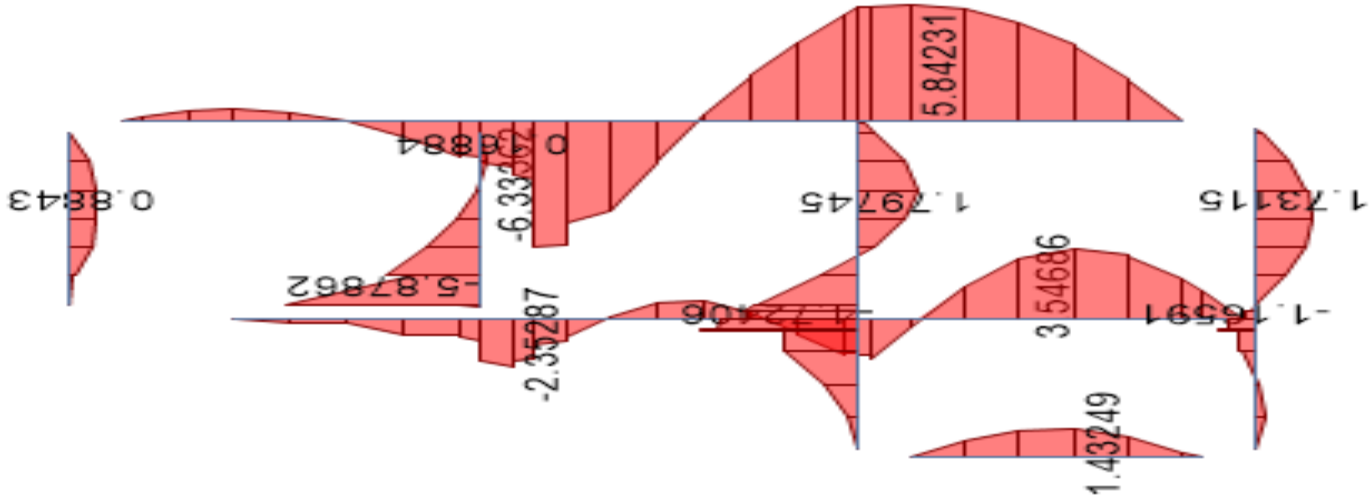


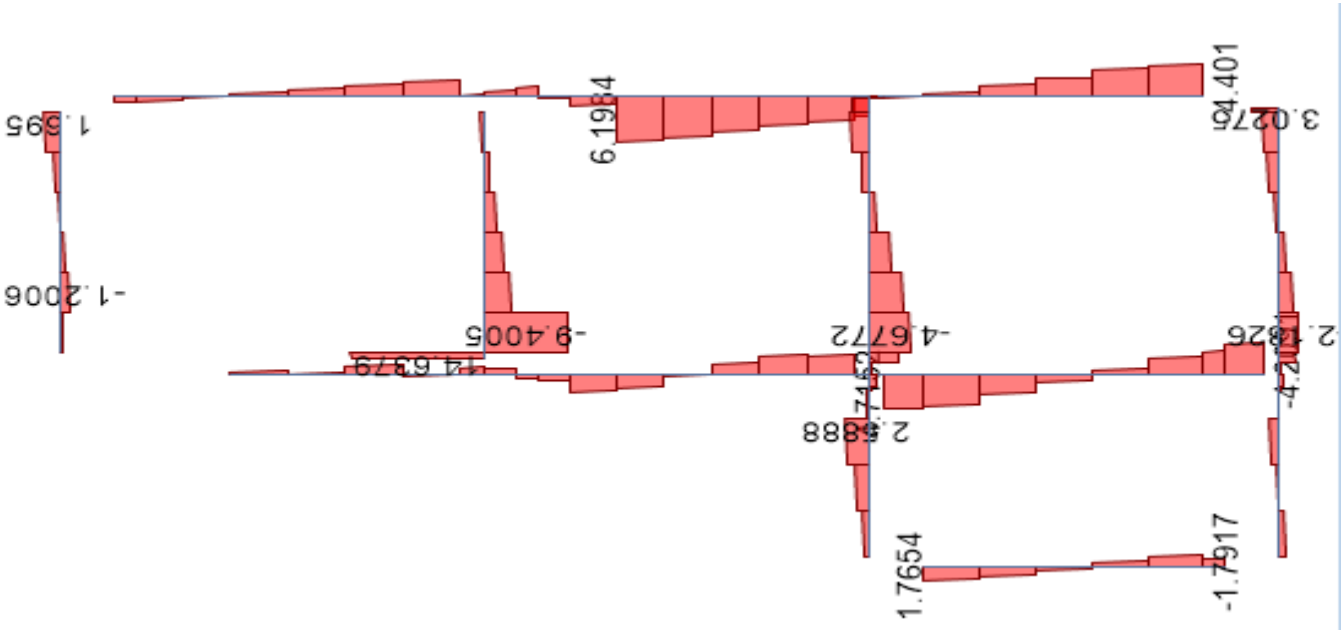
Figure 2.38: M1.1 negative additional

2.8.6. Design of beams

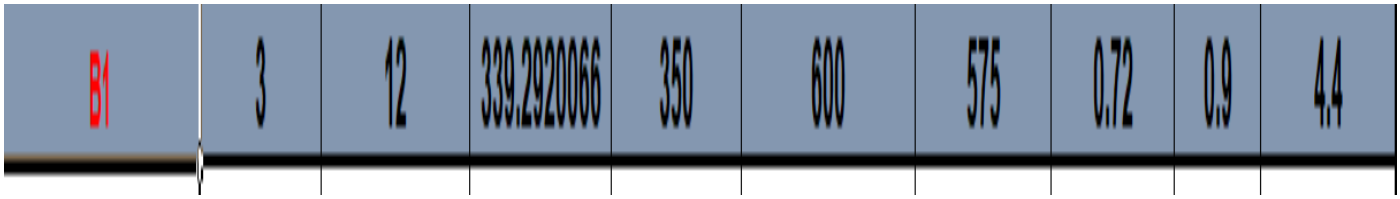
Moment of beams



Shear of beams



Design of beam

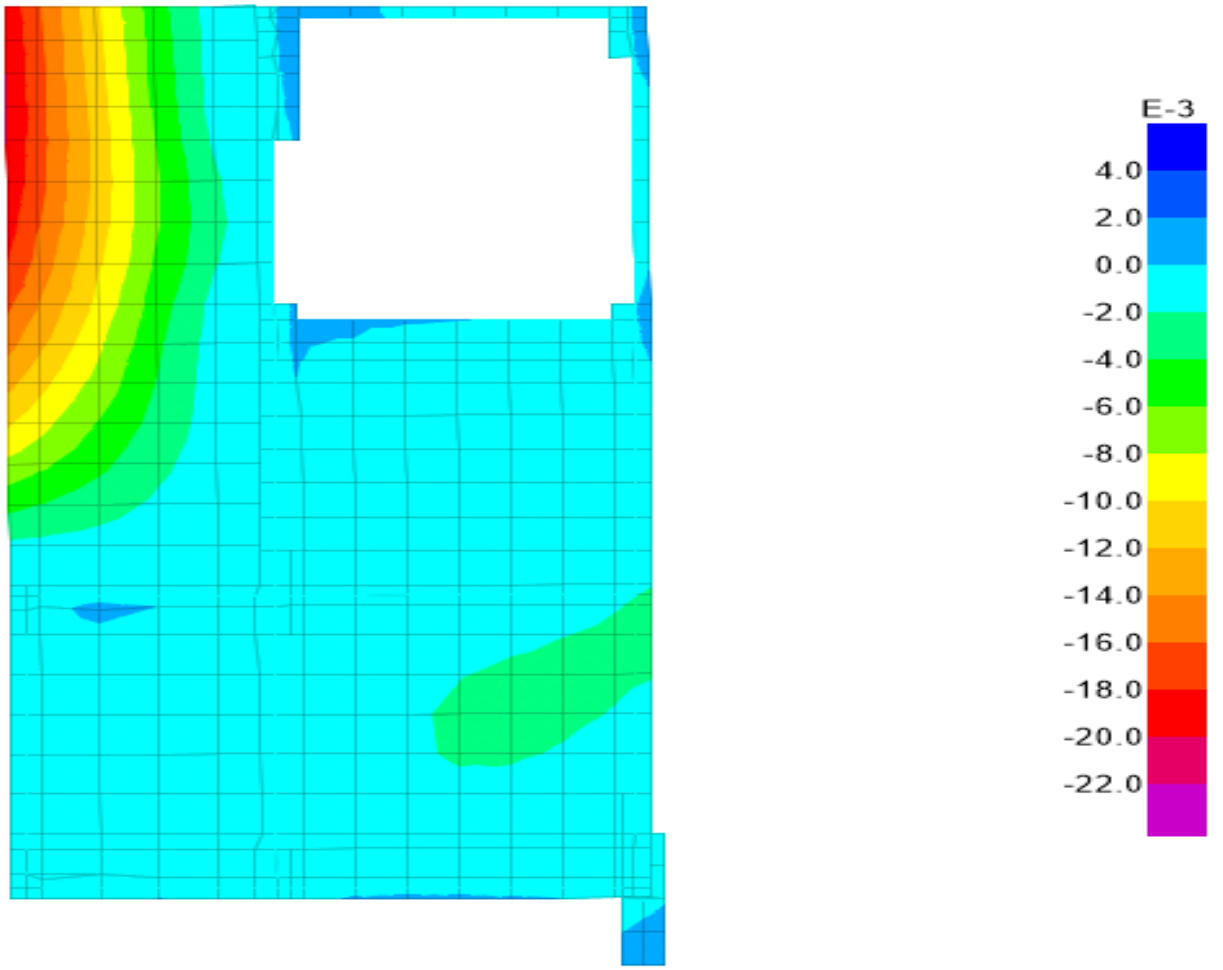


Check shear

Concrete F_{cu} =	400	kg/cm^2
Concrete q_{all} =	12.247	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	9	25	60	*6.00*	*-0.001*	2	*5* ϕ 8	***safe***

check of deflection



Δ max =1 cm

Δ all = span / 250

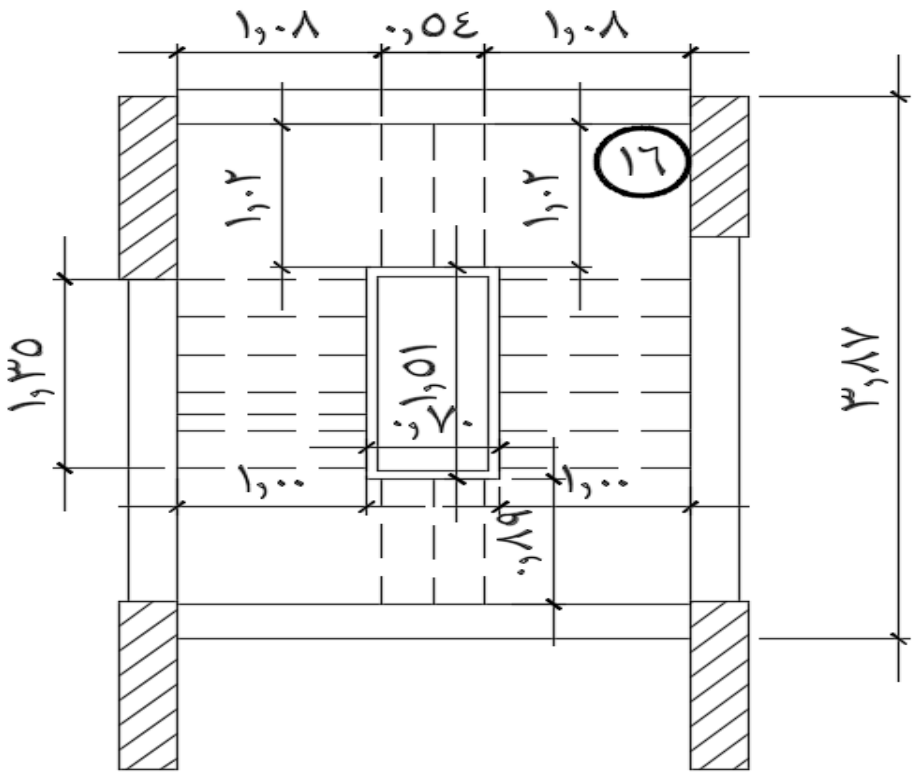
Δ all = 690 / 250 =2.7 cm

SAFE DEFLECTION

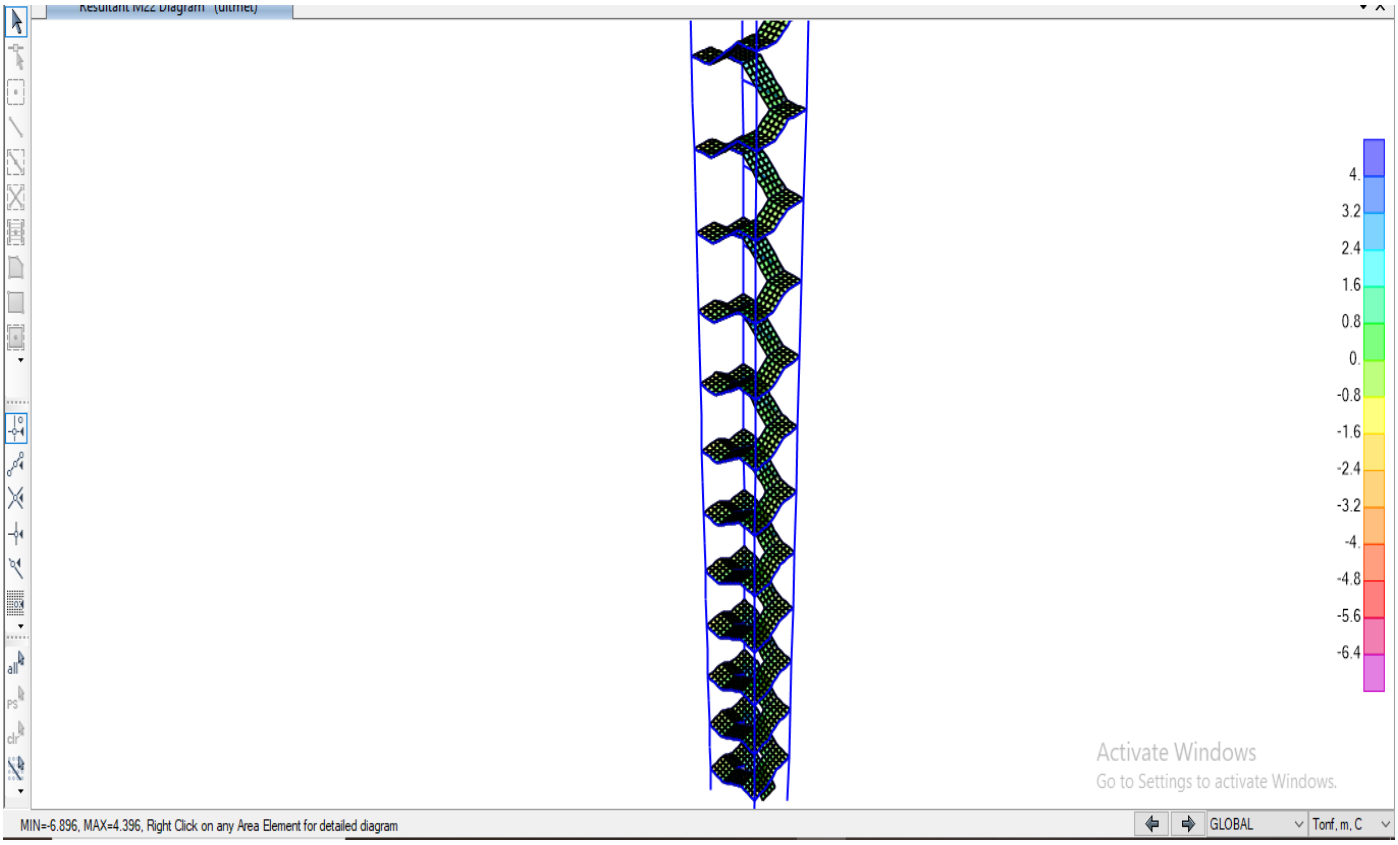
2.9. Design of stairs

2.9.1 Design of stairs

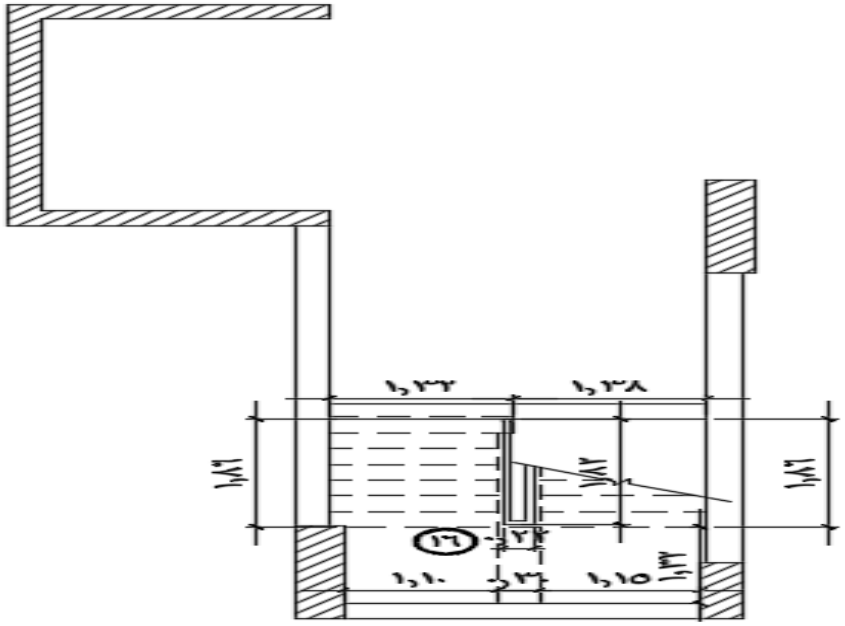
Upper stairs



Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	12	565.4867	350	160	140	0.826	2.288751



Lower stairs



Free standing stair

Input Data

Strength of Materials

fc' (kg/cm2) =	400
Fy (kg/cm2)	3500

Section details

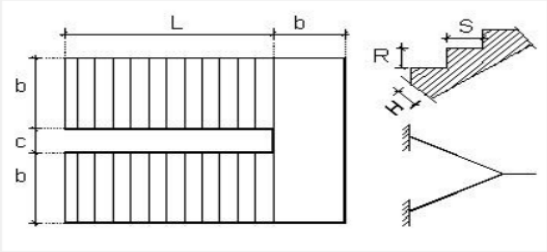
R (m) =	0.15
S (m)	0.3
H intial thickness (m) =	0.28
Concrete cover (m)	0.05

Dimensions

L (m) =	1.86
b (m) =	1.32
c (m) =	0.22

Loads

Live Load (t /m2)	0.5
Dead load (t/m2) =	0.2

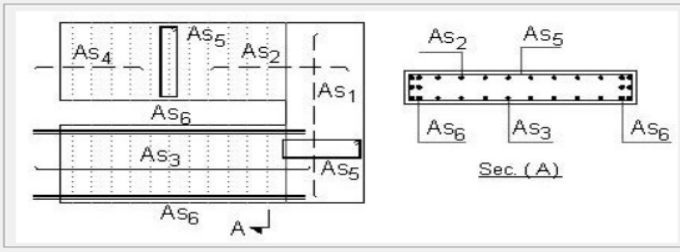


Design | Print Calculation to Excell | Print

Resuts

Reinforcement

	As (cm2)	Number / m		Diameter
As1	4.29	4	ϕ	12
As2	3.94	4	ϕ	12
As3	3.94	4	ϕ	12
As4	4.18	4	ϕ	12
As5 (Number/m.)		7	ϕ	12
As6	6.1	6	ϕ	12



2.10Seismic analysis

2.10.1 Seismic loads Calculations

Input Data	
Output Data	
Calculations	

SOIL TYPE A,B,C or D =	C
ZONE 1,2,3,4,5A or 5B =	2
REDUCTION FACTOR (R) =	5
Total Weight of building (TON)=	12627
TOTAL HEIGHT of building (m)=	42.14
IMPORTANCE FACTOR 1 or 1.2 =	1
Total Number Of Stories=	14

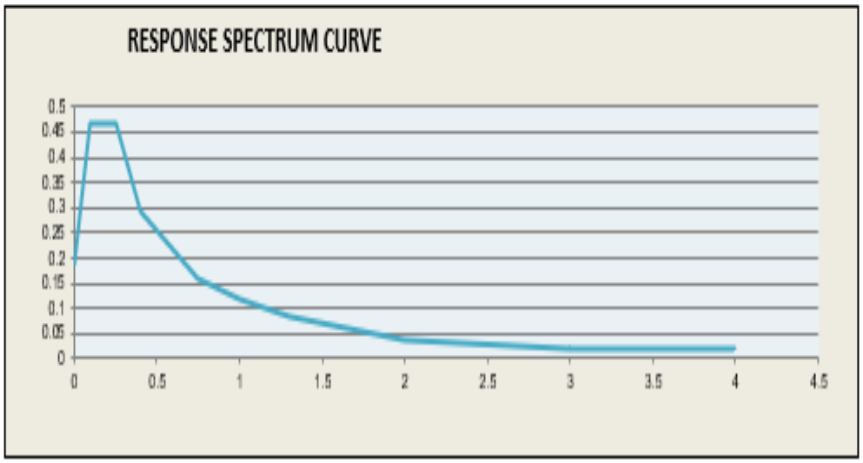
Soil Type	S	TB	TC	TD
C	1.5	0.1	0.25	1.2

TYPES OF SOIL	S	TB	TC	TD
A	1	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.1	0.25	1.2
D	1.8	0.1	0.3	1.2
REDUCTION FACTOR (R) =	5	1		

ZONE	1	2	3	4	5A	5B
a_g	0.1	0.13	0.15	0.2	0.3	0.3

Total building WEIGHT (TON	12627	
ag=	0.125	
H=	42.14	m
T1=Ct(H)^3/4=	0.827	Sec.
IMPORTANCE=	1	
CASE1	Sd(T)=	-0.1
CASE2	Sd(T)=	0.09
CASE3	Sd(T)=	0.03
CASE4	Sd(T)=	0.04
FINAL Sd(T)=	0.0283	
I =	1	
Total base shear Fb =	357.86	ton

Response Spectrum Functions											
T1=	0	0.1	0.25	0.4	0.75	1	1.2	1.3	2	3	4
SR	0.19	0.46875	0.47	0.293	0.1563	0.11719	0.0977	0.08321	0.04	0.02	0.02



Floor	hi	Wi (ton)	hi wi	Fi (ton)	Base Moment	
1	3.07	901.9	2768.9	3.47	10.64	47.59
2	6.14	901.9	5537.8	6.93	42.57	44.20
3	9.14	901.9	8243.6	10.32	94.34	40.81
4	12.14	901.9	10949.3	13.71	166.44	37.42
5	15.14	901.9	13655.1	17.10	258.86	34.04
6	18.14	901.9	16360.9	20.49	371.61	30.65
7	21.14	901.9	19066.6	23.87	504.68	27.26
8	24.14	901.9	21772.4	27.26	658.09	23.87
9	27.14	901.9	24478.1	30.65	831.82	20.49
10	30.14	901.9	27183.9	34.04	1025.88	17.10
11	33.14	901.9	29889.7	37.42	1240.26	13.71
12	36.14	901.9	32595.4	40.81	1474.98	10.32
13	39.14	901.9	35301.2	44.20	1730.02	6.93
14	42.14	901.9	38007.0	47.59	2005.38	3.47

2.10.2Check CM & CR

TABLE: Centers Of Mass And Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cum Mass X	Cum Mass Y	XCCM	YCCM	XCR	YCR	lx	ly			
		tonf-s^2/m	tonf-s^2/m	m	m	tonf-s^2/m	tonf-s^2/m	m	m	m	m					
Story1	D1	64.34139	64.34139	20.3314	9.0876	64.34139	64.34139	20.3314	9.0876	20.0153	7.5695	0.3161	1.5181	Lx	Ly	
Story2	D2	69.08955	69.08955	20.5836	9.8058	69.08955	69.08955	20.5836	9.8058	19.9348	7.5055	0.6488	2.3003	46.64	23.45	
Story3	D3	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	17.5639	9.0148	1.9117	0.1632	6.996	3.5175	15%
Story4	D4	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	16.5731	9.0986	2.9025	0.0794	5.1649	2.3003	max
Story5	D5	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	16.0625	9.1249	3.4131	0.0531			
Story7	D6	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.6168	9.1525	3.8588	0.0255			
Story6	D6	16.88195	16.88195	19.4756	9.178	33.76391	33.76391	19.4756	9.178	15.7795	9.1406	3.6961	0.0374			
Story8	D7	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.5229	9.1624	3.9527	0.0156			
Story9	D8	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.4702	9.171	4.0054	0.007			
Story10	D9	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.4426	9.1787	4.033	-0.0007			
Story11	D11	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.4291	9.1855	4.0465	-0.0075			
Story12	D12	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.4214	9.1913	4.0542	-0.0133			
Story13	D13	16.88195	16.88195	19.4756	9.178	16.88195	16.88195	19.4756	9.178	15.4117	9.196	4.0639	-0.018			
Story14	D14	61.47143	61.47143	20.5588	9.1523	61.47143	61.47143	20.5588	9.1523	15.3939	9.1993	5.1649	-0.047			

2.10.3Check displacement

TABLE: Story Max Over Avg Displacements

Story	Output Case	Case Type	Step Type	Step Number	Direction	Maximum	Average	Ratio			CM		ALL=TOTAL Hight/500	total Height
						m	m							
Story14	Ult	Combination			X	0.011302	0.003618	3.123	Act Dis X	0.0113	1.1302		8.414	42.14
Story14	sesimic1	Combination			X	0.007032	0.002356	2.985	Act Dis Y	0.0284	2.8399			
Story14	sesimic2	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic3	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic4	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic5	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic6	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic7	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic8	Combination			X	0.007032	0.002356	2.985						
Story14	sesimic9	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic10	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic11	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic12	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic13	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic14	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic15	Combination			X	0.005259	0.001788	2.941						
Story14	sesimic16	Combination			X	0.005259	0.001788	2.941						
Story14	Ult	Combination			Y	0.028399	0.010374	2.738						
Story14	sesimic1	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic2	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic3	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic4	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic5	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic6	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic7	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic8	Combination			Y	0.017221	0.006251	2.755						
Story14	sesimic9	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic10	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic11	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic12	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic13	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic14	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic15	Combination			Y	0.012766	0.004624	2.761						
Story14	sesimic16	Combination			Y	0.012766	0.004624	2.761						

2.10.4.Check drift

Story	Load Case/Combo	Direction	Max Drift
Story	Load Case/Combo	Direction	Max Drift
			m
Story14	sesimic1	X	0.000795
Story14	sesimic2	X	0.000795
Story14	sesimic3	X	0.000795
Story14	sesimic4	X	0.000795
Story14	sesimic5	X	0.000795
Story14	sesimic6	X	0.000795
Story14	sesimic7	X	0.000795
Story14	sesimic8	X	0.000795
Story14	sesimic9	X	0.000594
Story14	sesimic10	X	0.000594
Story14	sesimic11	X	0.000594
Story14	sesimic12	X	0.000594
Story14	sesimic13	X	0.000594
Story14	sesimic14	X	0.000594

Eng.Abdallh Mostafa		Concrete Design Diploma 2019
H	3	m
Max Drift	0.001998	m
Allowable Drift	0.015	m
Actual Drift	0.000999	m
check	SAFE	

Limitations of Interstorey Drift ٨-٨-٣-٢ حدود الحركة النسبية للدور

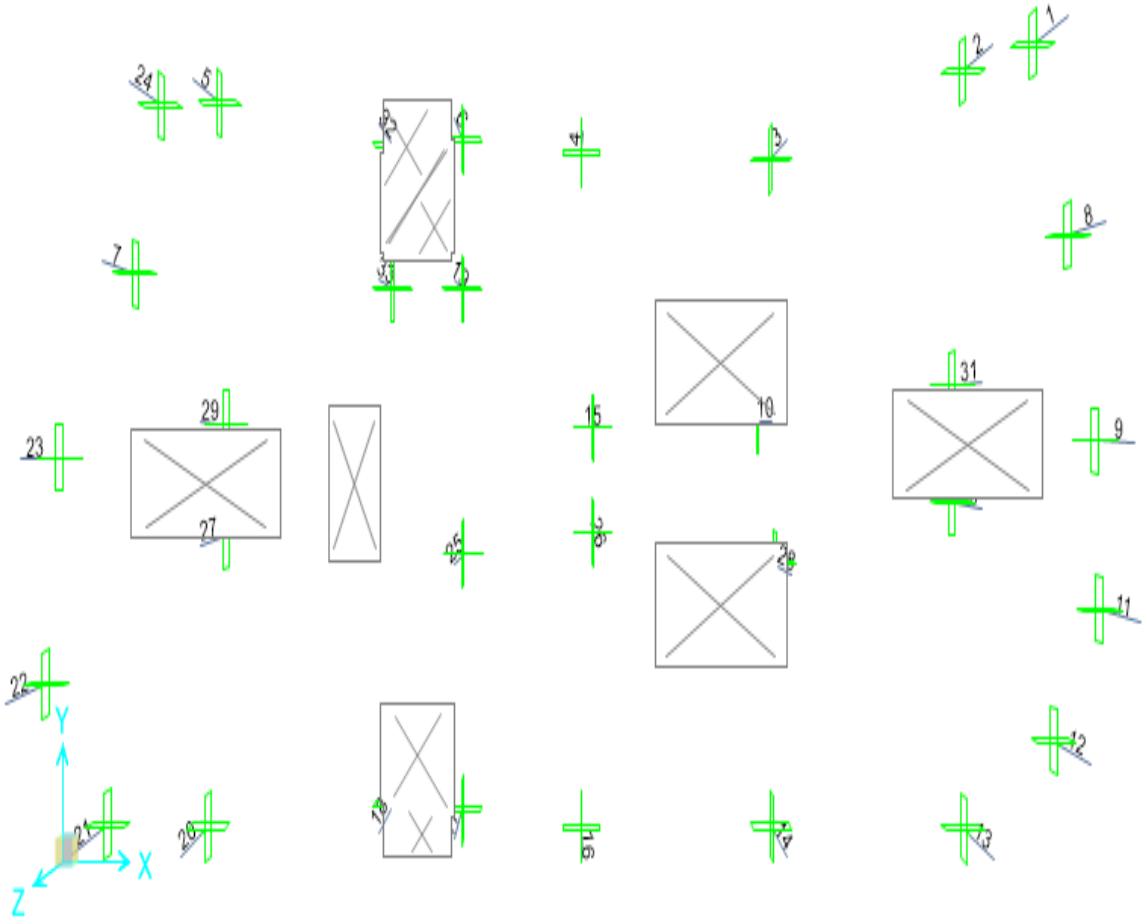
١ – ما لم يتم تحديد حدود الحركة النسبية للدور فى الكودات التصميمية للمواد المختلفة فانه يجب مراعاة الحدود التالية :

أ – للمنشآت التى بها عناصر غير إنشائية قصفة متلاصقة (مثل المباني الطوب غير المسلحة):

$$d_{rv} = d_r \cdot v \leq 0.0050\ h \qquad (8\text{-}30)$$

2.11.Columns

2.11.1.Design of columns



Activate Windows

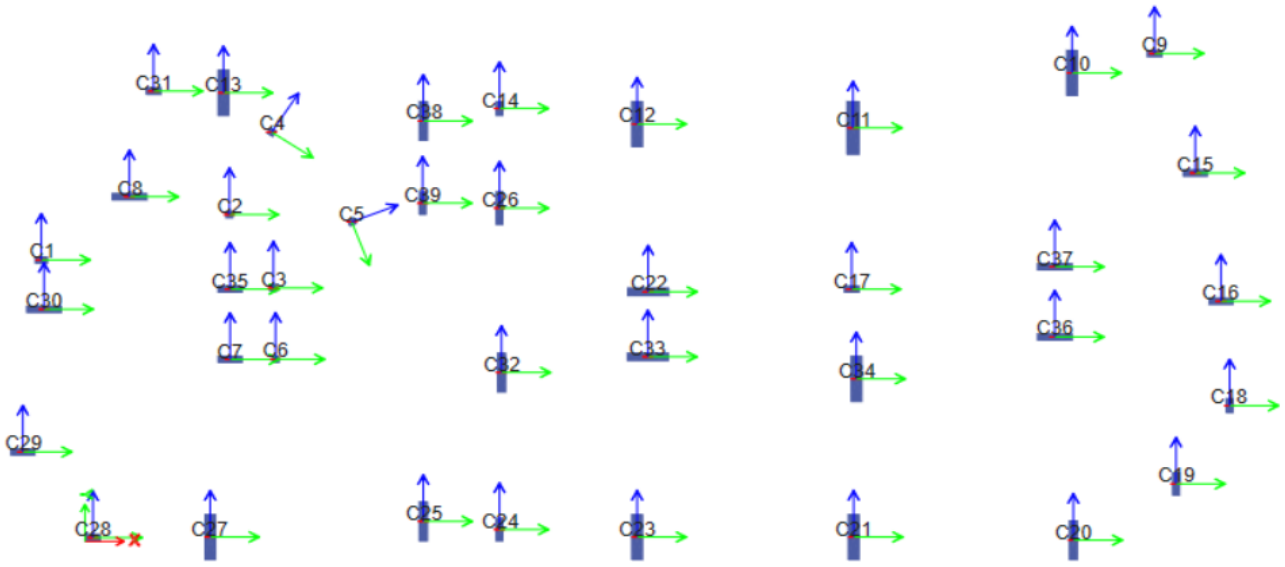
Design Of Short Columns Under Axial Force Only

Fcu= 400 Kg/cm2
Fy= 3500 Kg/cm2

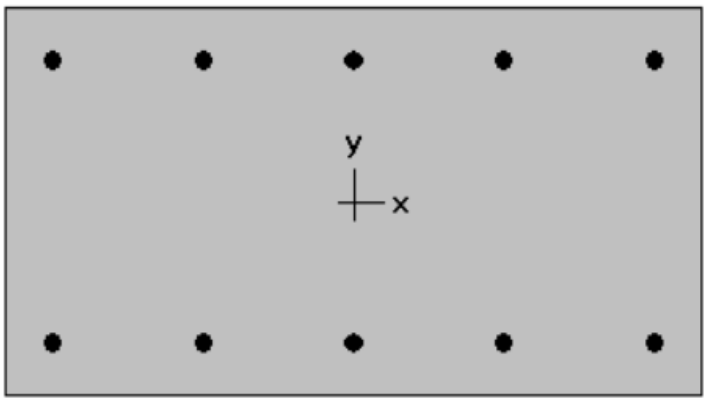
umber Of Floors 14
μ = 1.0%

Coulmn	R ton	Total R ton	AC cm2	b cm	t cm	As cm2	Ø	n	RFT Ø	
24	0.5421	8.34834	51.076	30	60	18	16	10	10Ø16	
10	4.6E-16	7.04242E-15	4E-14	30	60	18	16	10	10Ø16	
1	-10.708	164.90628	1008.9	30	60	18	16	10	10Ø16	c1(30*60)
6	-10.791	166.17832	1016.7	30	60	18	16	10	10Ø16	
21	-14.642	225.49296	1379.6	30	60	18	16	10	10Ø16	
11	-15.633	240.7405	1472.9	30	60	18	16	10	10Ø16	
9	-19.332	357.260904	2185.8	30	95	28.5	16	16	16Ø16	
12	-21.631	333.11894	2038	30	95	28.5	16	16	16Ø16	
17	-22.956	353.52086	2162.9	30	95	28.5	16	16	16Ø16	
29	-23.416	360.5987	2206.2	30	95	28.5	16	16	16Ø16	
27	-24.098	371.10304	2270.4	30	95	28.5	16	16	16Ø16	c2(30*95)
33	-25.454	391.98852	2398.2	30	95	28.5	16	16	16Ø16	
8	-27.58	424.72584	2598.5	30	95	28.5	16	16	16Ø16	
22	-29.812	459.0971	2808.8	30	95	28.5	16	16	16Ø16	
23	-34.971	538.54878	3294.9	30	135	40.5	16	22	22Ø16	
7	-37.115	571.57254	3496.9	30	135	40.5	16	22	22Ø16	
19	-37.257	573.76088	3510.3	30	135	40.5	16	22	22Ø16	c3(30*135)
30	-42.116	648.5787	3968.1	30	135	40.5	16	22	22Ø16	
31	-42.743	658.24066	4027.2	30	135	40.5	16	22	22Ø16	
26	-54.399	837.74152	5125.4	35	160	56	16	28	28Ø16	
18	-56.741	873.81294	5346.1	35	160	56	16	28	28Ø16	
32	-57.176	880.50424	5387	35	160	56	16	28	28Ø16	
25	-57.305	882.4893	5399.1	35	160	56	16	28	28Ø16	c4(35*160)
15	-58.154	895.56852	5479.2	35	160	56	16	28	28Ø16	
13	-58.468	900.41336	5508.8	35	160	56	16	28	28Ø16	
16	-72.561	1117.4394	6836.6	45	185	83.25	18	34	34Ø18	
4	-74.371	1145.3134	7007.1	45	185	83.25	18	34	34Ø18	
5	-74.631	1149.31586	7031.6	45	185	83.25	18	34	34Ø18	
20	-74.856	1152.7824	7052.8	45	185	83.25	18	34	34Ø18	c5(45*185)
14	-80.715	1243.0033	7604.8	45	185	83.25	18	34	34Ø18	
2	-85.783	1321.05358	8082.3	45	185	83.25	18	34	34Ø18	
28	-87.4	1345.96	8234.7	45	185	83.25	18	34	34Ø18	
3	-113.81	1752.66322	10723	50	215	107.5	18	44	44Ø18	c6(50*215)

2.11.2 Check on SpColumn:

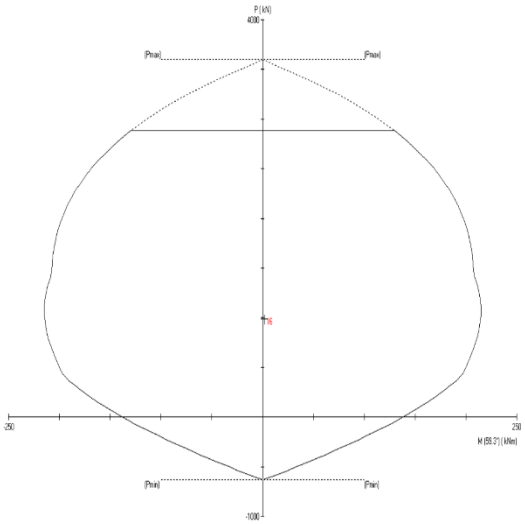


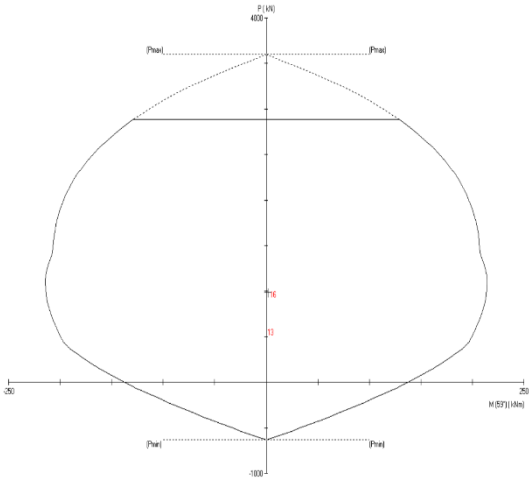
FOR C9

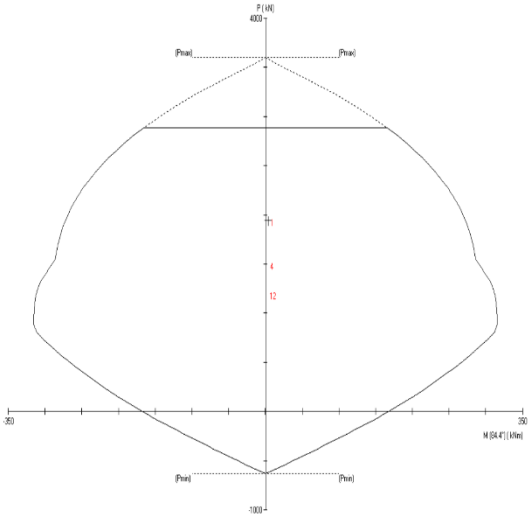


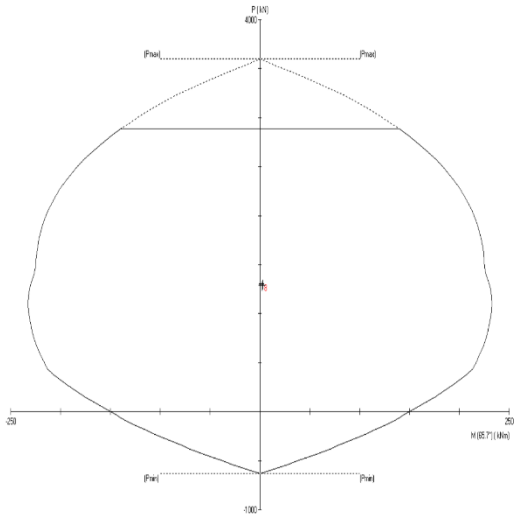
600 x 300 mm
1.12% reinf.

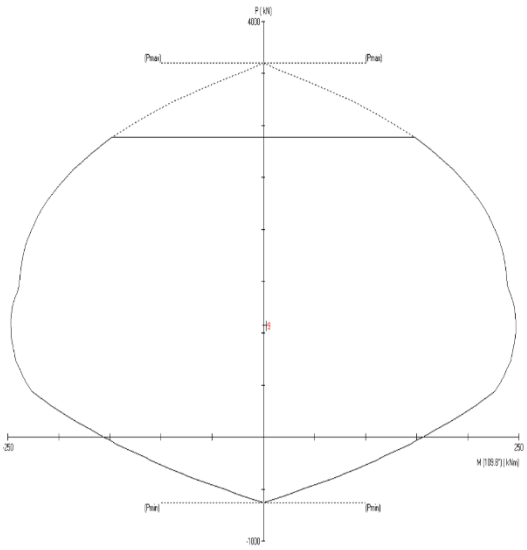
n kn	mx kn.m	my kn
1941.888	0.375	3.843
1492.994	0.28	4.28
886.467	-0.11	0.385
1499.619	0.316	4.368
879.842	-0.146	0.297
1302.542	1.024	2.287
1076.919	-0.854	2.378
1289.486	0.953	2.113
1089.975	-0.784	2.552
1188.344	0.221	3.677
581.818	-0.169	-0.218
1194.97	0.257	3.766
575.192	-0.204	-0.306
997.892	0.965	1.684
772.27	-0.913	1.775
984.837	0.895	1.51
785.326	-0.842	1.949

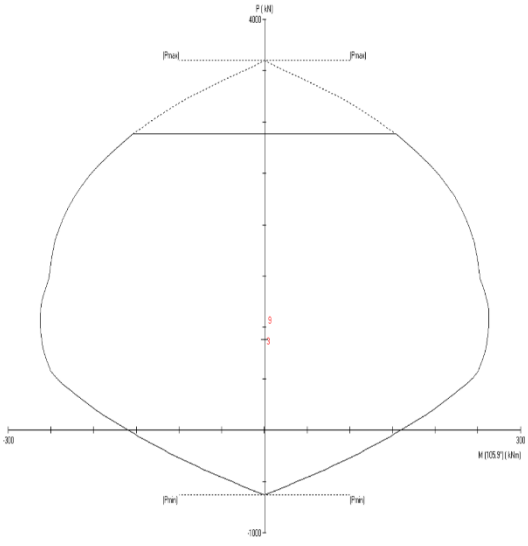


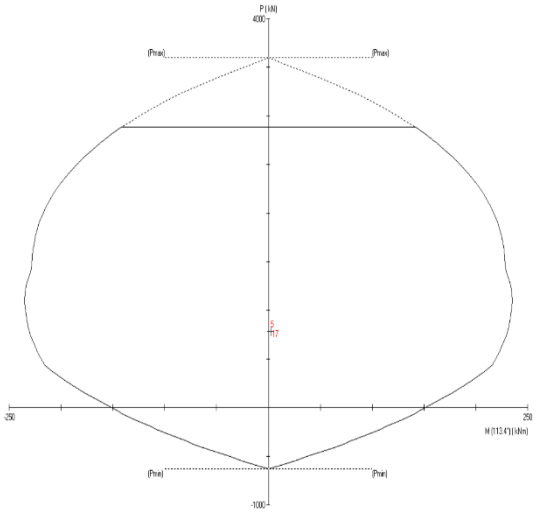


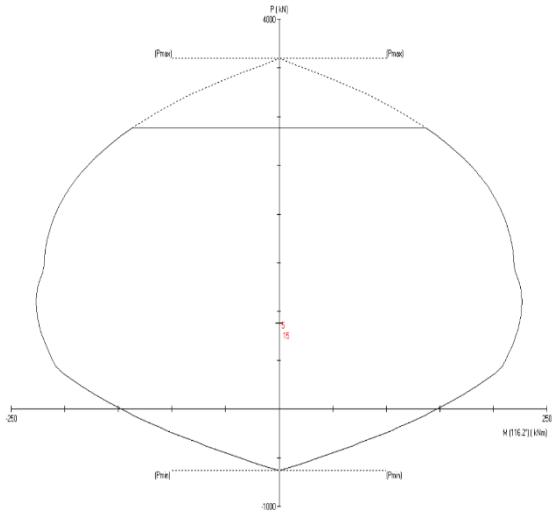




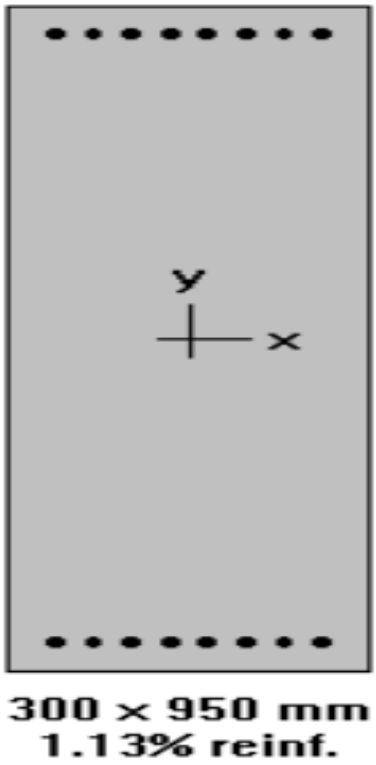




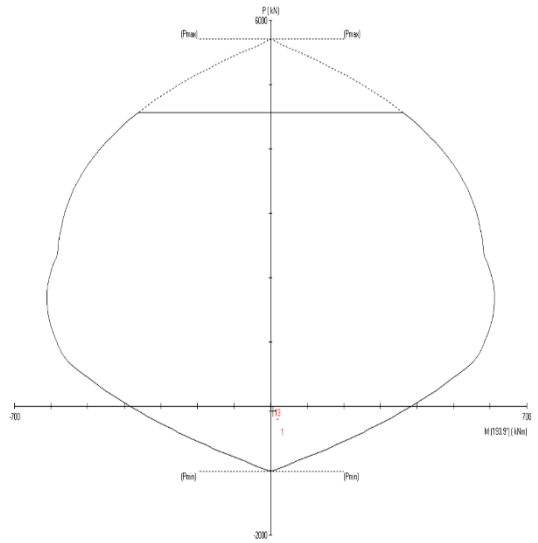


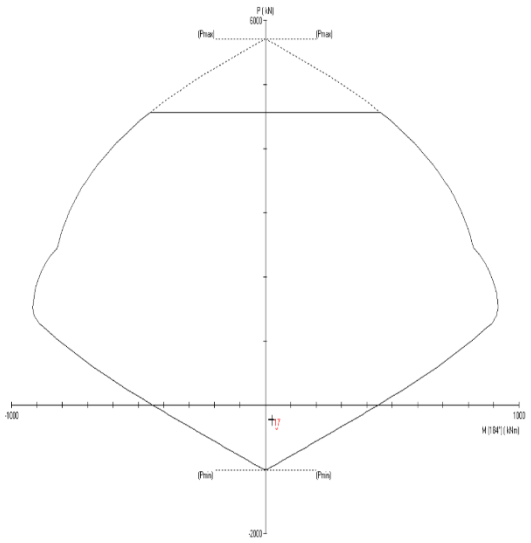


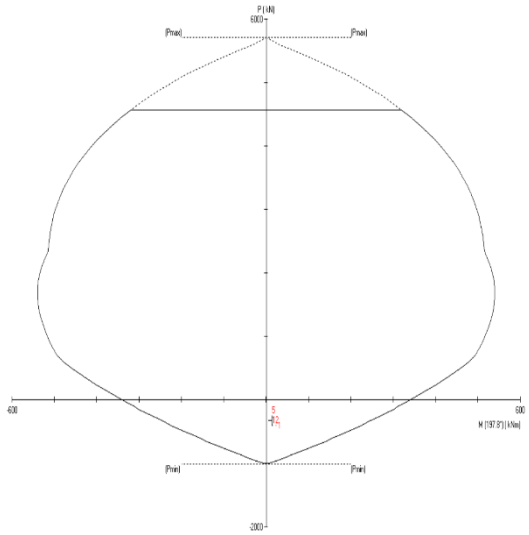
FOR C24

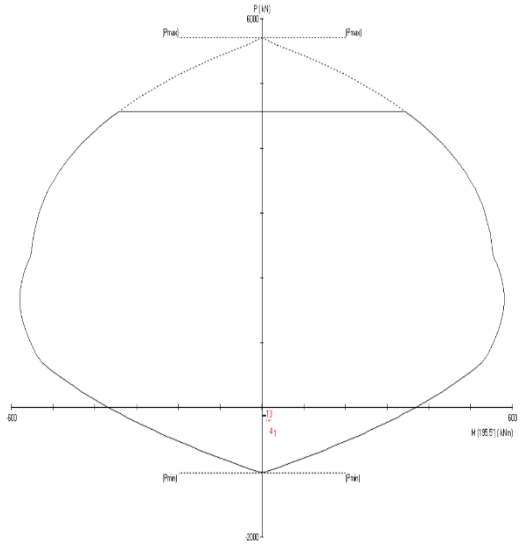


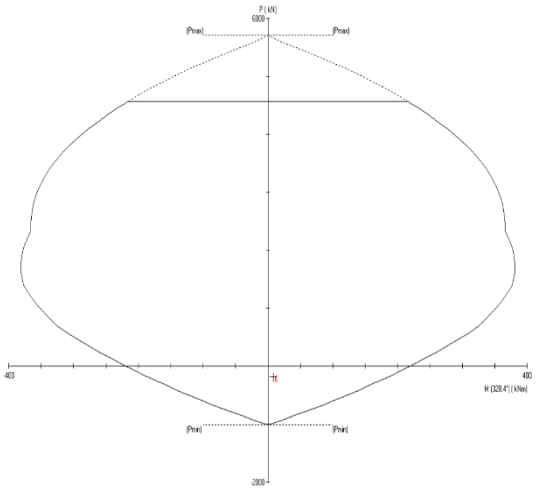
n kn	mx kn.m	my kn
-358.42	-22.86	-6.342
-322.8605	-13.572	-4.348
-131.9298	-9.687	-2.554
-330.6087	-14.068	-4.515
-124.1816	-9.191	-2.387
-181.6051	6.807	-4.181
-273.1852	-30.066	-2.721
-166.3383	7.785	-3.851
-288.452	-31.044	-3.051
-268.1939	-9.989	-3.353
-77.2632	-6.104	-1.56
-275.9421	-10.485	-3.521
-69.515	-5.608	-1.392
-126.9385	10.39	-3.186
-218.5186	-26.483	-1.726
-111.6717	11.368	-2.856
-233.7854	-27.461	-2.057

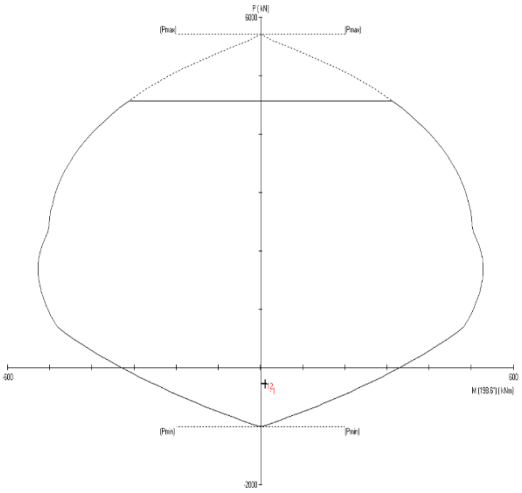


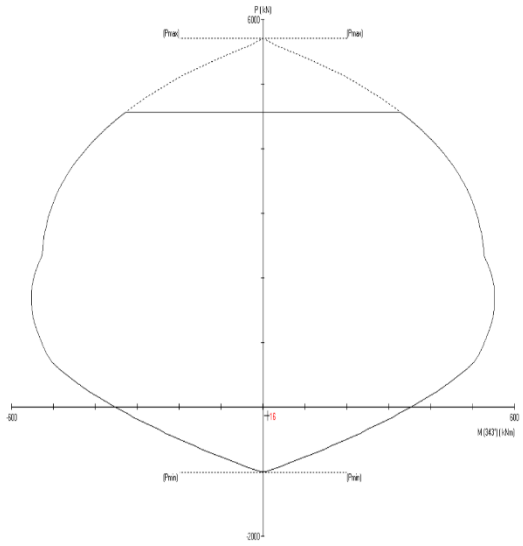


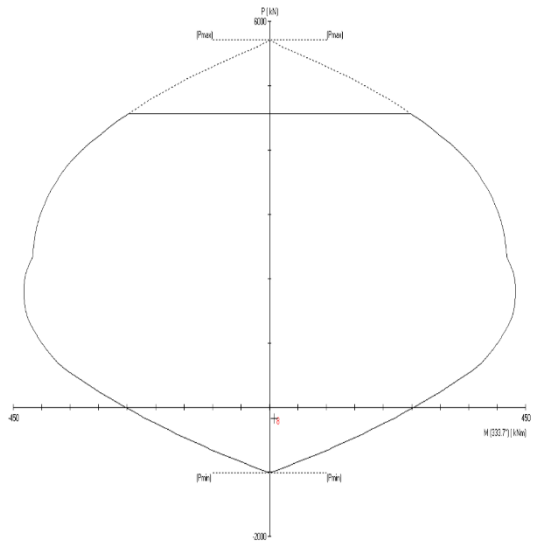




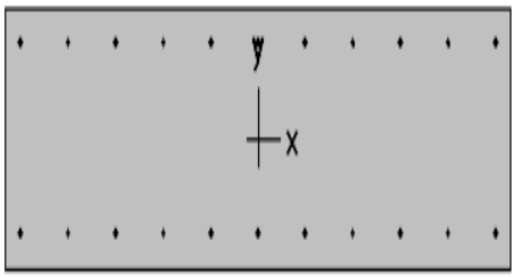






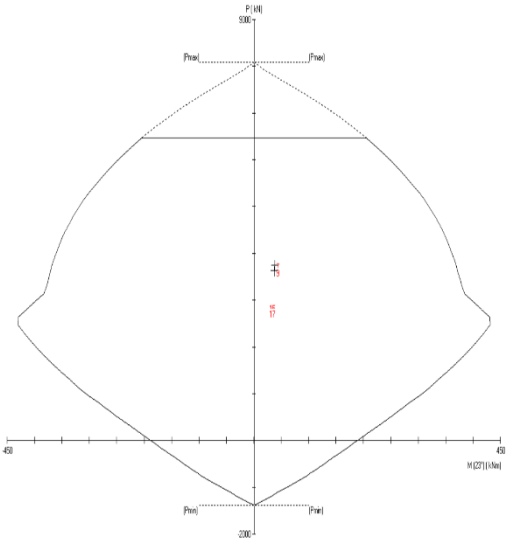


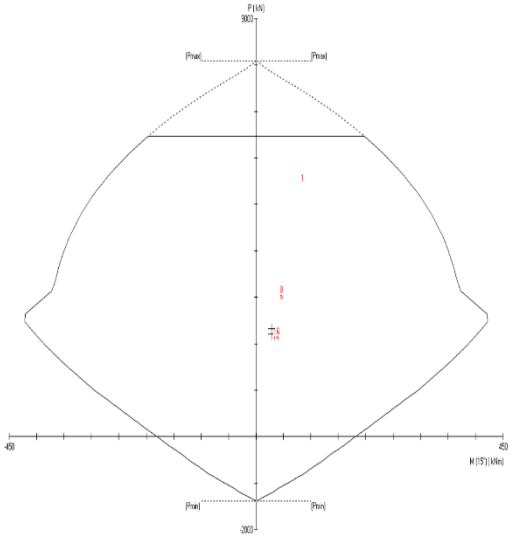
FOR C36

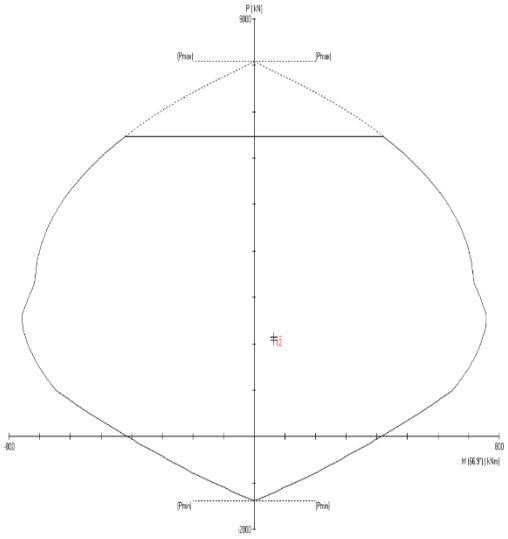


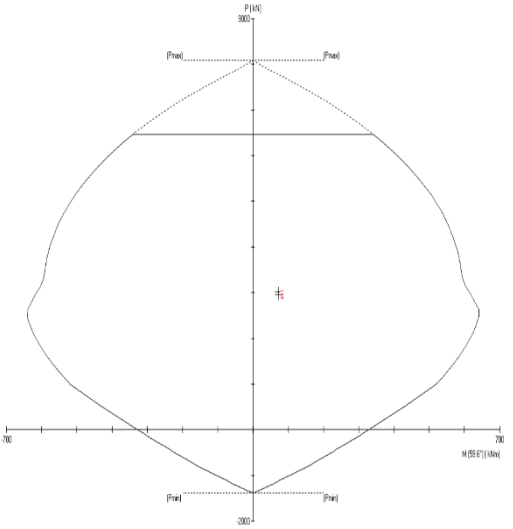
n	mx	my
kn	kn.m	kn
5620.966	74.675	23.903
3024.351	37.002	63.107
3816.443	36.077	-37.489
2961.824	36.785	63.09
3878.97	36.294	-37.472
3086.525	38.43	10.932
3754.269	34.649	14.686
3209.729	38.858	10.966
3631.065	34.221	14.652
2142.549	25.299	59.36
2934.642	24.374	-41.237
2080.022	25.082	59.343
2997.168	24.591	-41.219
2204.723	26.727	7.185
2872.467	22.946	10.939
2327.927	27.155	7.218
2749.263	22.518	10.905

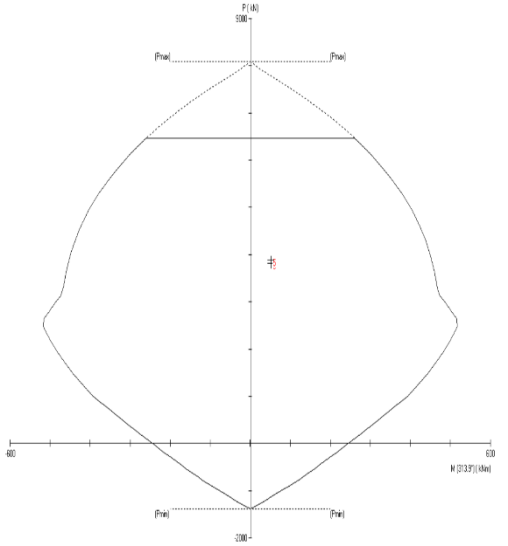
1350 x 300 mm
1.09% reinf.

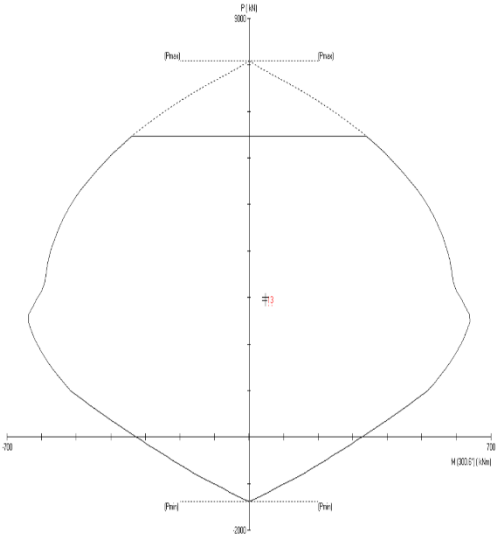


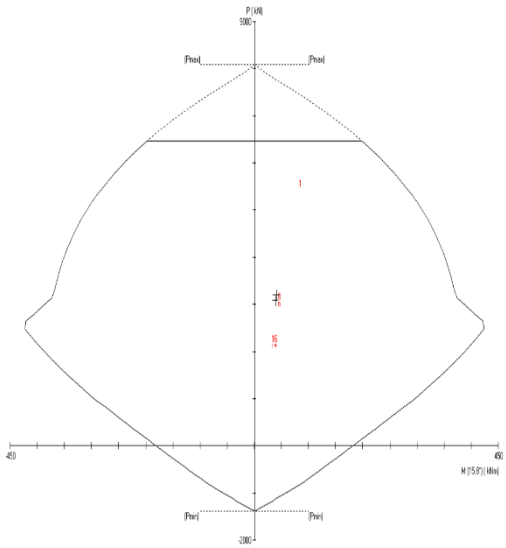


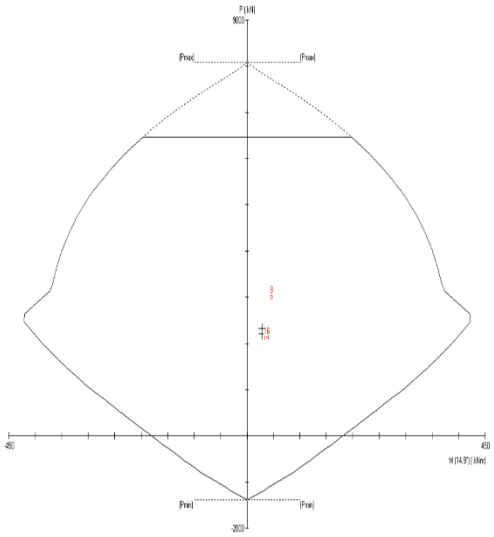




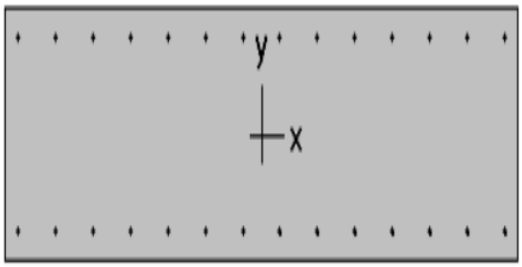






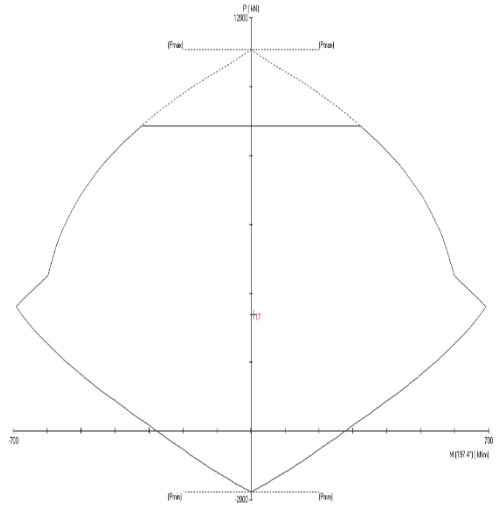


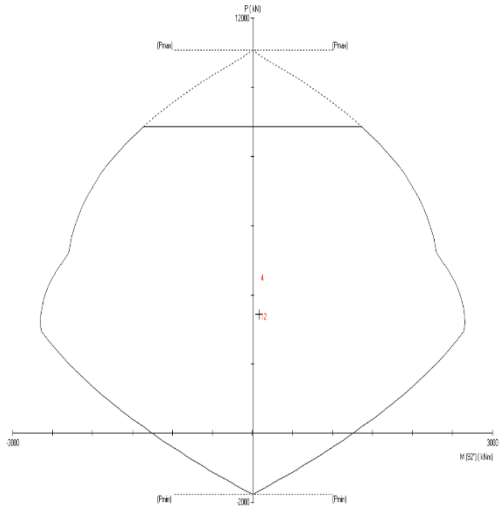
FOR C33

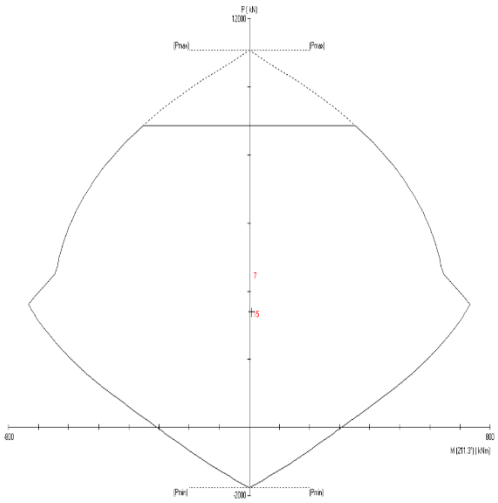


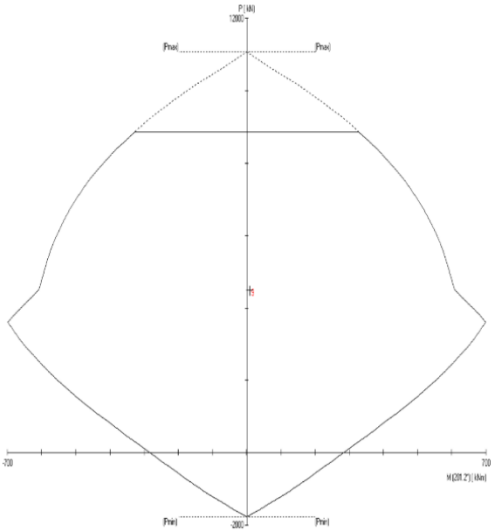
1600 x 350 mm
1.00% reinf.

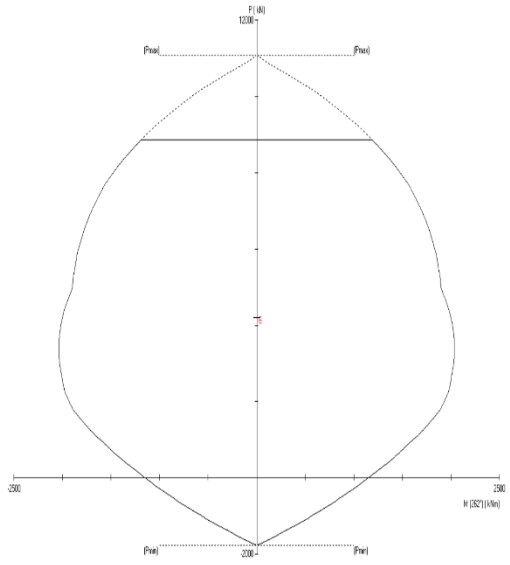
p kn	mx kn.m	my kn.m
7075.242	-9.939	-7.209
4551.926	-4.473	81.219
4145.252	-4.284	-89.771
4544.994	-4.561	82.198
4152.184	-4.196	-90.75
4192.422	-0.469	-3.332
4504.755	-8.289	-5.22
4206.08	-0.295	-5.262
4491.098	-8.462	-3.29
3441.921	-2.916	82.35
3035.247	-2.728	-88.64
3434.989	-3.004	83.329
3042.179	-2.64	-89.619
3082.418	1.088	-2.201
3394.751	-6.732	-4.089
3096.075	1.262	-4.131
3381.093	-6.905	-2.159

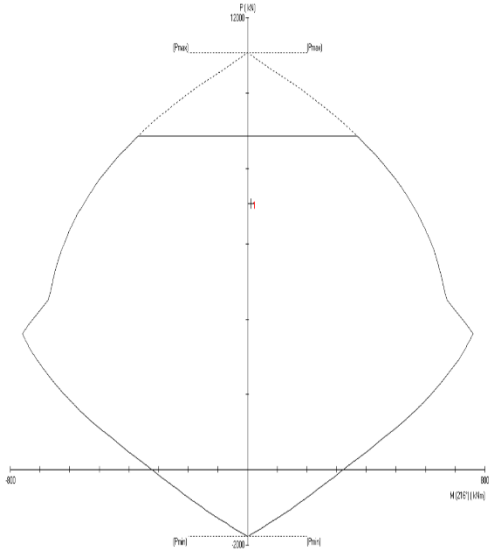


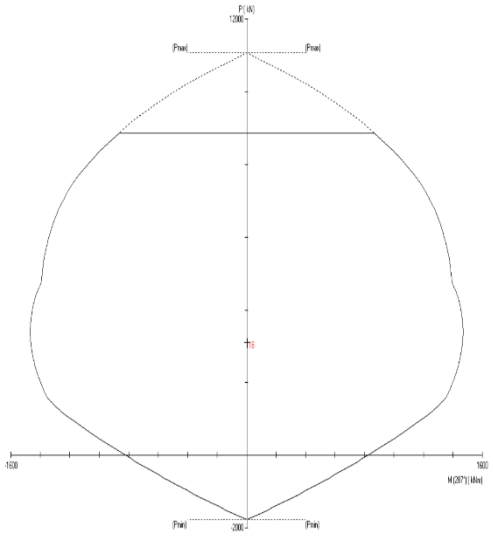


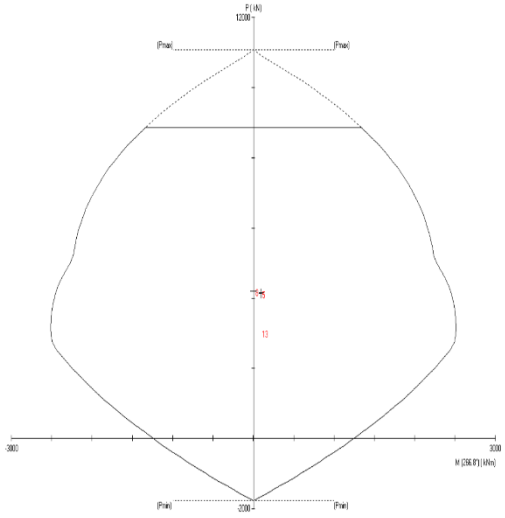




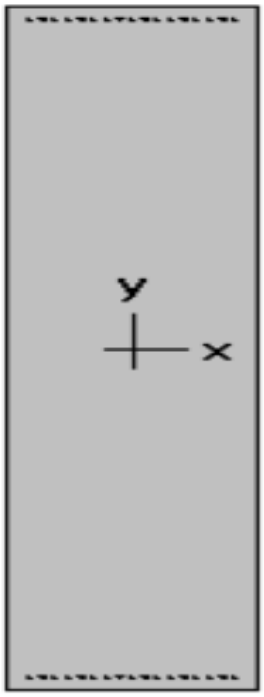






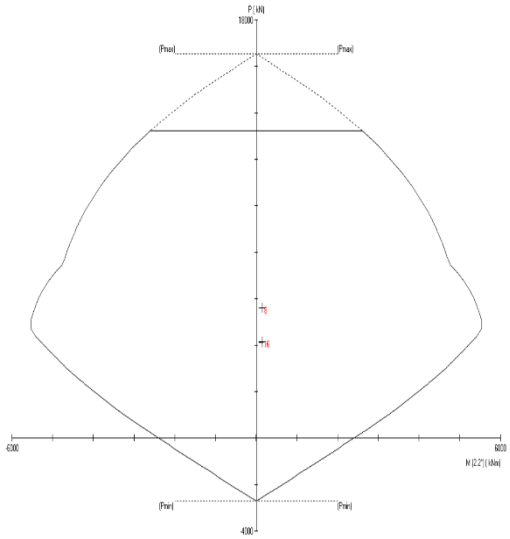


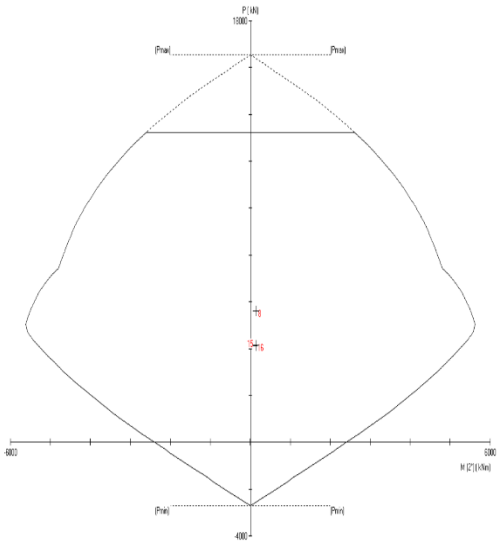
FOR C34

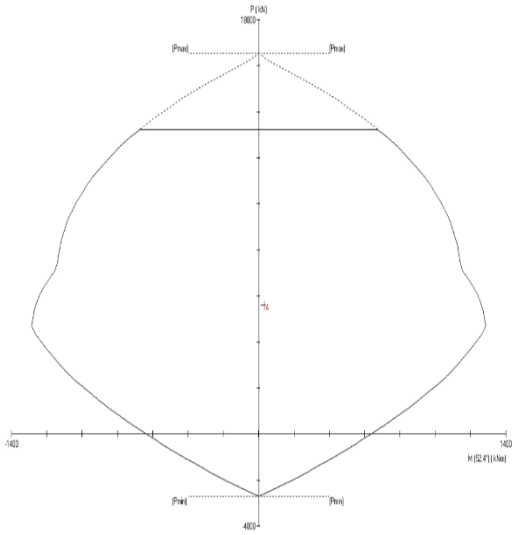


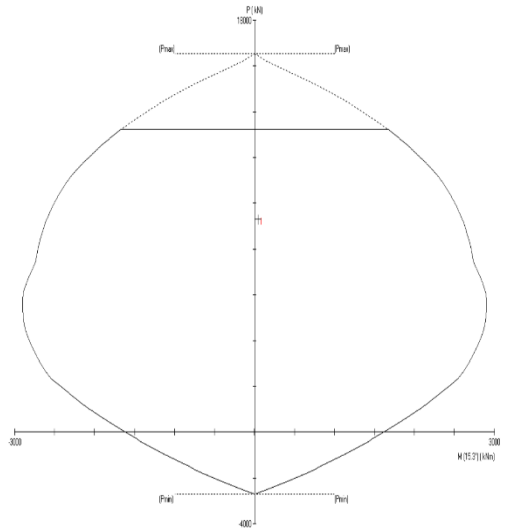
450 x 1850 mm
1.04% reinf.

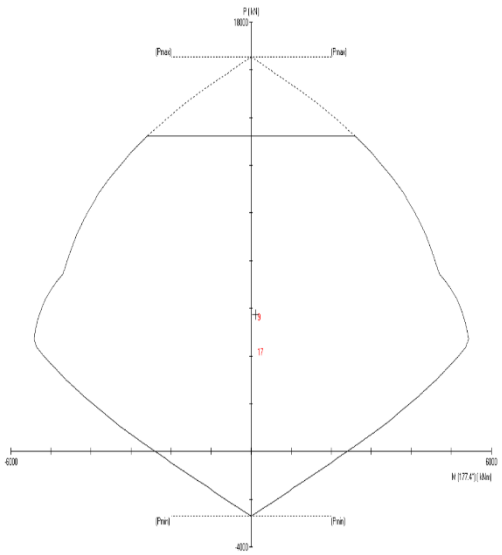
p kn	mx kn.m	my kn.m
9318.593	40.899	11.176
5609.405	19.616	25.511
5752.191	17.273	-14.357
5596.719	18.709	25.923
5764.876	18.18	-14.768
5590.685	149.575	6.706
5770.911	-112.686	4.448
5615.679	151.365	5.895
5745.916	-114.476	5.26
4147.515	13.208	23.759
4290.301	10.866	-16.108
4134.83	12.301	24.171
4302.987	11.773	-16.52
4128.795	143.168	4.955
4309.021	-119.093	2.697
4153.79	144.957	4.143
4284.027	-120.883	3.508

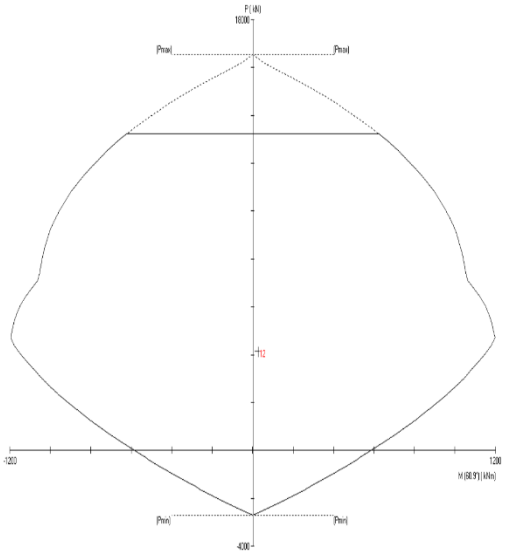


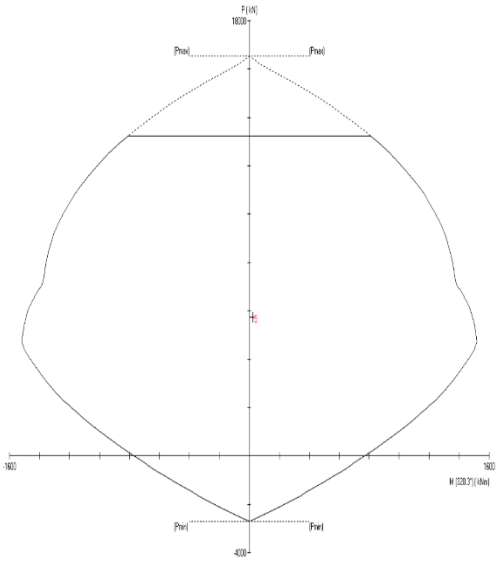


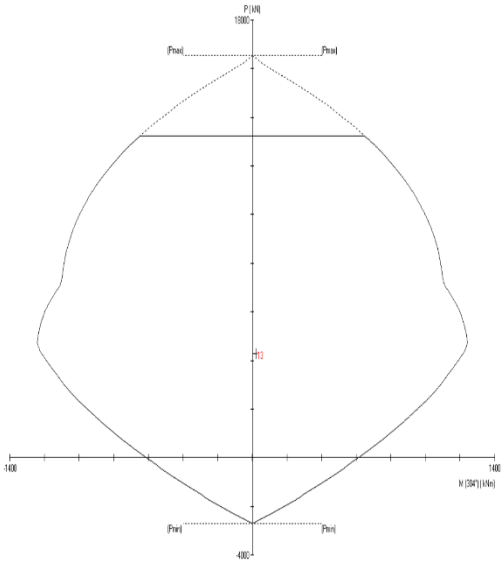




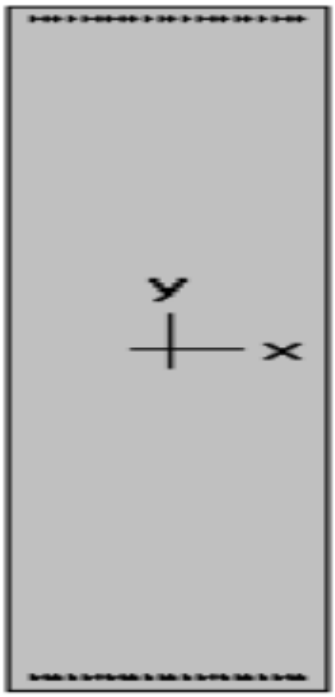






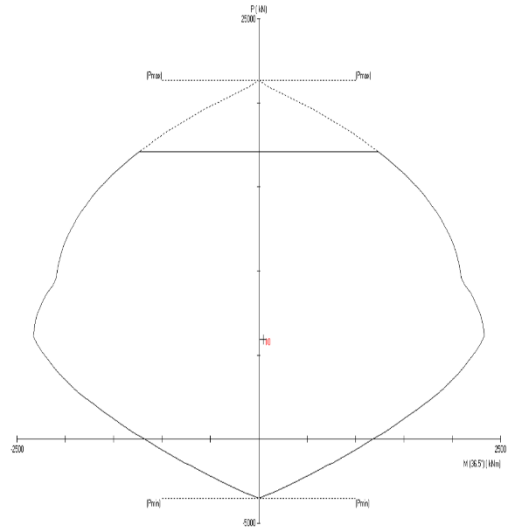


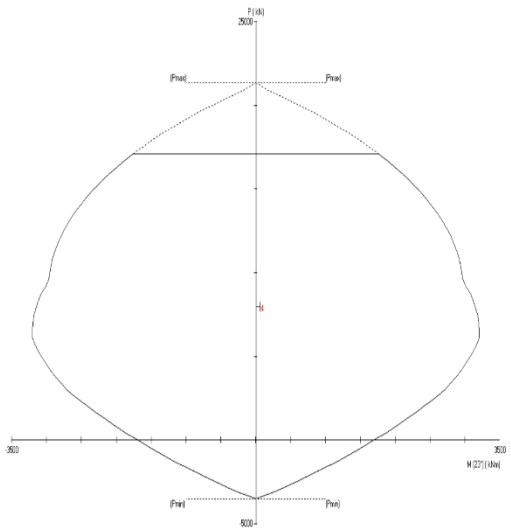
FOR C11

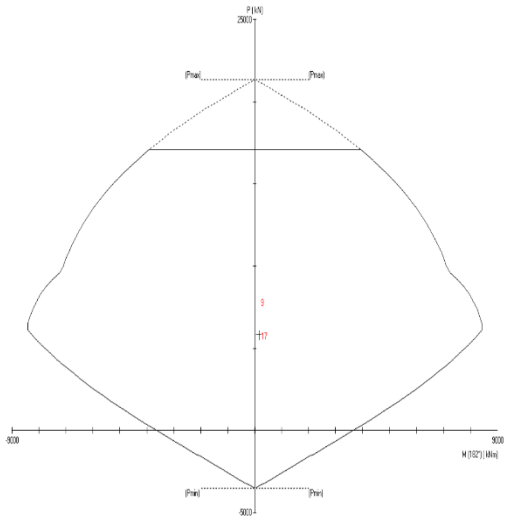


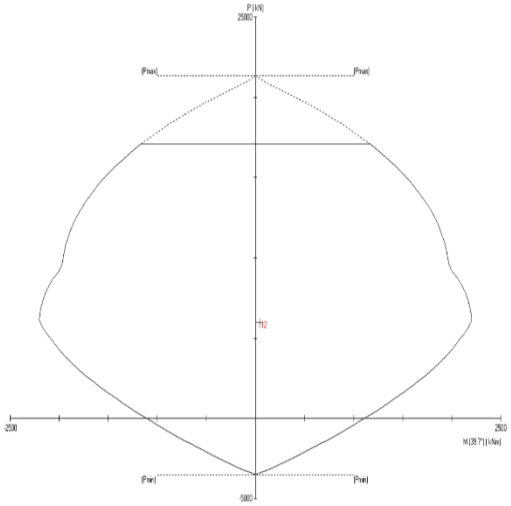
500 x 2150 mm
1.04% reinf.

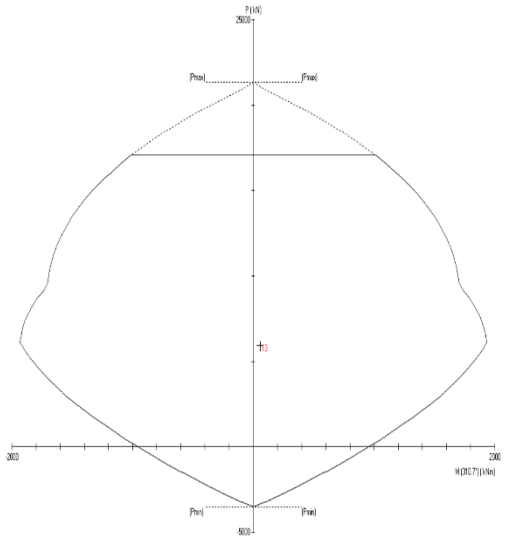
p kn	mx kn.m	my kn.m
13021.333	97.992	-29.14
7985.514	51.603	22.217
7983.096	47.139	-48.837
8002.867	46.287	21.08
7965.743	52.454	-47.7
8089.094	244.246	-16.45
7879.516	-145.504	-10.17
8054.906	254.727	-14.209
7913.704	-155.986	-12.412
5942.678	36.244	26.782
5940.261	31.78	-44.272
5960.031	30.928	25.645
5922.907	37.096	-43.135
6046.259	228.887	-11.885
5836.68	-160.863	-5.605
6012.071	239.369	-9.643
5870.868	-171.345	-7.846

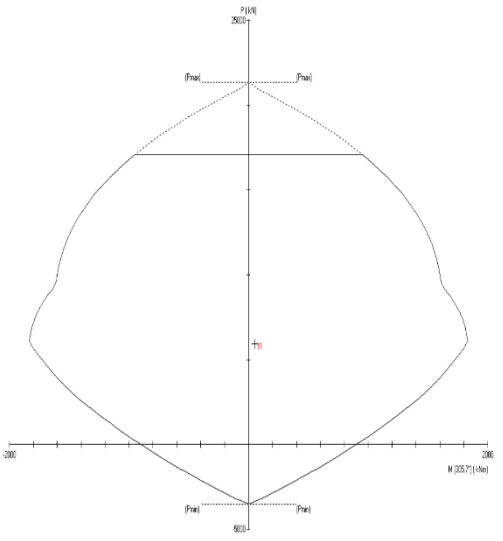


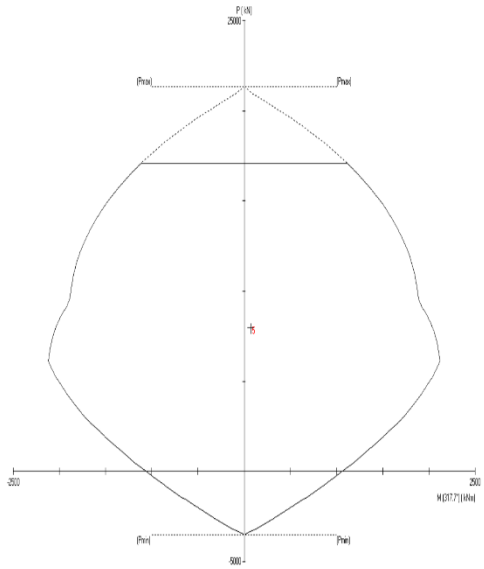


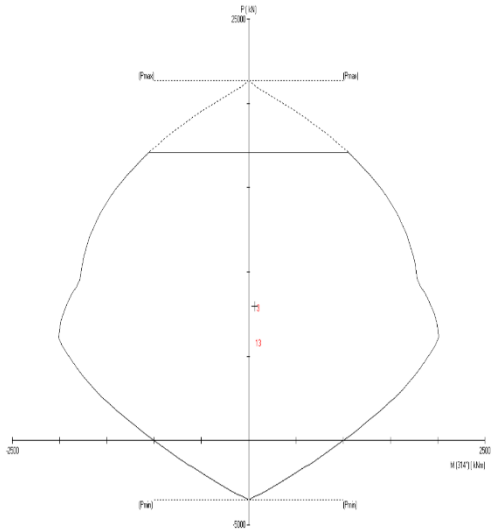


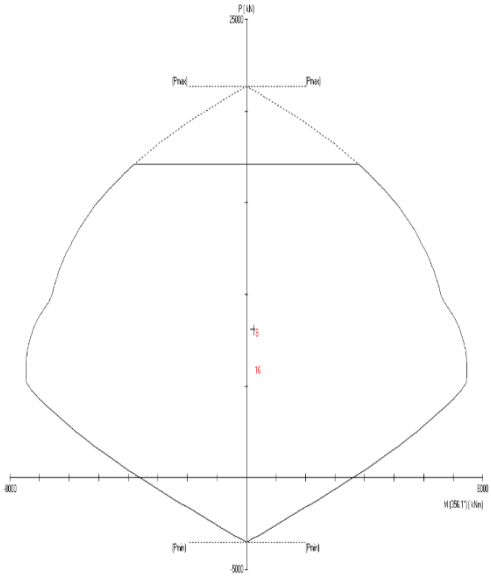


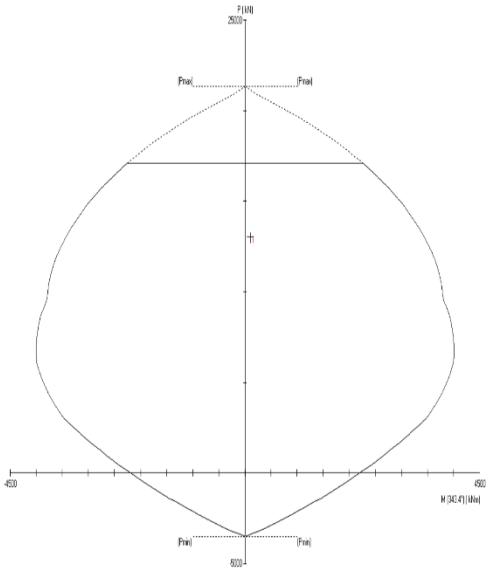






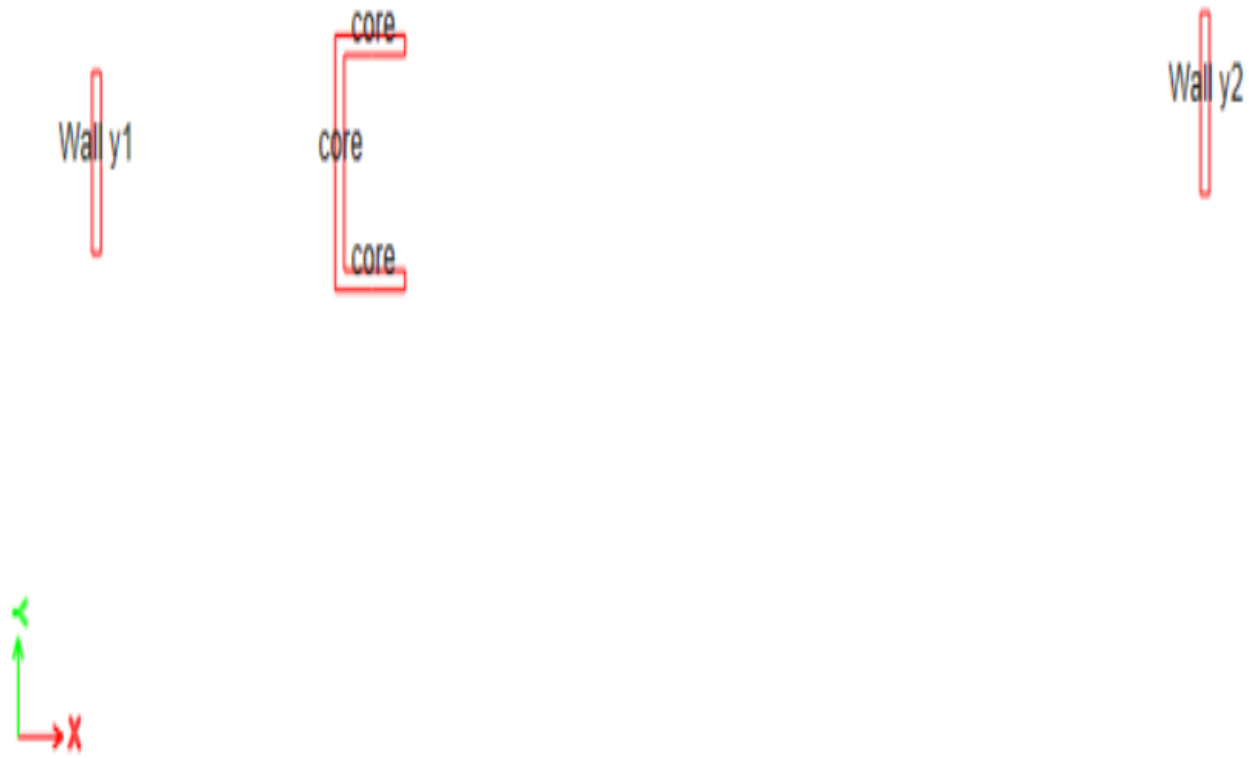




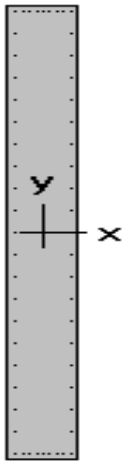


2.12. shear walls

2.12.1Shear Walls and Cores Labels:

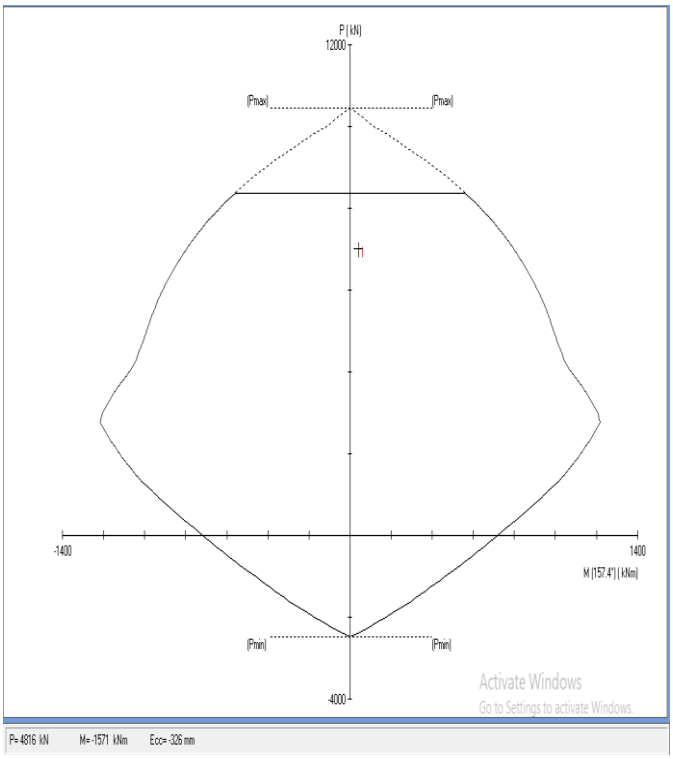


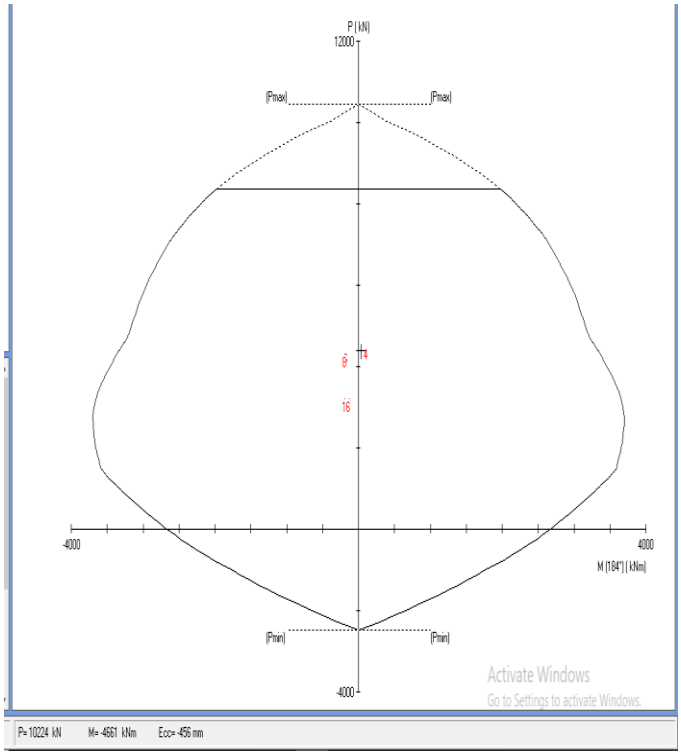
2.12.2Check of Shear Wall

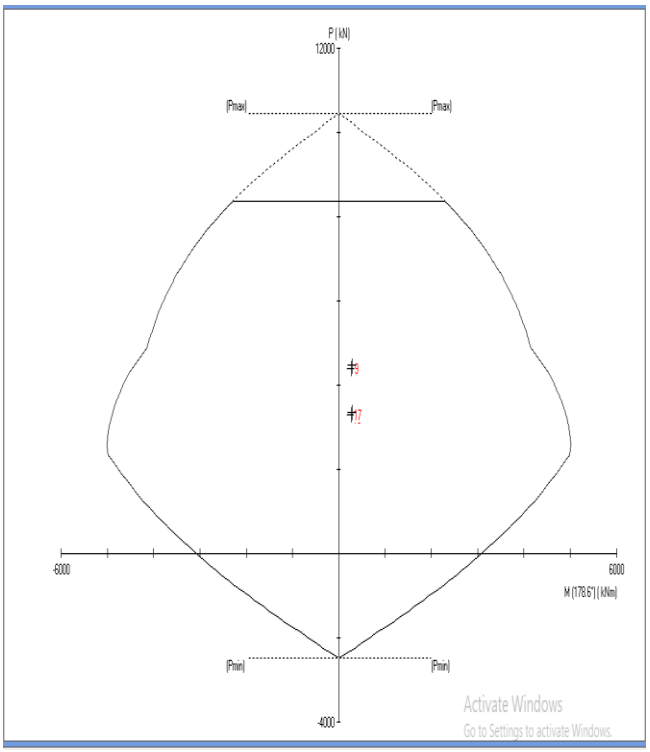


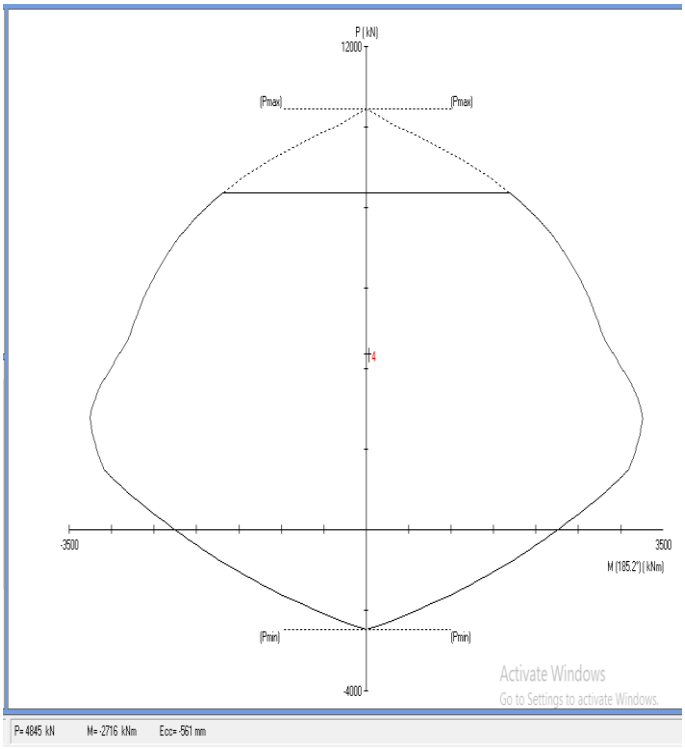
300 × 2750 mm
0.96% reinf.

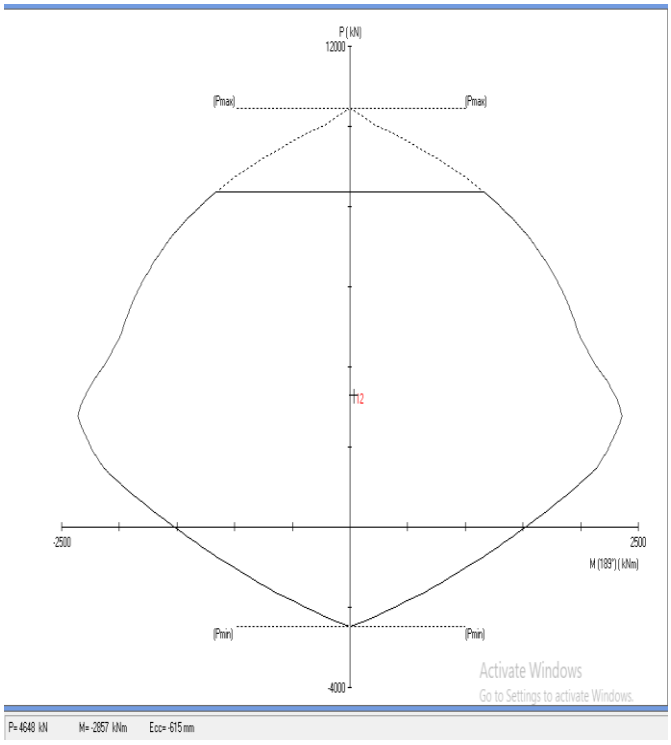
17
3367.671 -285.246 4.83
6115.746 3.994 1.64
3827.539 9.482 -1.807
3864.297 -4.784 3.192
3824.144 10.362 -1.668
3867.692 -5.664 3.053
3829.34 297.144 2.131
3862.496 -292.447 -0.746
3836.026 295.42 1.857
3855.81 -290.722 -0.472
2867.945 8.855 -2.064
2904.703 -5.411 2.936
2864.55 9.735 -1.925
2908.098 -6.291 2.797
2869.746 296.517 1.874
2902.902 -293.073 -1.003
2876.432 294.793 1.6
2896.216 -291.349 -0.729




P (kN)
12000
Pmax
Pmax
T4
16
-4000
4000
M (184°) (kNm)
Pmin
Pmin
-4000
Activate Windows
Go to Settings to activate Windows.
P= 10224 kN
M= -4661 kNm
Ecc= 456 mm


P (kN)
12000
Pmax
Pmax
T7
-6000
6000
M (178.6°) (kNm)
Pmin
Pmin
-4000
Activate Windows
Go to Settings to activate Windows.

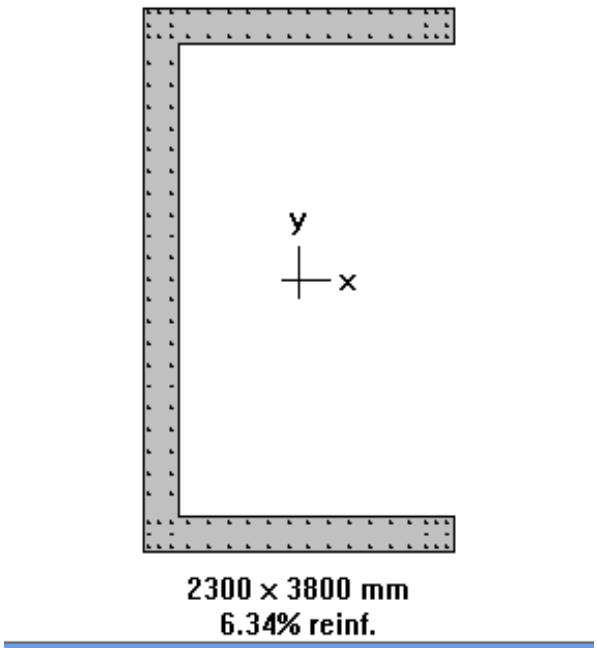

P (kN)
12000
Pmax
Pmax
T4
-3500
3500
M (185.2°) (kNm)
Pmin
Pmin
-4000
Activate Windows
Go to Settings to activate Windows.
P= 4845 kN
M= -2716 kNm
Ecc= 561 mm

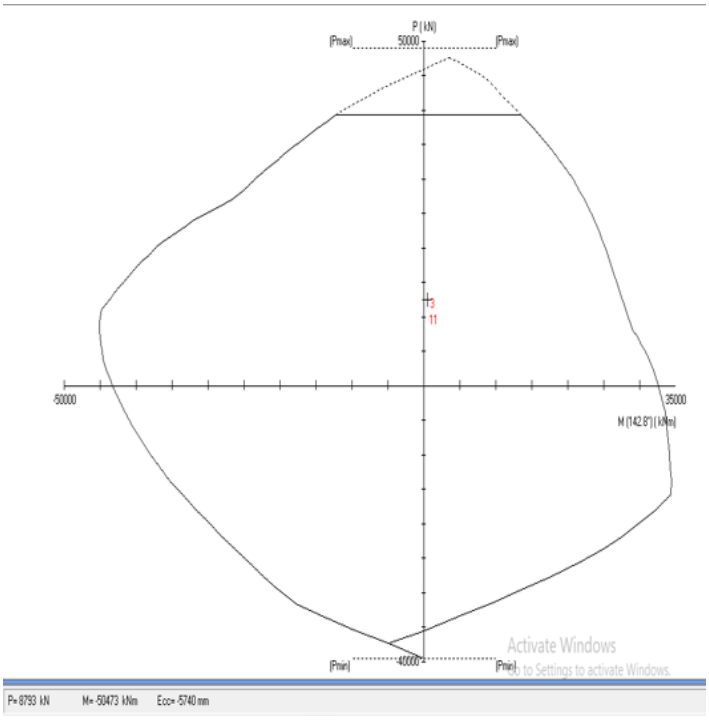

P (kN)
12000
Pmax
Pmax
T2
-2500
2500
M (189°) (kNm)
Pmin
Pmin
-4000
Activate Windows
Go to Settings to activate Windows.
P= 4648 kN
M= -2857 kNm
Ecc= 615 mm

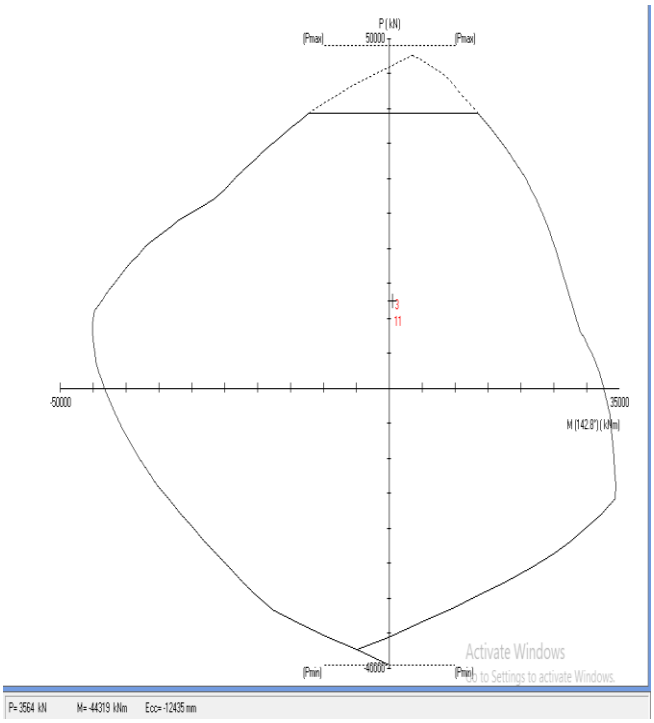
2.12.3 Check of Cores

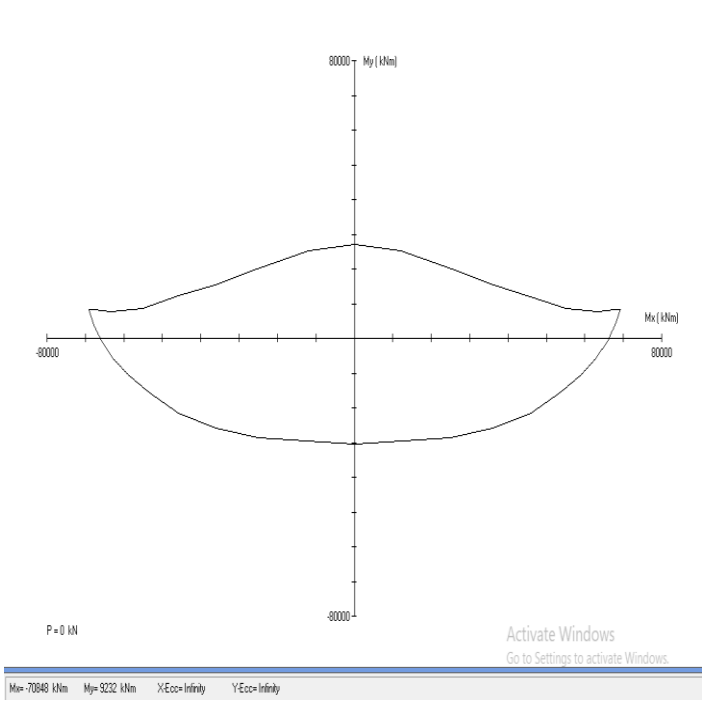
Pier	Output Case	P	M2	M3
		tonf	tonf-m	tonf-m
core	UITIMATE	-1595.4662	2.8505	-19.9476
core	seismic1	-792.5314	-27.3323	18.3133
core	seismic2	-1247.9792	30.4047	-40.083
core	seismic3	-790.8193	-27.7172	-29.2057
core	seismic4	-1249.6914	30.7897	7.436
core	seismic5	-1010.7055	2.9934	511.6716
core	seismic6	-1029.8051	0.0791	-533.4413
core	seismic7	-1014.0789	3.7525	605.3246
core	seismic8	-1026.4318	-0.68	-627.0943
core	seismic9	-542.1705	-27.7792	21.4409
core	seismic10	-997.6183	29.9578	-36.9554
core	seismic11	-540.4584	-28.1642	-26.0782
core	seismic12	-999.3305	30.3428	10.5636
core	seismic13	-760.3447	2.5465	514.7991
core	seismic14	-779.4442	-0.3678	-530.3137
core	seismic15	-763.718	3.3056	608.4522
core	seismic16	-776.0709	-1.1269	-623.9667

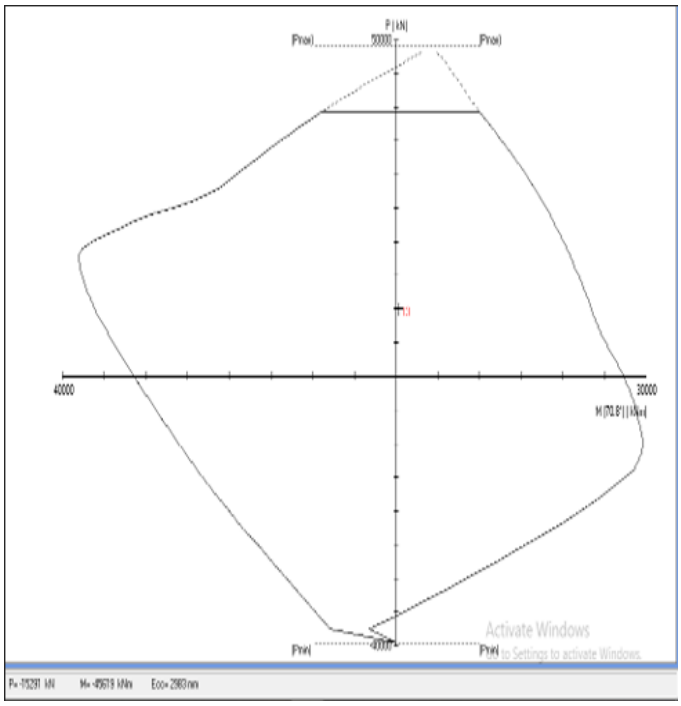
17
15954.662 -199.476 28.505
7925.314 183.133 -273.323
12479.792 -400.83 304.047
7908.193 -292.057 -277.172
12496.914 74.36 307.897
10107.055 5116.716 29.934
10298.051 -5334.413 0.791
10140.789 6053.246 37.525
10264.318 -6270.943 -6.8
5421.705 214.409 -277.792
9976.183 -369.554 299.578
5404.584 -260.782 -281.642
9993.305 105.636 303.428
7603.447 5147.991 25.465
7794.442 -5303.137 -3.678
7637.18 6084.522 33.056
7760.709 -6239.667 -11.269

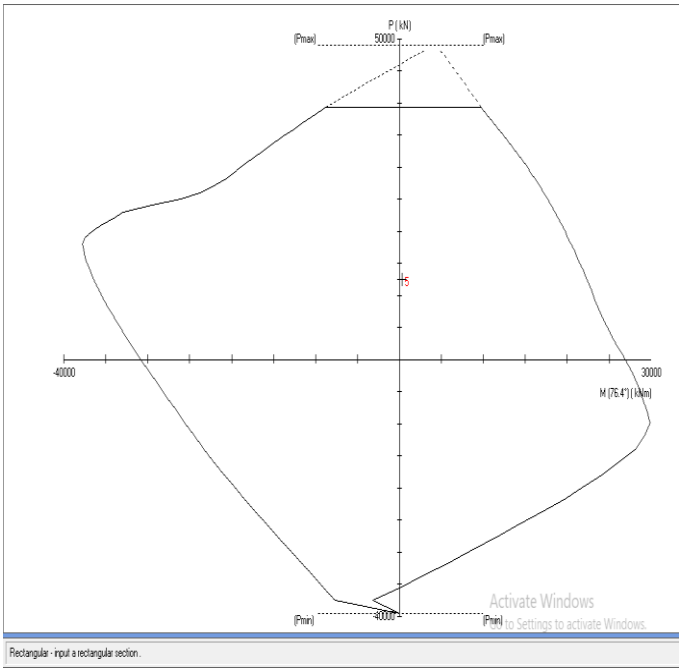


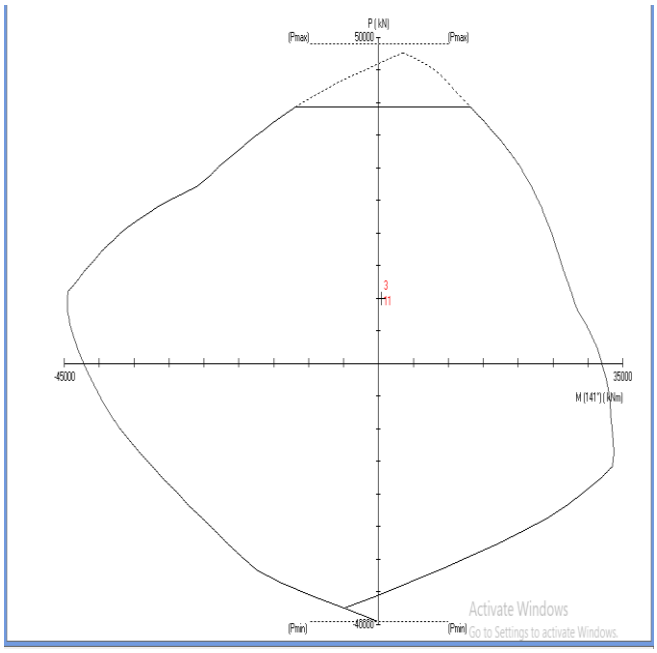

P (kN)
(Pmax)
50000
(Pmax)
-50000
35000
M (142.8°) (kNm)
(Pmin)
-40000
(Pmin)
Activate Windows
Go to Settings to activate Windows.
P= 8793 kN
M= -50473 kNm
Ecc= -5740 mm

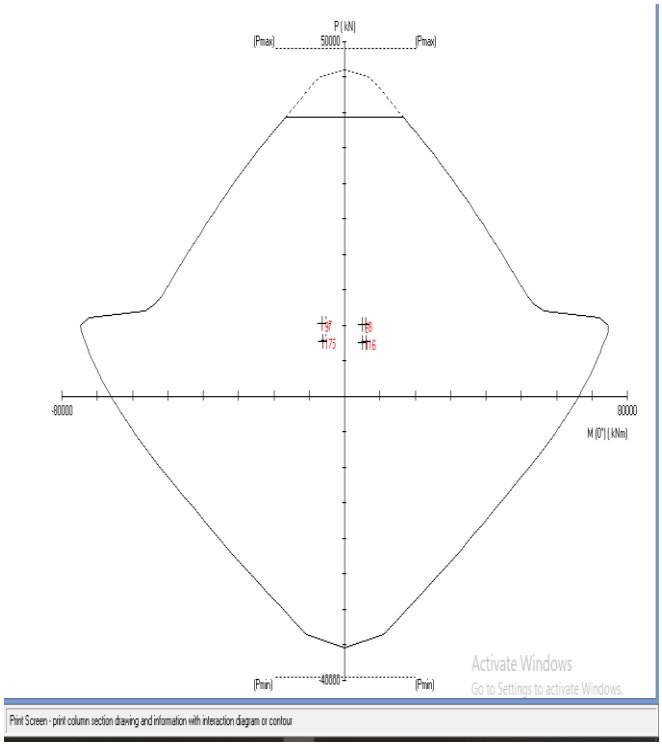

P (kN)
(Pmax)
50000
(Pmax)
-50000
35000
M (142.8°) (kNm)
(Pmin)
-40000
(Pmin)
Activate Windows
Go to Settings to activate Windows.
P= 3564 kN
M= -44319 kNm
Ecc= -12435 mm

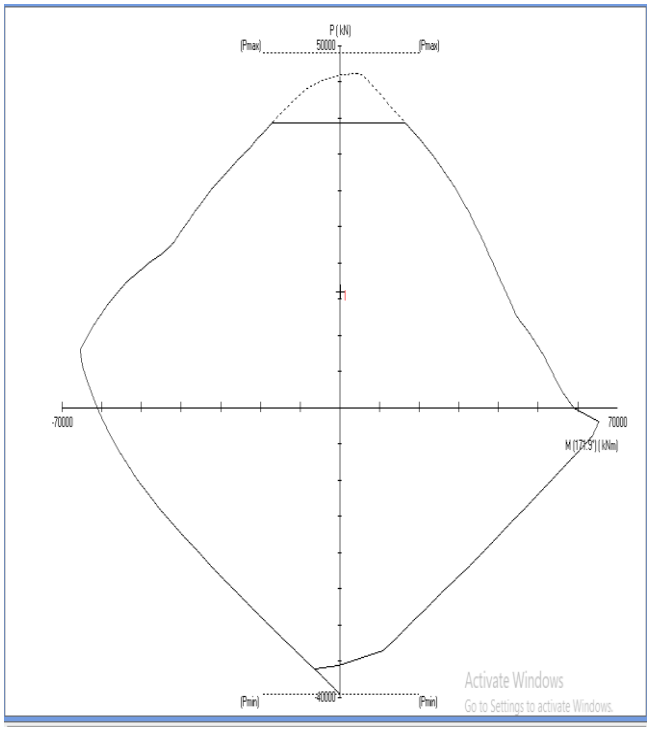

80000
My (kNm)
Mx (kNm)
-80000
80000
-80000
P = 0 kN
Activate Windows
Go to Settings to activate Windows.
Mx= -70848 kNm
My= 9232 kNm
X-Ecc= Infinity
Y-Ecc= Infinity


P (kN)
(Pmax)
50000
(Pmax)
40000
30000
(Pmin)
-40000
(Pmin)
Activate Windows
Go to Settings to activate Windows.
P= -15291 kN
M= 45619 kNm
Ecc= 2983 mm


P (kN)
(Pmax)
50000
(Pmax)
-40000
30000
M (76.4°) (kNm)
(Pmin)
-40000
(Pmin)
Activate Windows
Go to Settings to activate Windows.
Rectangular - input a rectangular section.


P (kN)
(Pmax)
50000
(Pmax)
-45000
35000
M (141°) (kNm)
(Pmin)
-40000
(Pmin)
Activate Windows
Go to Settings to activate Windows.


P (kN)
(Pmax)
50000
(Pmax)
-80000
80000
M (0°) (kNm)
(Pmin)
-48000
(Pmin)
Activate Windows
Go to Settings to activate Windows.
Print Screen - print column section drawing and information with interaction diagram or contour


P (kN)
(Pmax)
50000
(Pmax)
-70000
70000
M (121.5°) (kNm)
(Pmin)
-48000
(Pmin)
Activate Windows
Go to Settings to activate Windows.

2.13.Raft

2.13.1Design notes

For raft only

- Bearing capacity for raft is 1.85Kg/Cm²
- Tr.c = 1.4m
- Tp.c = 0.3m

- *For raft on piles*
- *Pile length = 6m*
- *Pile can carry = 120t*
- *Stiffnes of pile =2780000*($\pi * \frac{D^2}{4}$) /6=232778.7*
- *Total weight of building = 22631.7t*
- *Number of piles=total weight/pile capacity =22631.7/1.5*120= 126 piles*

2.13.2. Design of raft

Check Positive Moment in X Direction

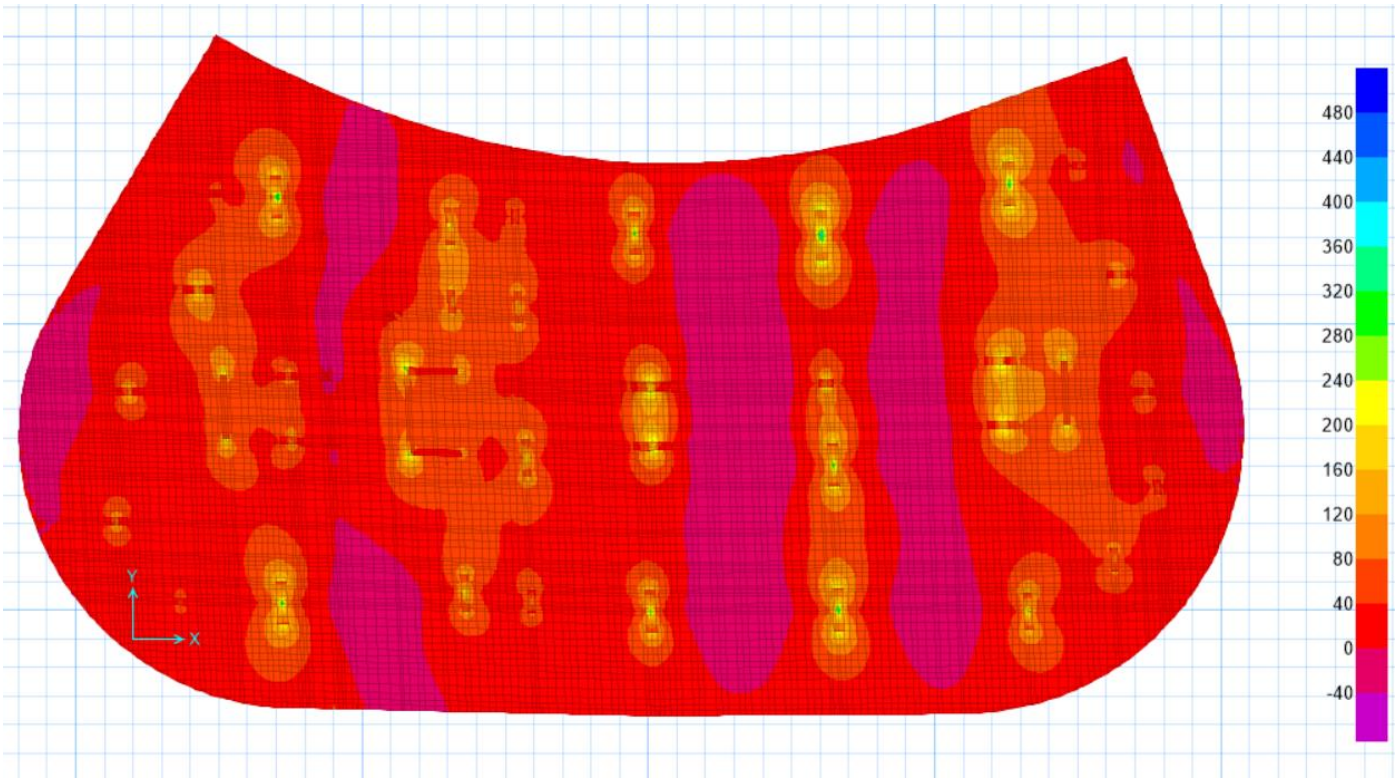


Figure 2.39: M1.1 positive

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

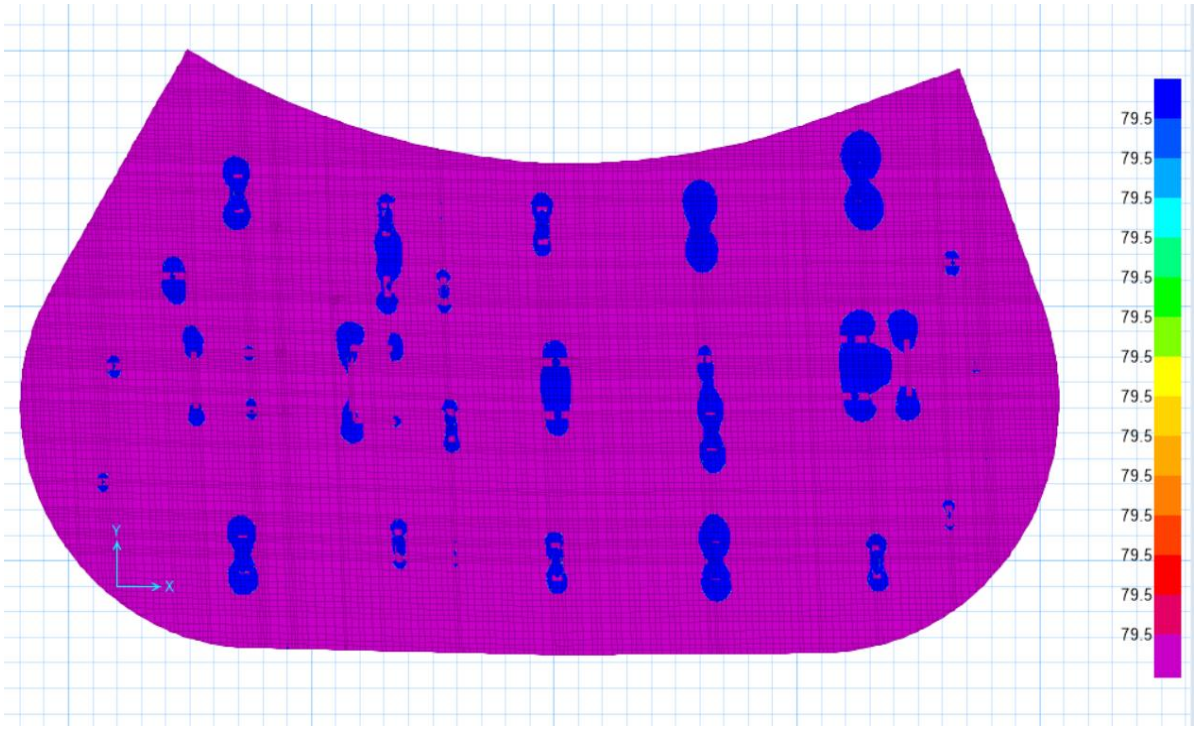


Figure 2.40: M1.1 positive with mesh

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

Additional		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

Total	158.90

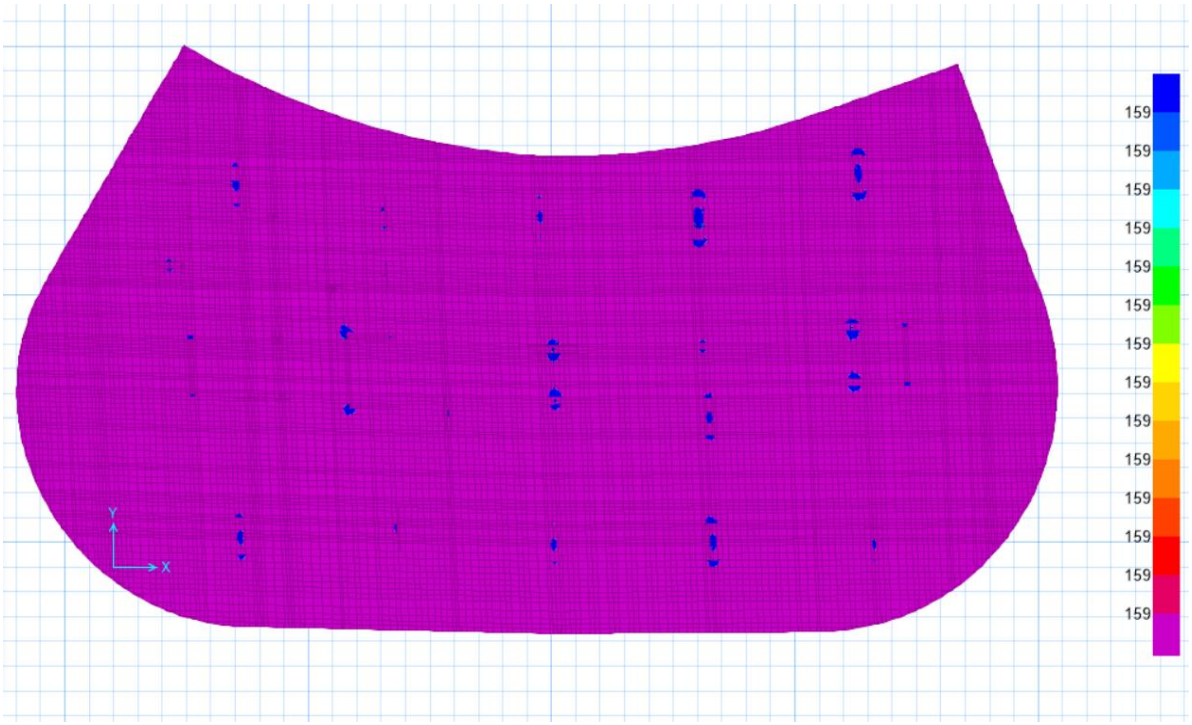


Figure 2.41: M1.1 positive with additional

Check Positive Moment in Y Direction

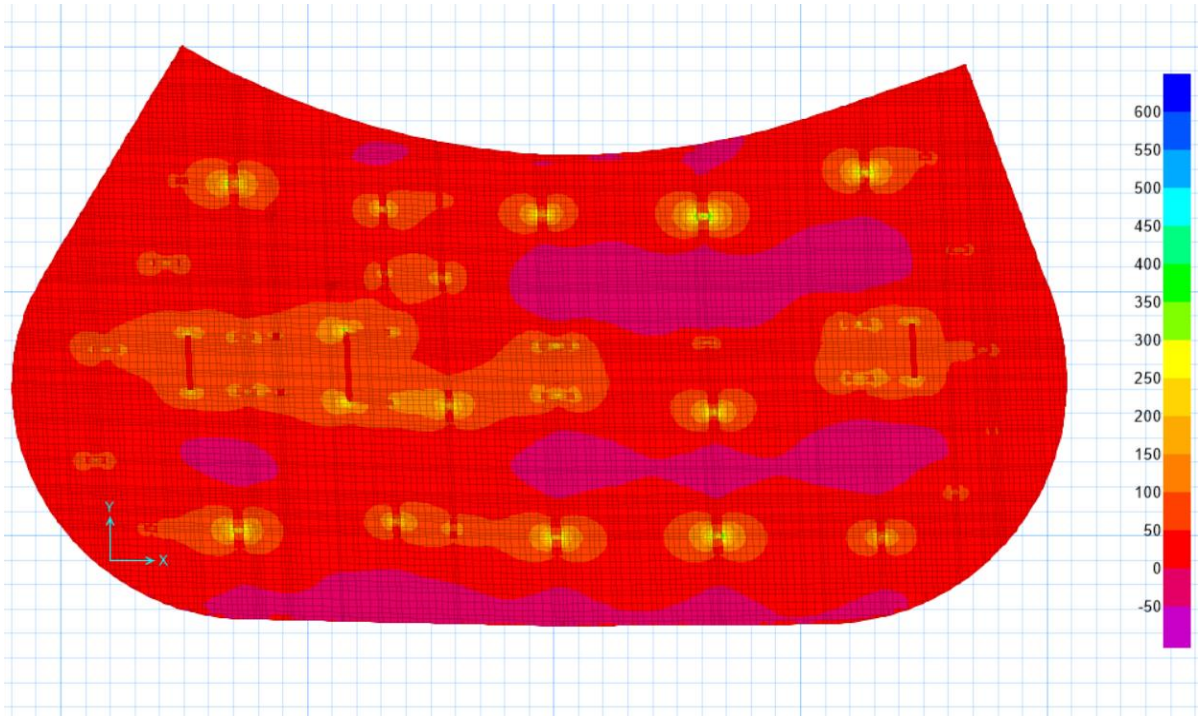


Figure 2.42: M2.2 positive

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

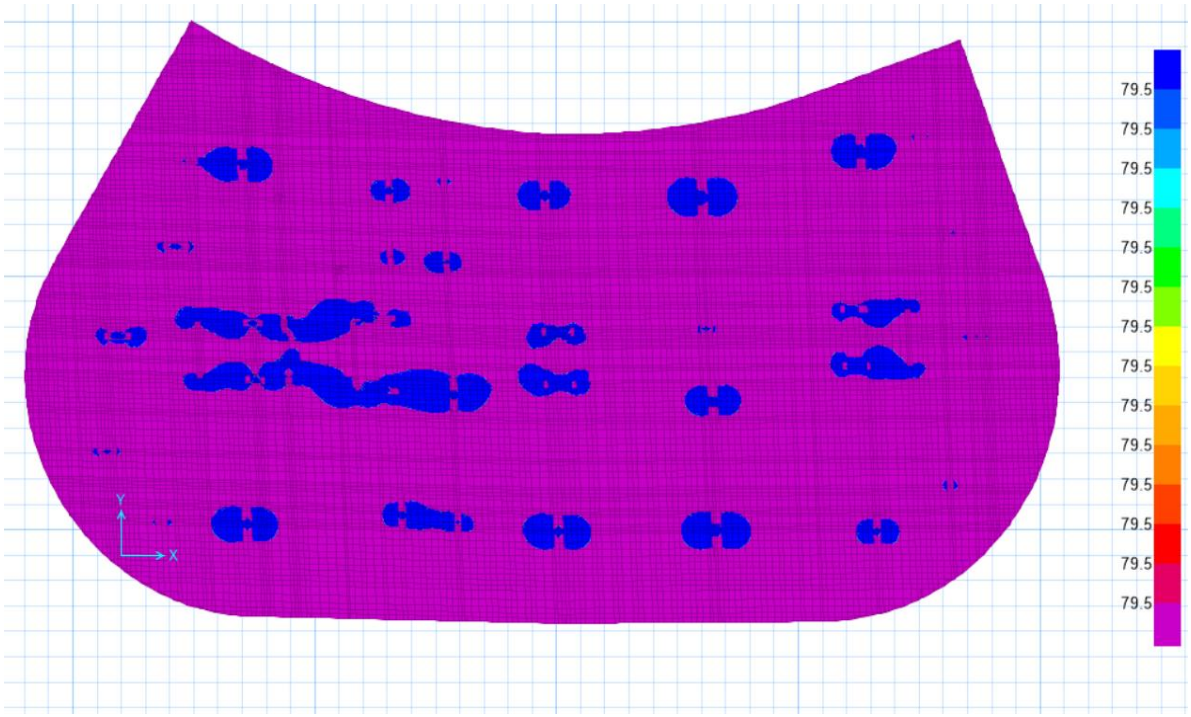


Figure 2.43: M2.2 positive with mesh

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

Additional		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

Total	158.90

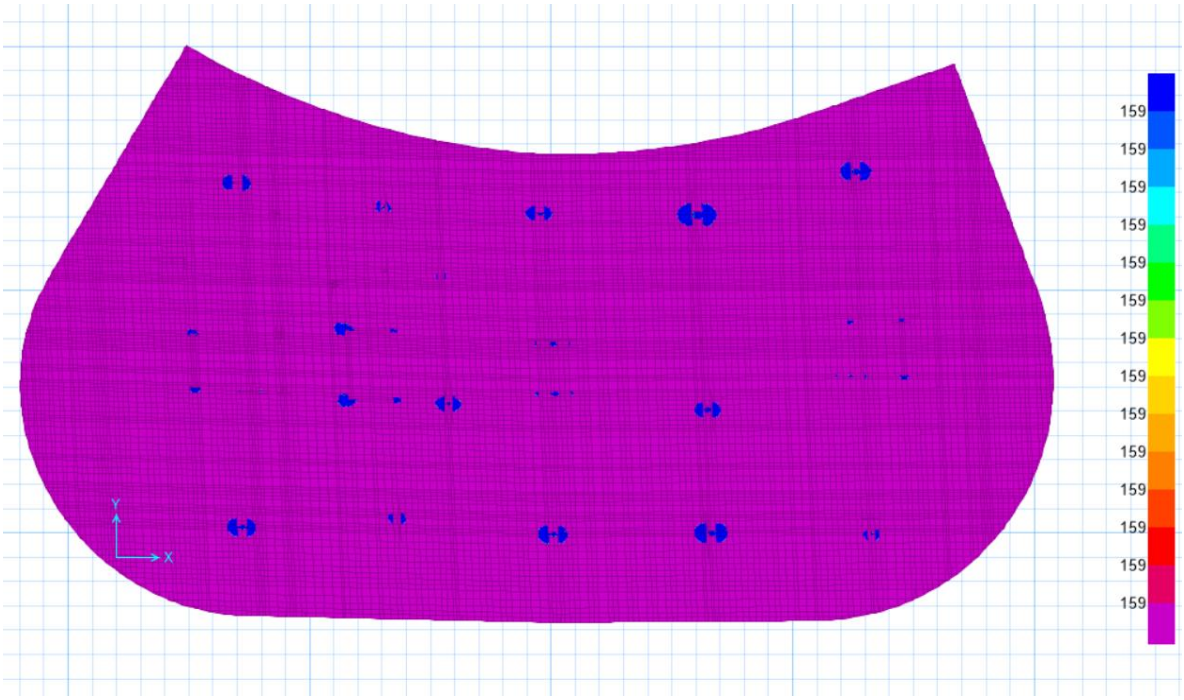


Figure 2.44: M2.2 positive with additional

Check negative Moment in X Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

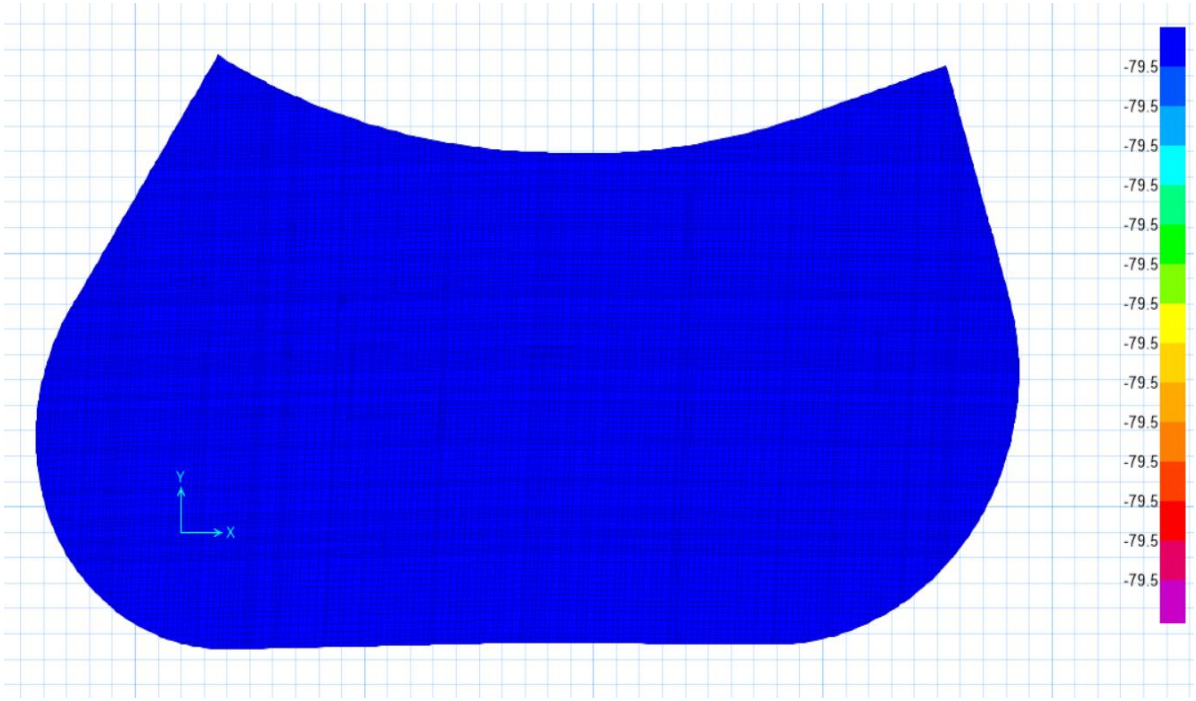


Figure 2.45: M1.1 negative with mesh

Check negative Moment in Y Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	18	2035.75	350	1400	1350	0.826	79.452348

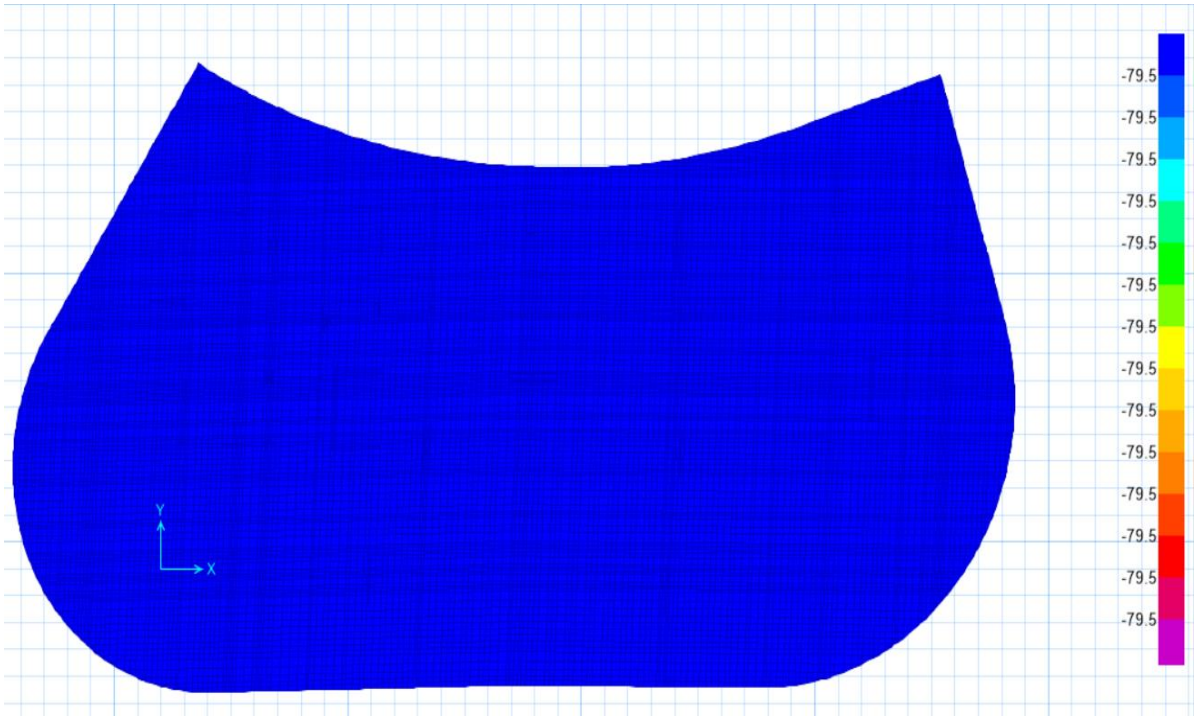
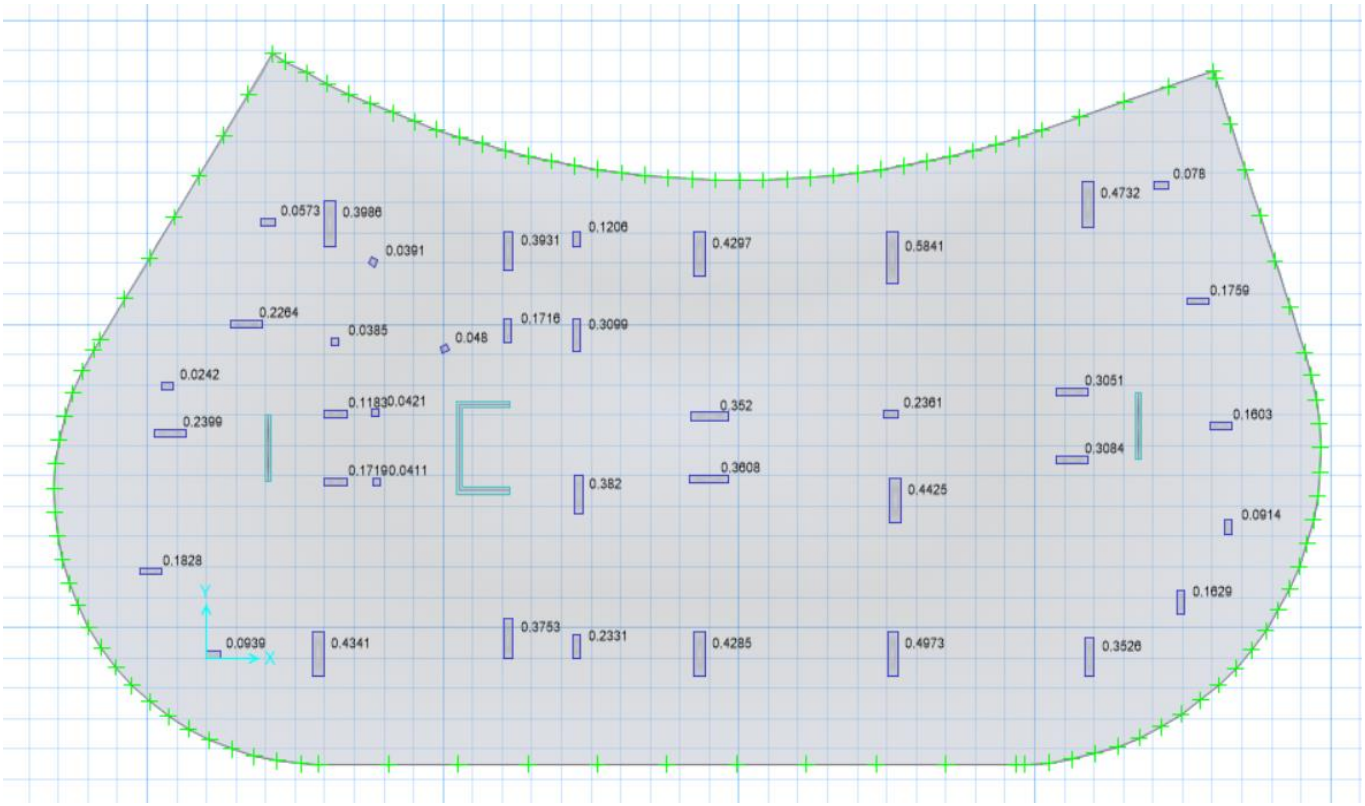


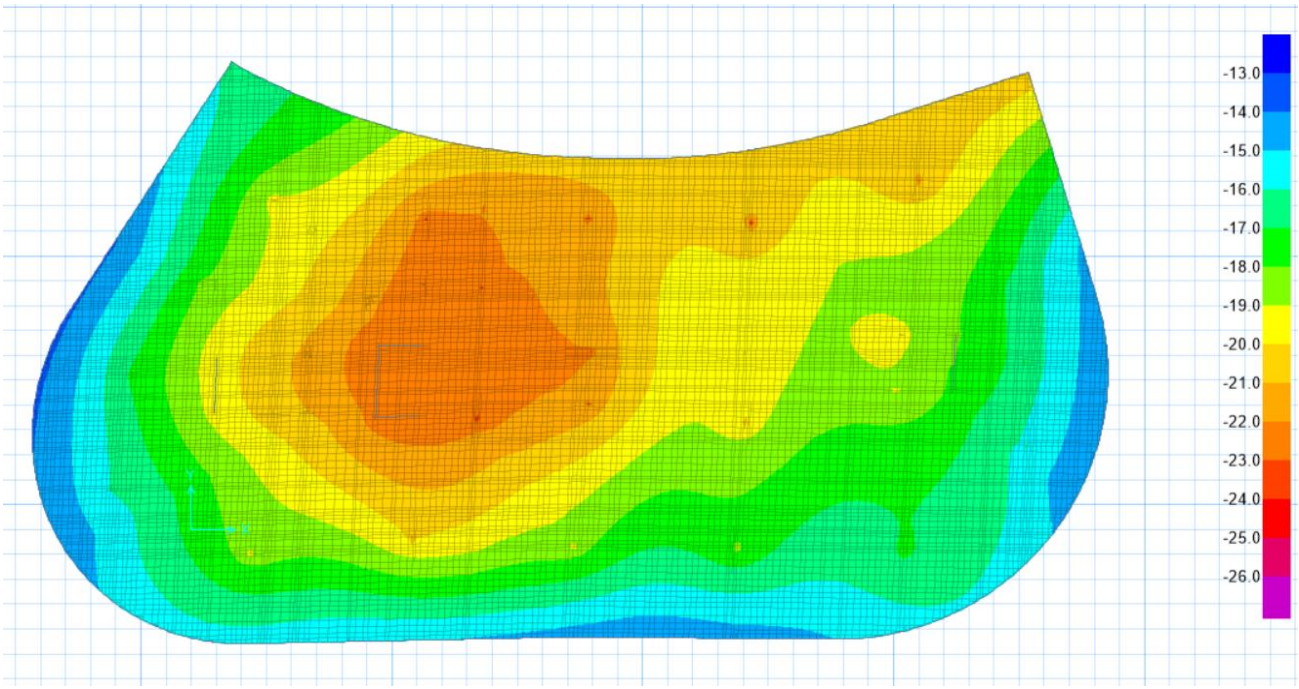
Figure 2.46: M2.2 negative with mesh

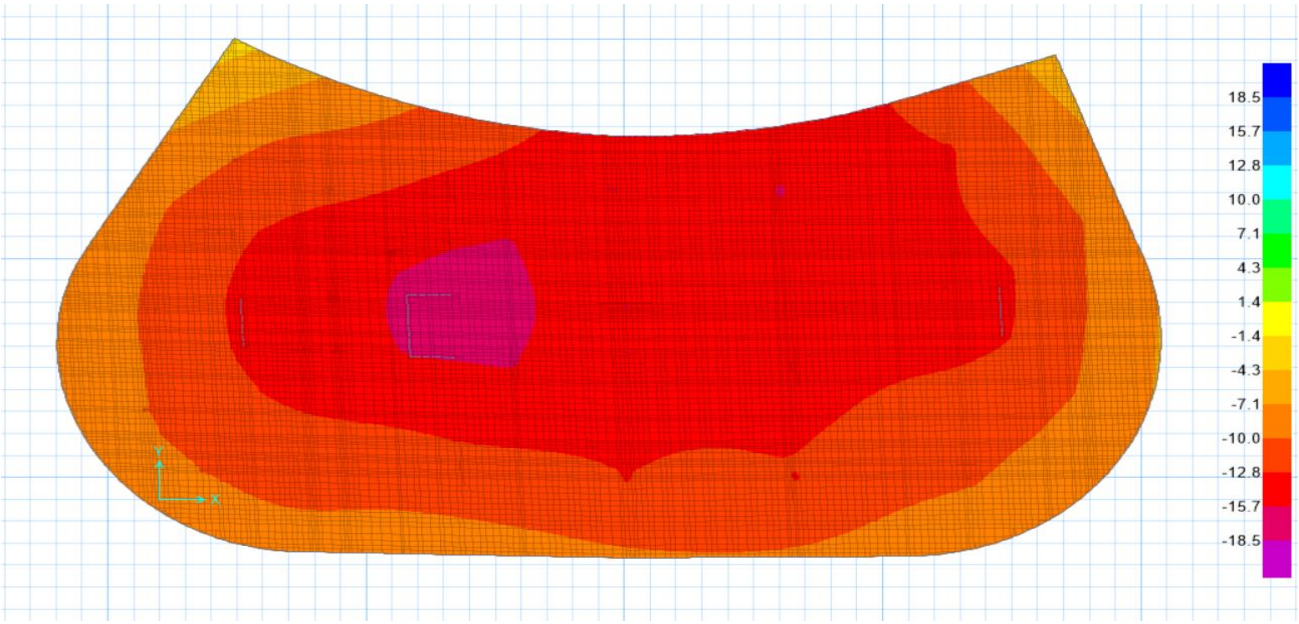
Check of punching



- Safe punching

Check of stress





- Unsafe stress
- Use raft with pile

2.13.3. Design of raft on piles

Check Positive Moment in X Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

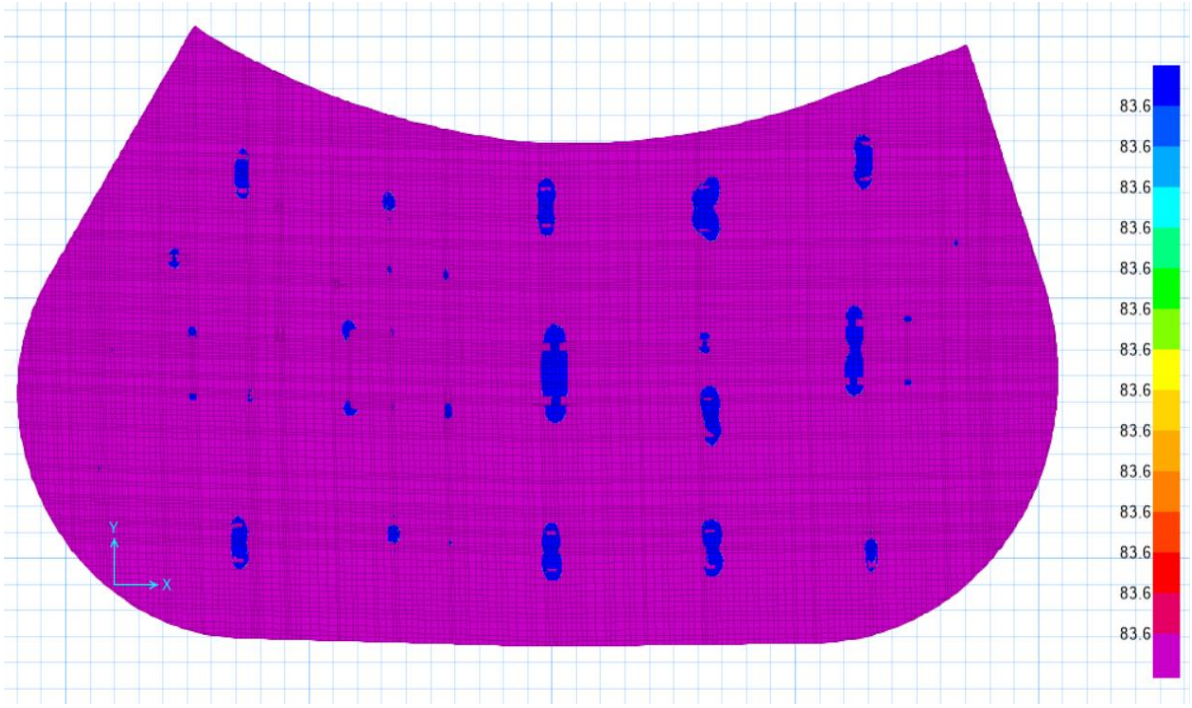


Figure 2.47: M1.1 positive with mesh

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

Additional		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

Total	167.12

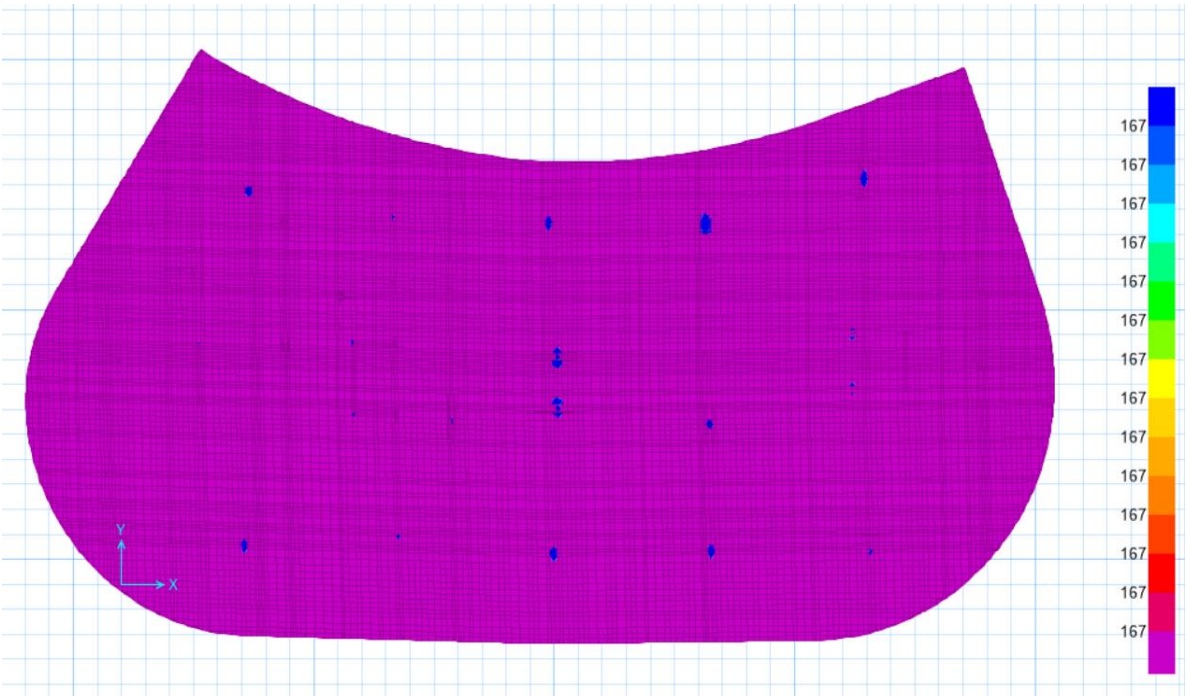


Figure 2.48: M1.1 positive with additional

Check Positive Moment in Y Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

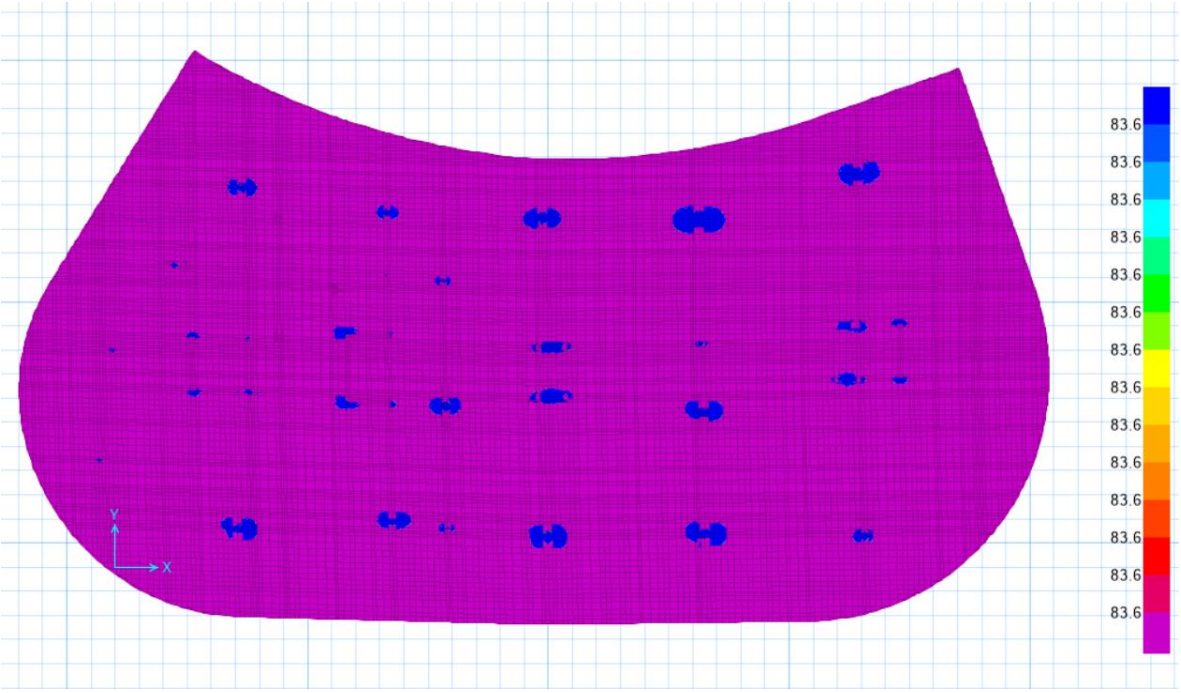


Figure 2.49: M2.2 positive with mesh

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

Additional		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

Total	167.12

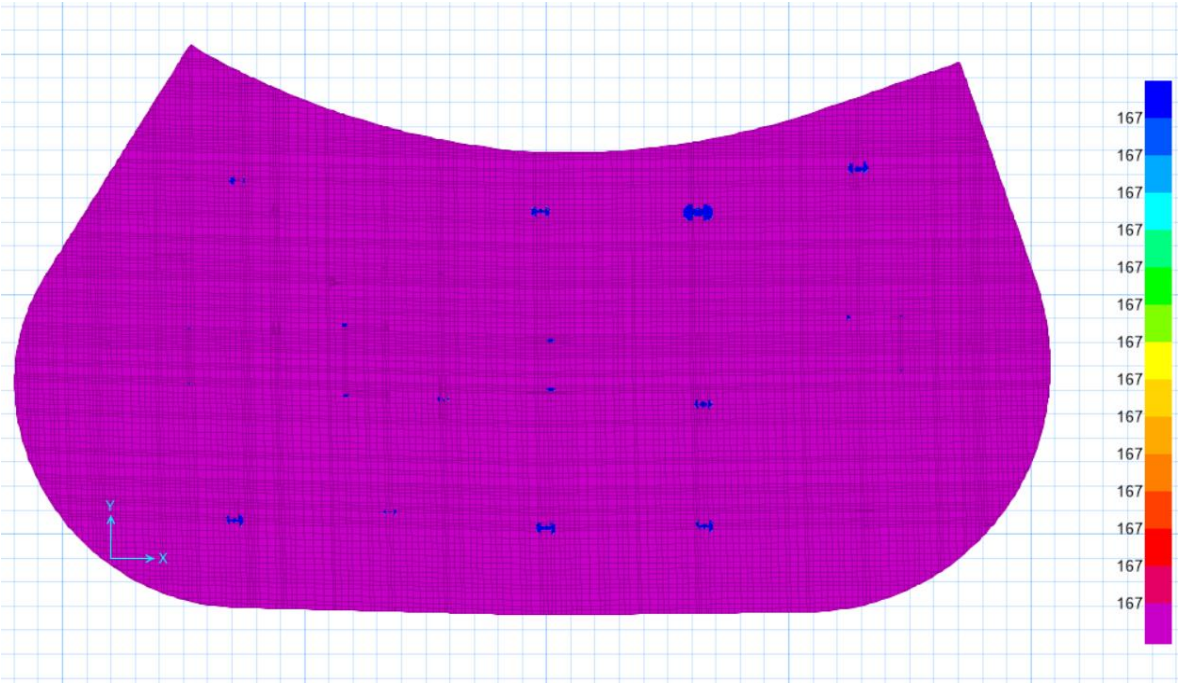


Figure 2.50: M2.2 positive with additional

Check negative Moment in X Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

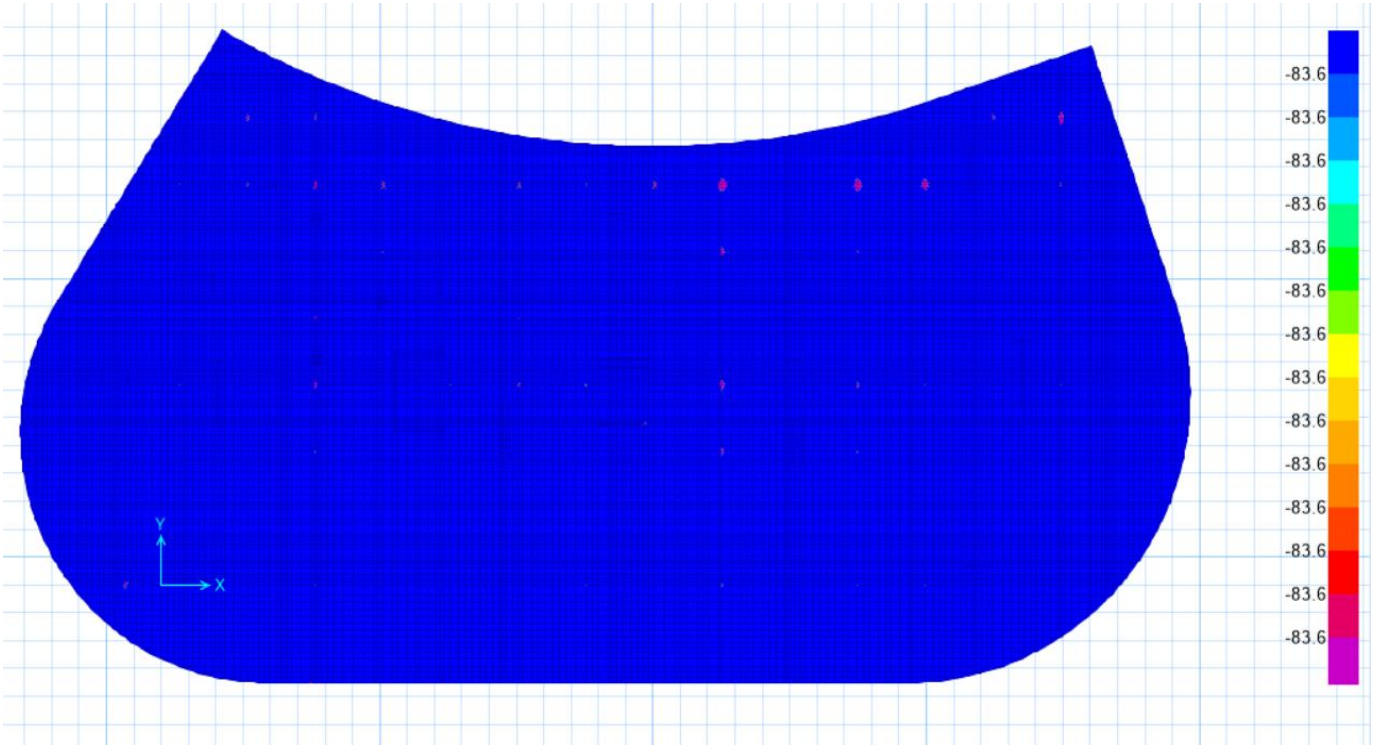


Figure 2.51: M1.1 negative with mesh

Check negative Moment in Y Direction

Mesh		ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	20	2513.27	350	1200	1150	0.826	83.557568

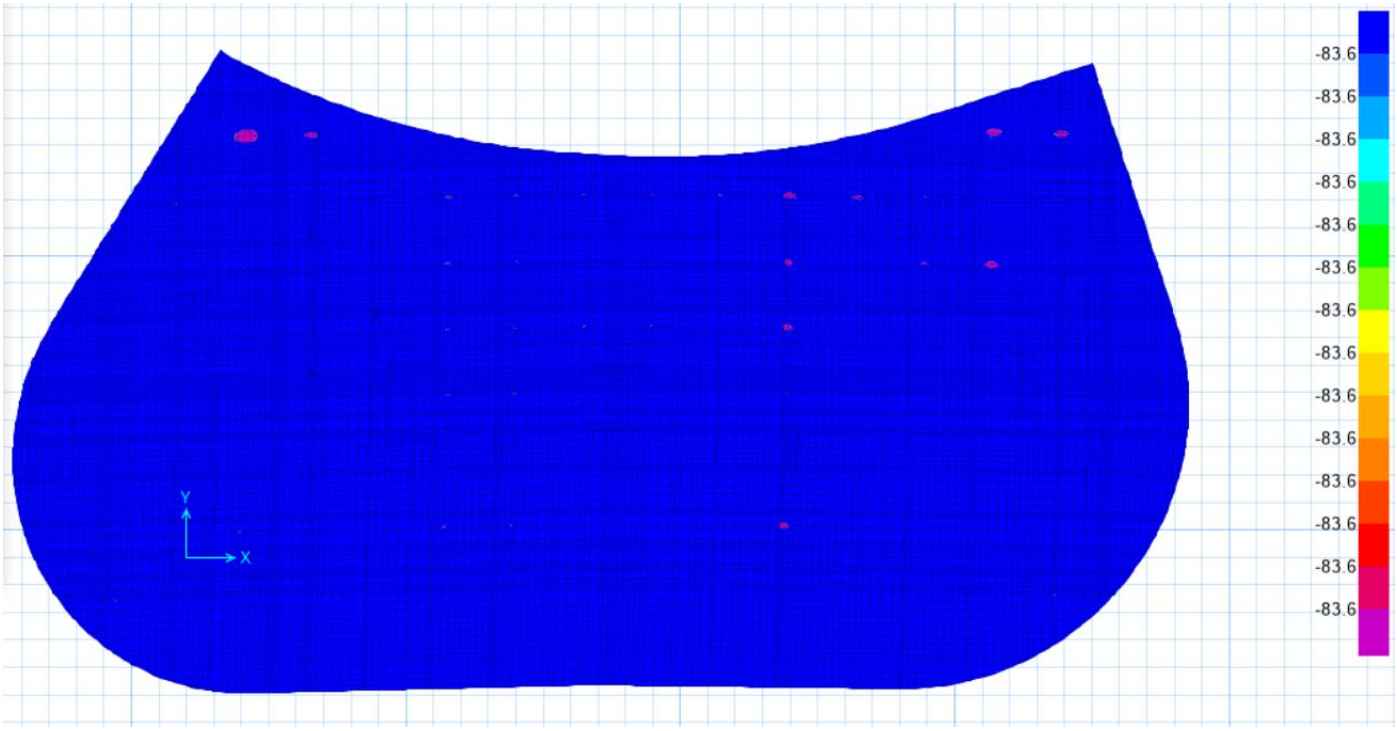
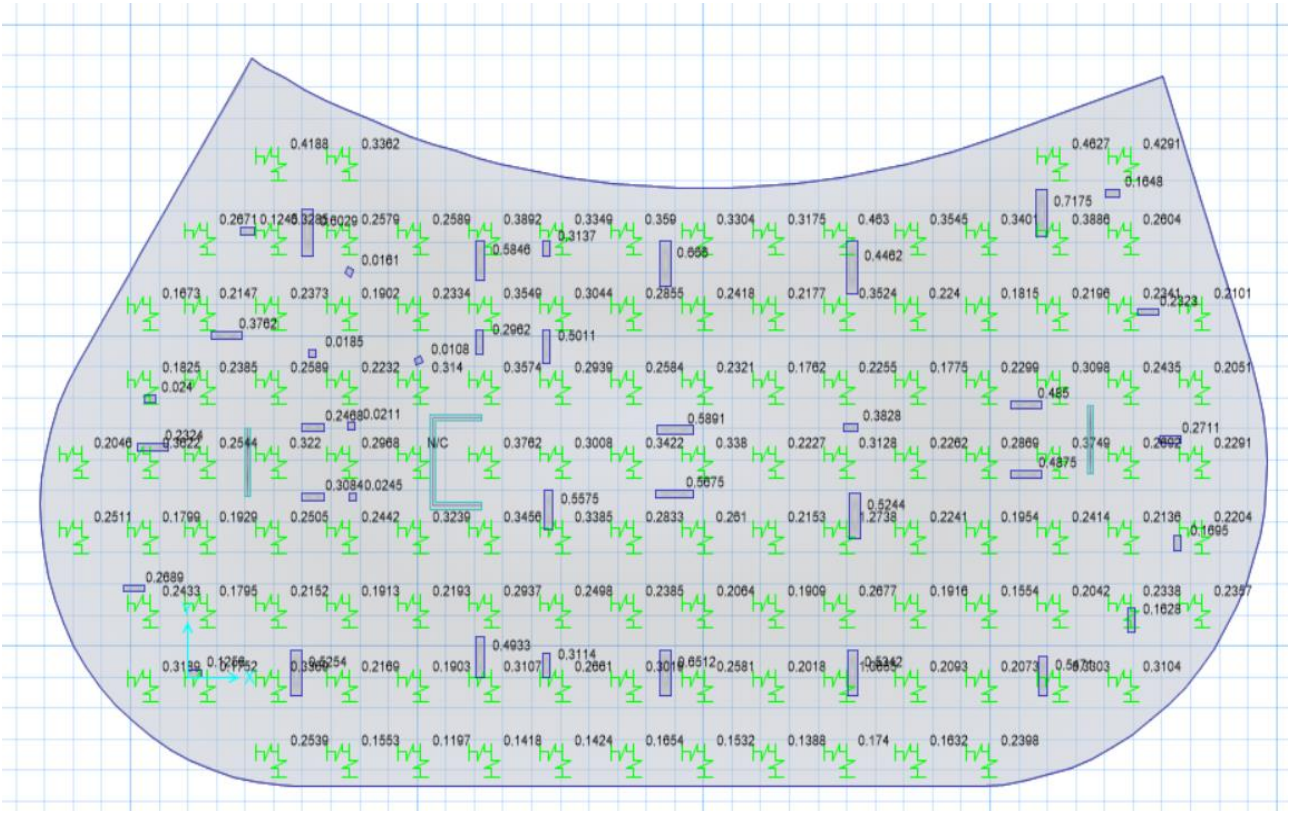


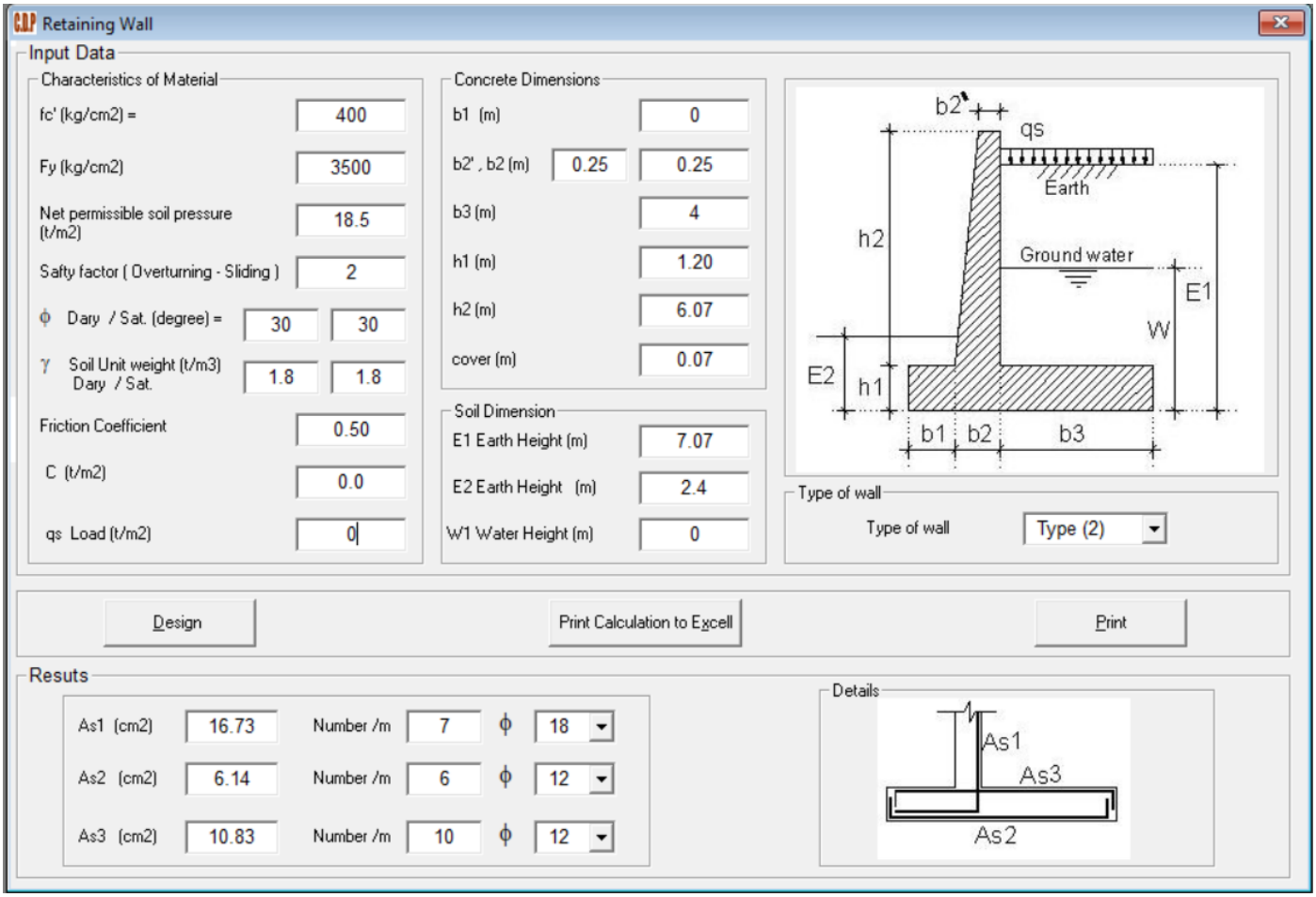
Figure 2.52: M2.2 negative with mesh

Check of punching



- Safe punching

Design of Retaining walls



Design of Rumb(upper)

Moment of slabs

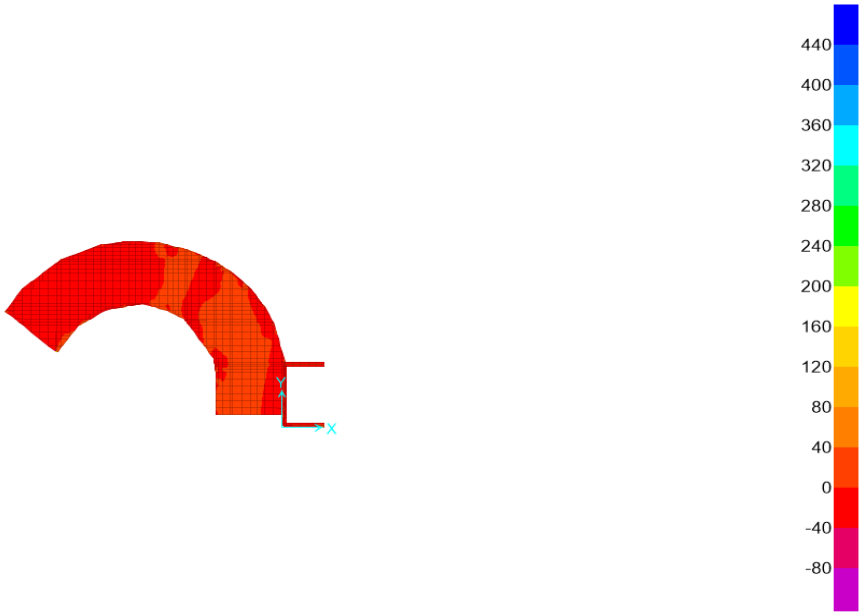


Figure 2.53: M1.1

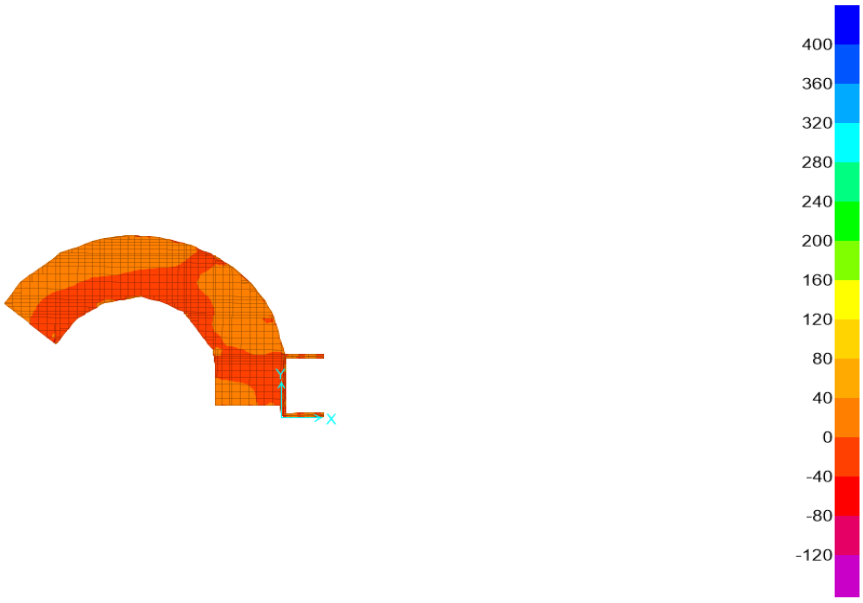


Figure 2.54: M2.2

Design of slab

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	12	904.7787	350	150	130	0.826	3.40043

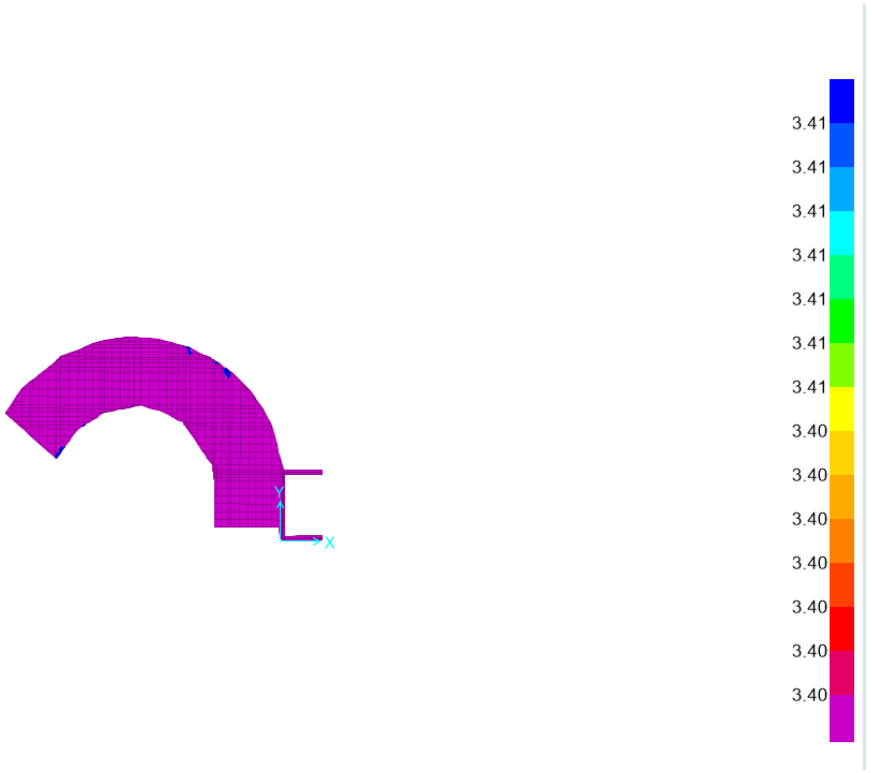


Figure 2.55: M1.1

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	8	12	904.7787	350	150	130	0.826	3.40043

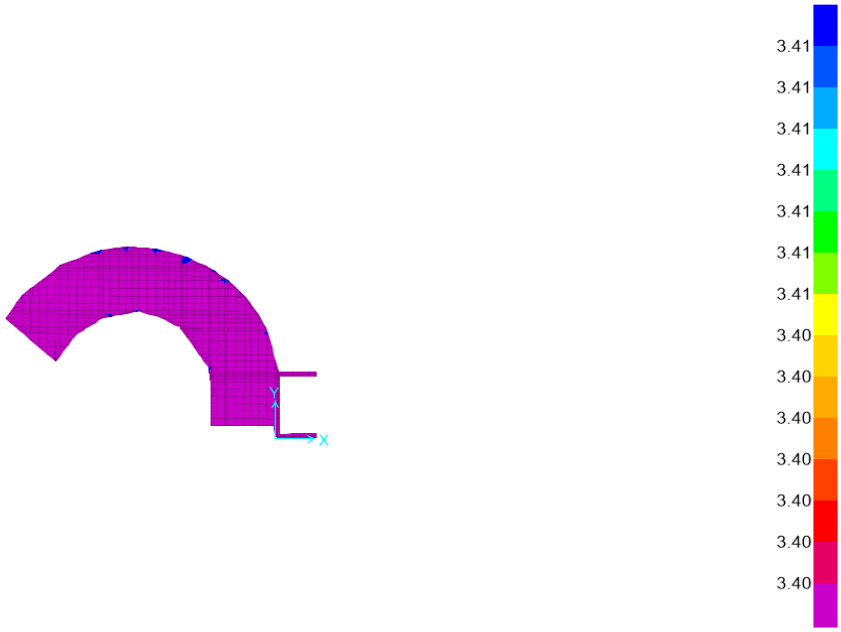
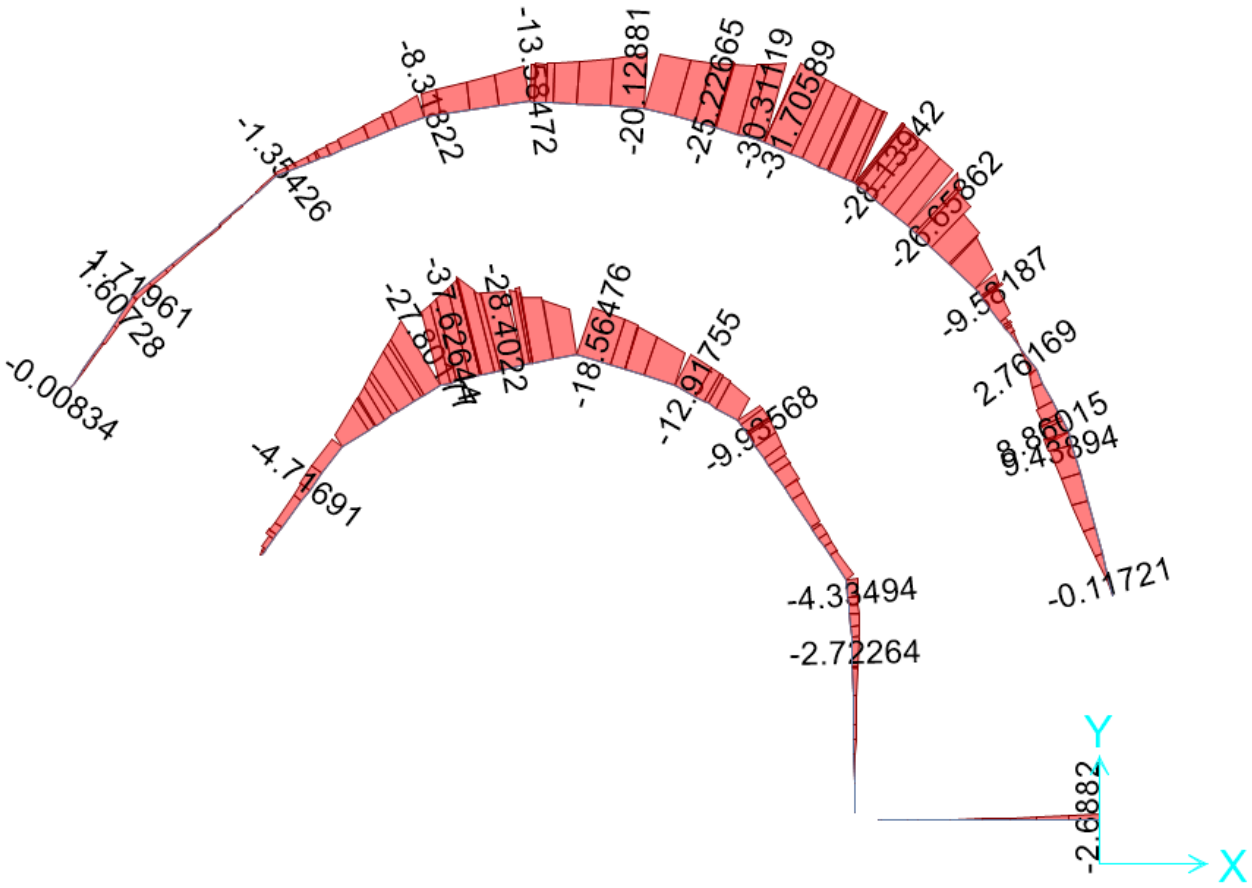


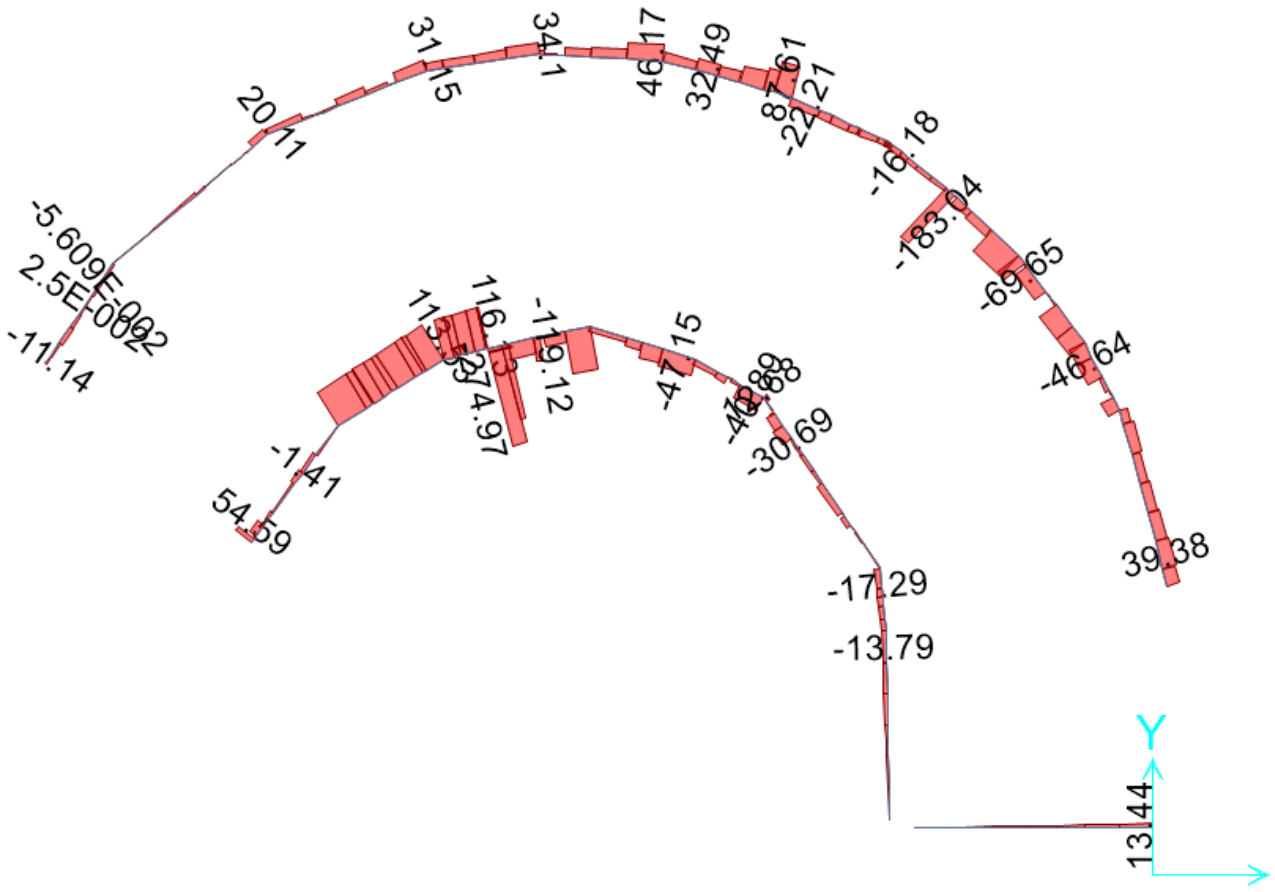
Figure 2.56: M2.2

Design of Ring Beam

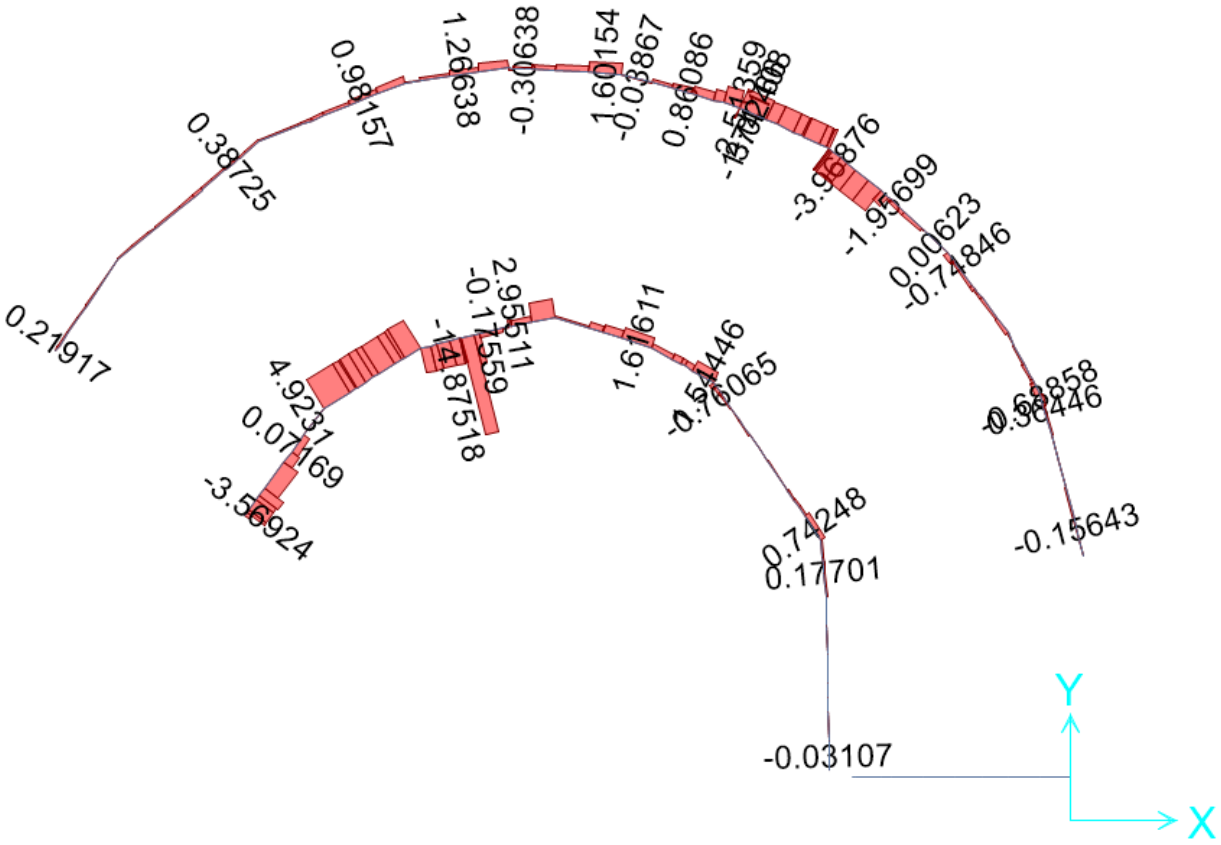
moment of Beams



Shear of Beam



Torsion of Beam



Check concrete dimensions

Concrete F_{cu} =	400	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	37.6	25	25	60	*3.094*	*0.753*	*4.71*	*23.79*	*7* ϕ 22	***safe***

Check shear and torsion

Concrete	F_{cu} =	400	kg/cm^2
Concrete	q_{all} =	12.247	kg/cm^2
Stirrups	F_y =	3500	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
1	4.92	25	60	22

Due to shear	q_{su}		Notes
	16.00	kg/cm^2	***unsafe***

Due to torsion	q_{tu}		Notes
	39.36	kg/cm^2	***unsafe***

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	2.8	16	

Due to torsion	no.	ϕ	Notes
	4.2	16	

Horizontal Rft.	no.	ϕ
	7	16

Design of Beam

Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	8	22	3041.061689	350	600	575	0.72	0.9	39.7

Design of Rumb(Lower)

Moment of slabs

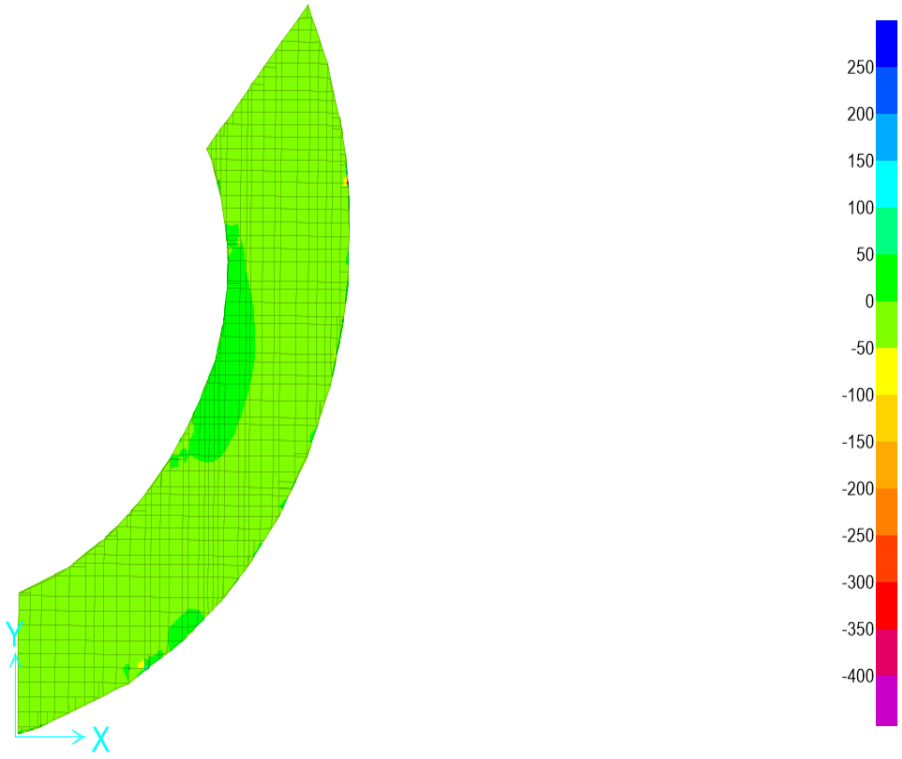


Figure 2.57: M1.1

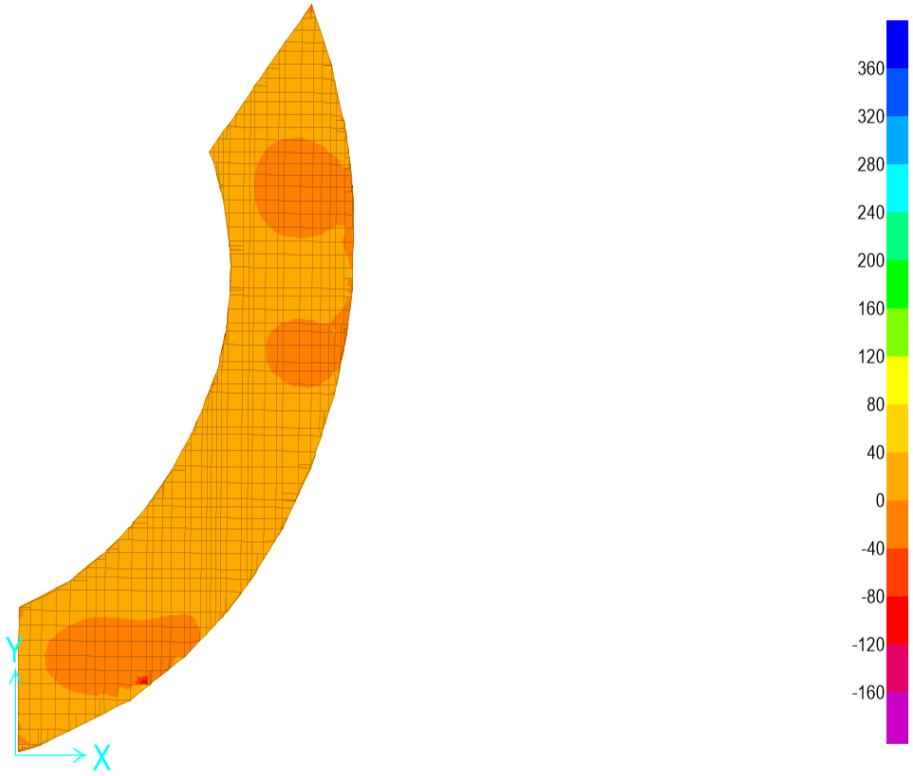


Figure 2.58: M2.2

Design of slab

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	16	1206.372	350	150	130	0.826	4.533906



Figure 2.59: M1.1

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	6	16	1206.372	350	150	130	0.826	4.533906

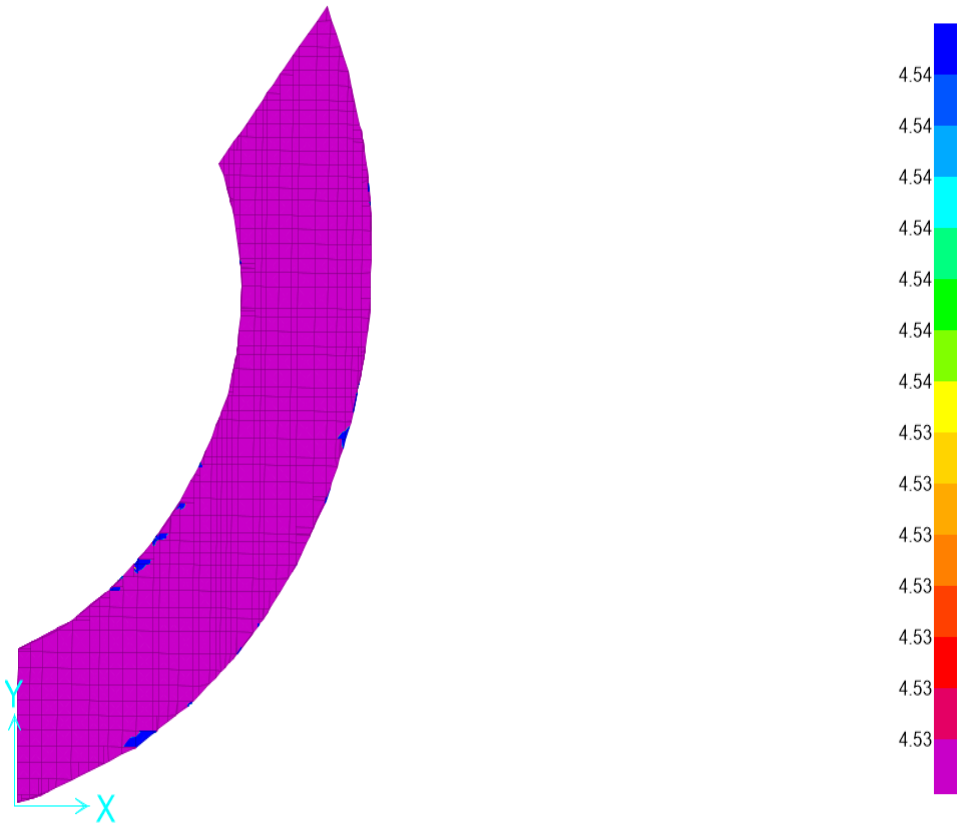
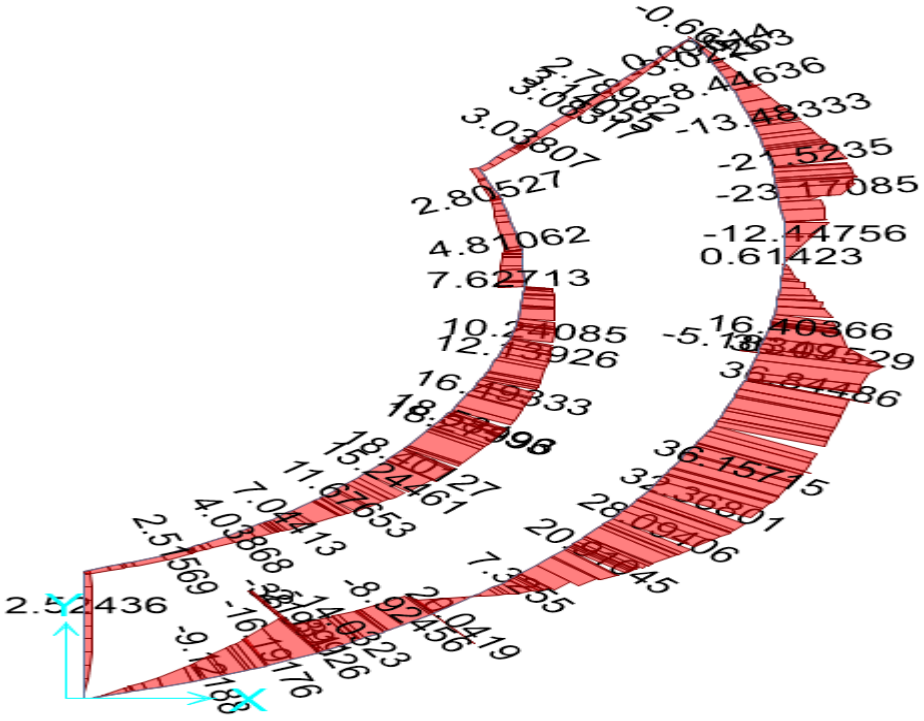


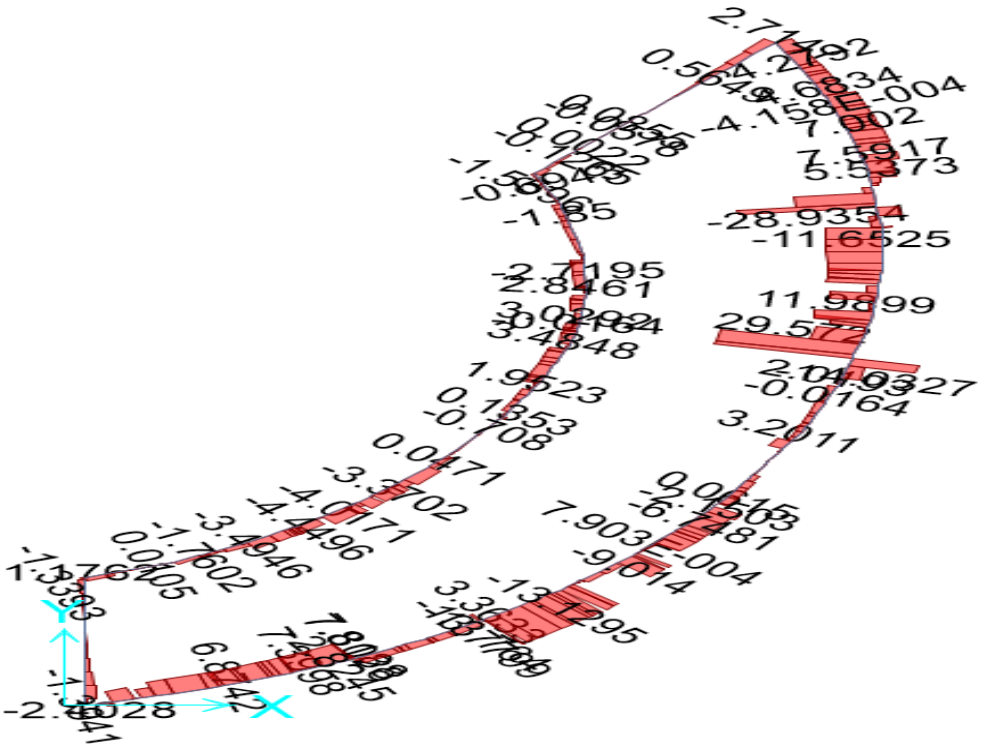
Figure 2.60: M2.2

Design of Ring Beam

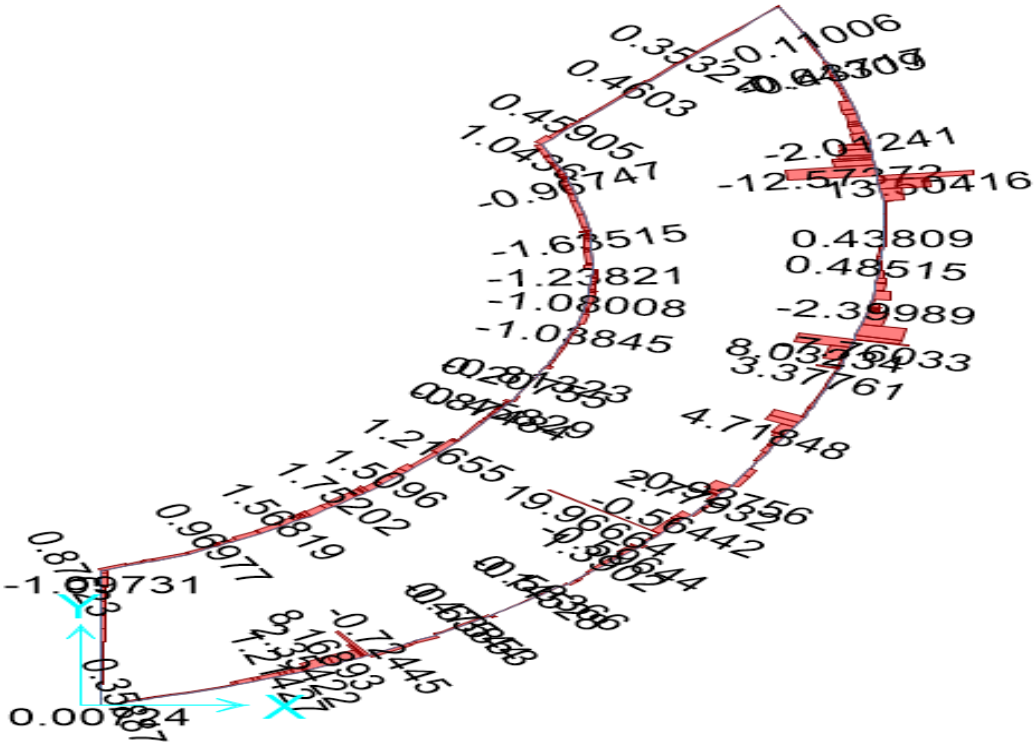
moment of Beams



Shear of Beam



Torsion of Beam



Check concrete dimensions

Concrete	F_{cu} =	400	kg/cm^2
Steel	F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.			Notes
	18.5	25	25	60	*4.411*	*0.817*	*4.71*	*10.79*	*3*	ϕ	22	***safe***

Check shear and torsion

Concrete	F_{cu} =	400	kg/cm^2
Concrete	q_{all} =	12.247	kg/cm^2
Stirrups	F_y =	3500	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
1	1.7	25	60	3.4

Due to shear	q_{su}		Notes
	2.47	kg/cm^2	*safe*

Due to torsion	q_{tu}		Notes
	13.60	kg/cm^2	*safe*

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	1.1	8	

Due to torsion	no.	ϕ	Notes
	3.8	8	

Horizontal Rft.	no.	ϕ
	6	8

Design of Beam

Main RFT		Ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	8	16	1608.495439	350	600	575	0.72	0.9	21.0

	UNIT 3 / FRAMES	
	TITLE	
1	Project description	
2	The programs used	
3	The Architecture plans	
4	Design of level zero	
5	Design of level 5.4m	
6	Design of level 11.4m	
7	Design of *saw tooth stair*	
8	Design of Frames	
9	Design of columns	
10	Design of footing	

3.1. Project description

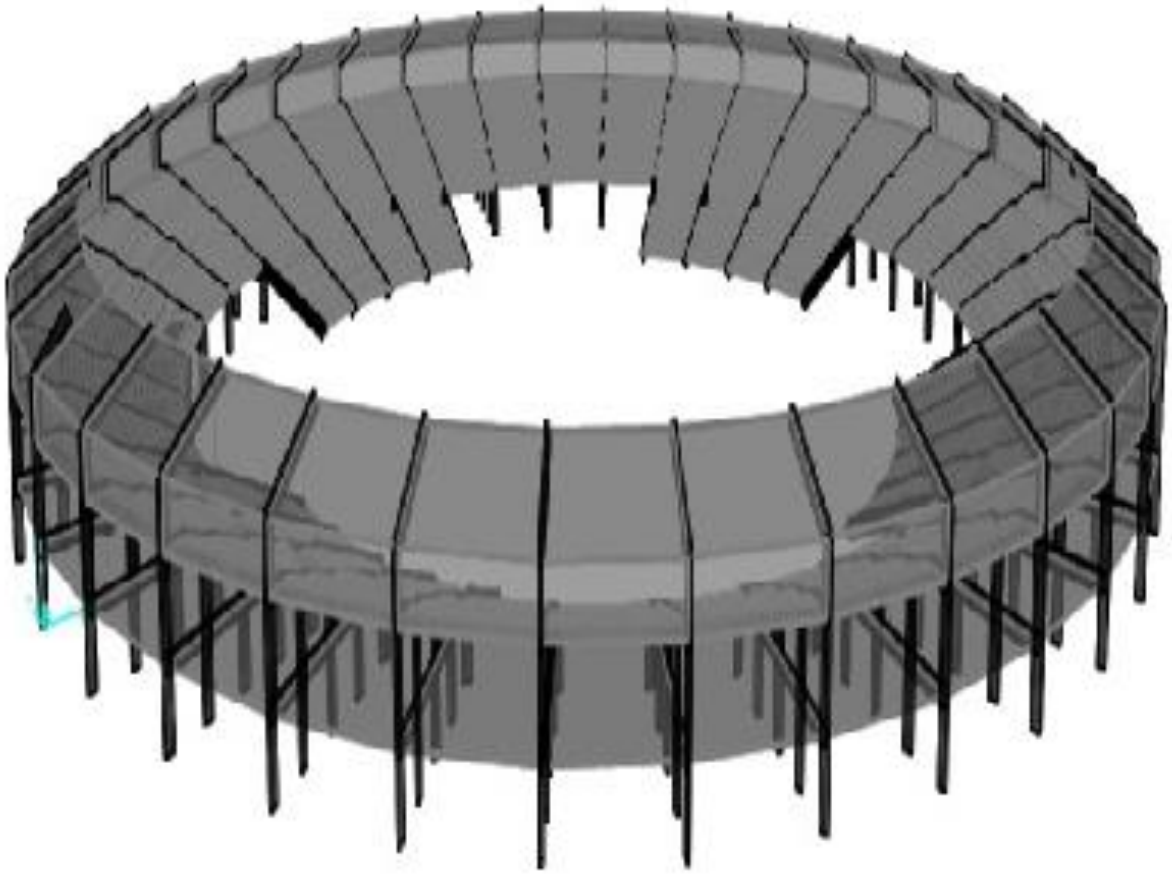
- *The Project consists of 5 floors.*
- *Basement, ground, 3 typical floors.*
- *Building area is 4415 m^2*
- *the height of the floor is 3.6 m, except for the basement is 2.40m, and ground floor is 3m*
- *Capacity 120000 watching*
- *Total height of building is 15 m*
- *Statical system: solid slab-saw tooth stair-frames*
- *All Slabs Designed Due To Solid slab System*

With Thickness = 10 cm & 12 cm

Design Codes

- *Egyptian code for design concrete structure (ECP 203-2018).*
- *Egyptian code for calculating loads and forces in construction and building works ECP(201-2018).*

3D MODEL



3.3.the programs used



SAFE 2016

POWERPOINT

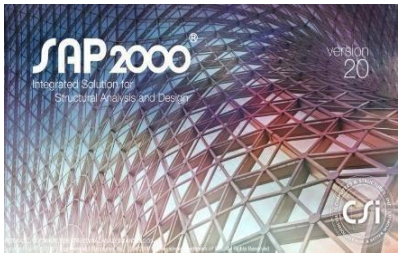


EGYPTIAN CODE CONCRETE (C.D.P)

EXCEL



AUTOCAD 2020



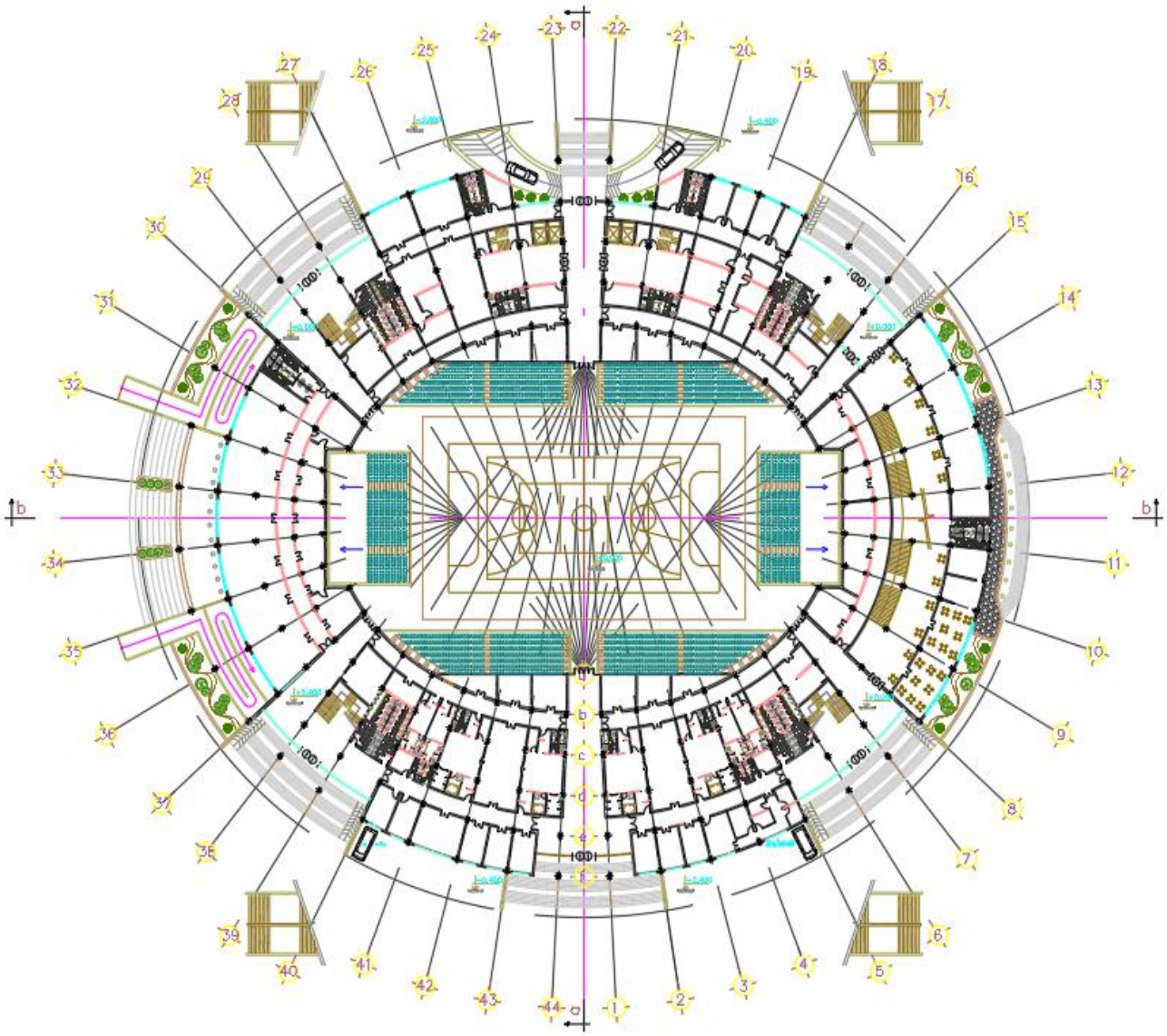
Sap 2020

WORD

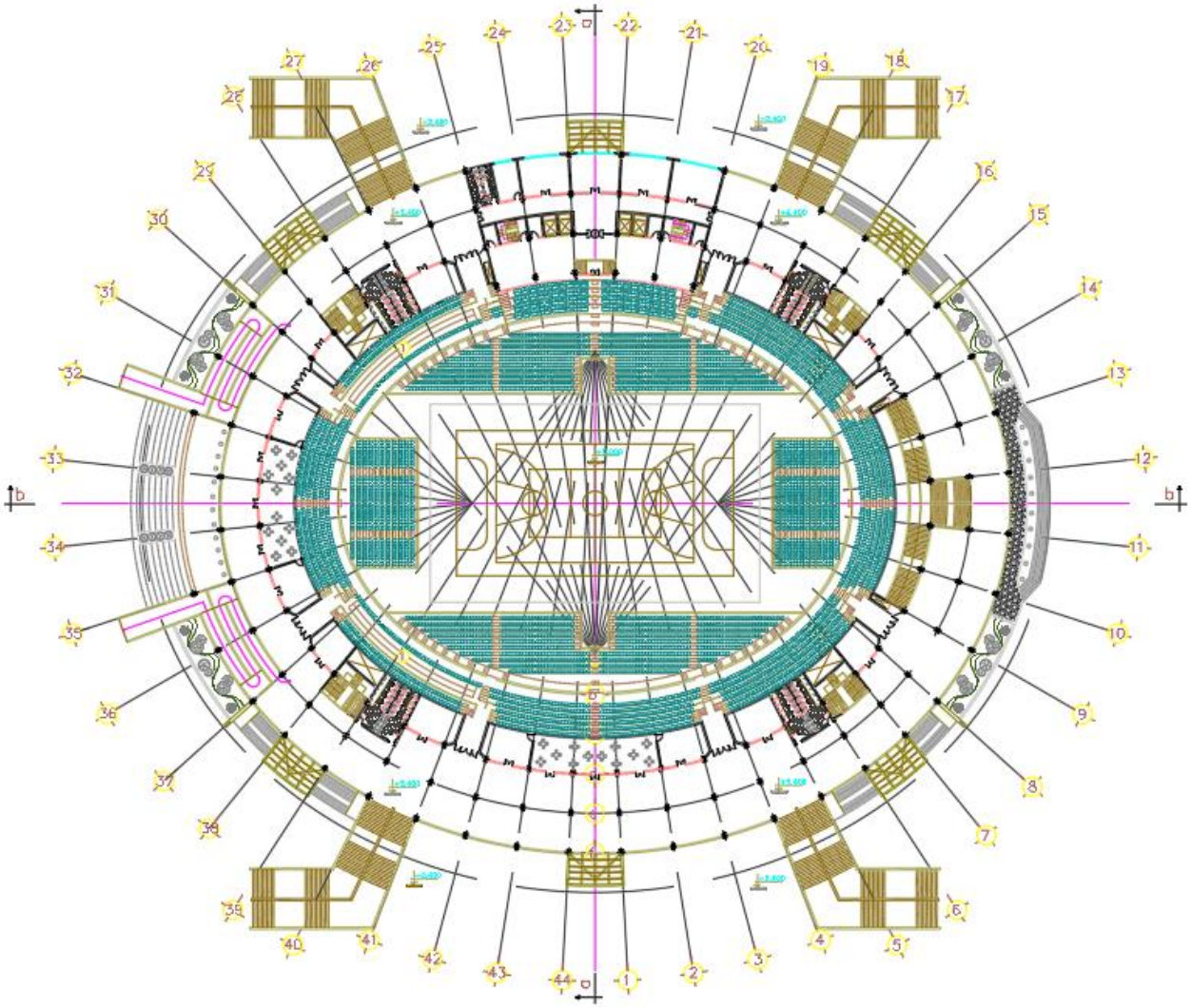
3.3 The Architecture plans

3.1.1 The Architecture plans

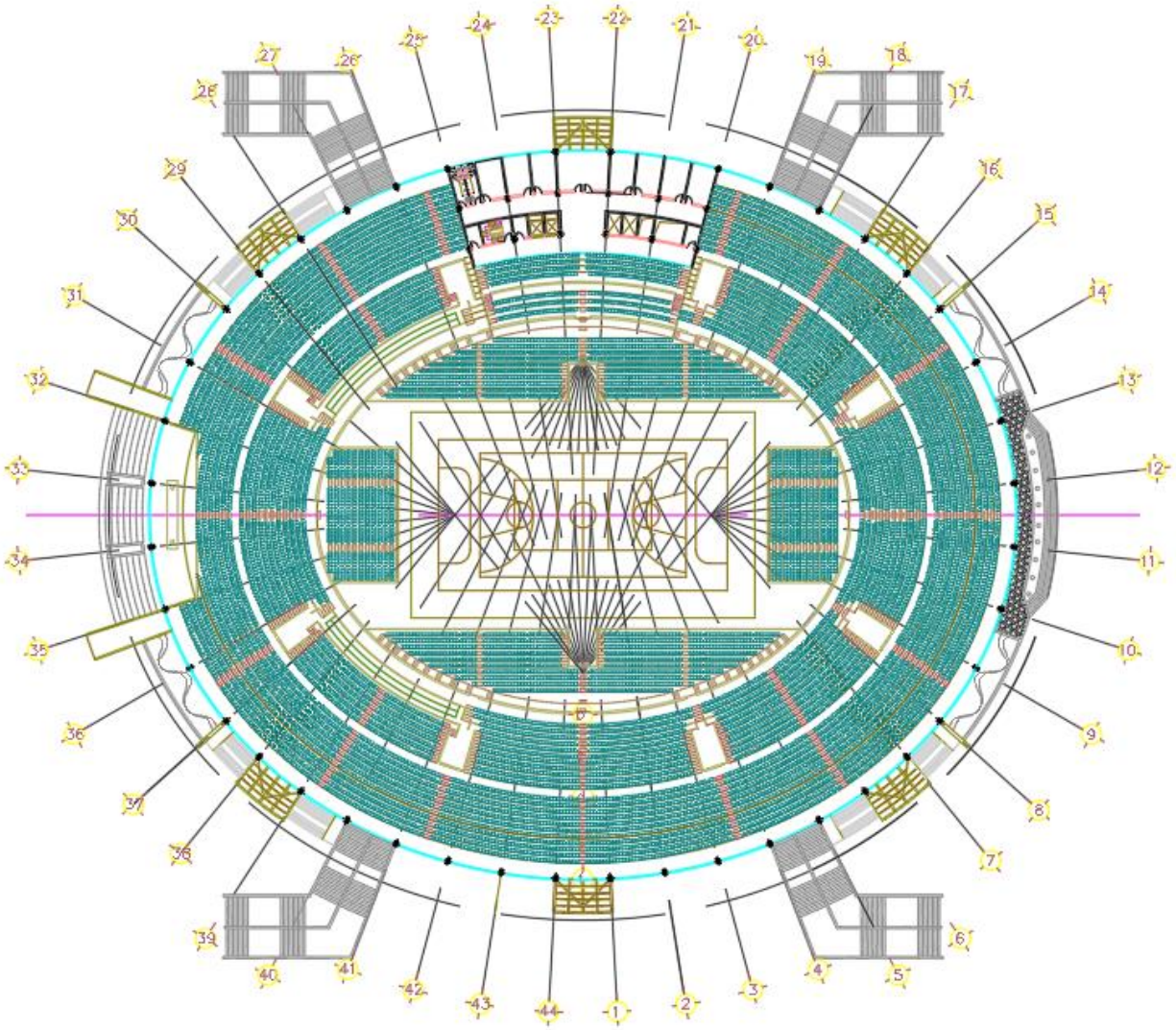
Level zero



Level 5.4m



Level 11.4m



3.4 Design of Level (zero)

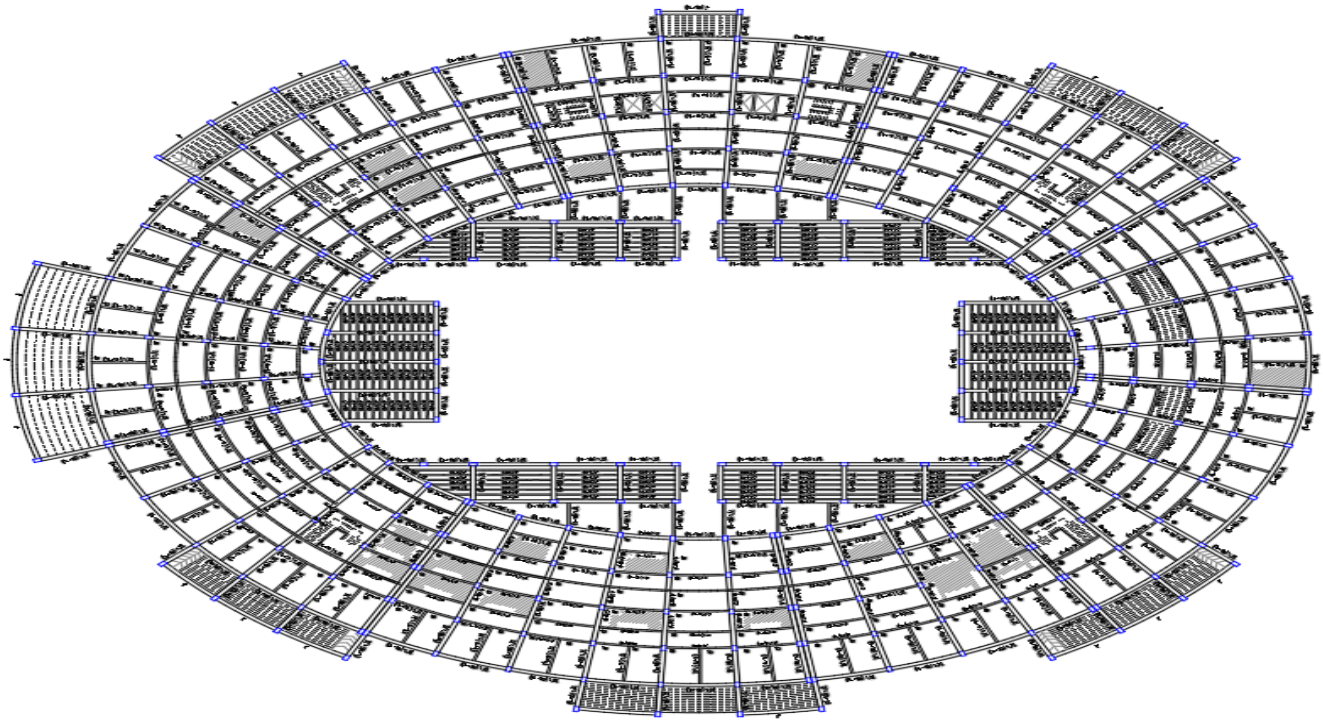
3.4.1. ***Design notes***

- The Ceiling of the first floor is designed in solid slab system

Designed on:

- Own wight calculated by safe
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2800 kg/cm²)

3.4.2. *Statical system*



3.4.3 Moment of slabs

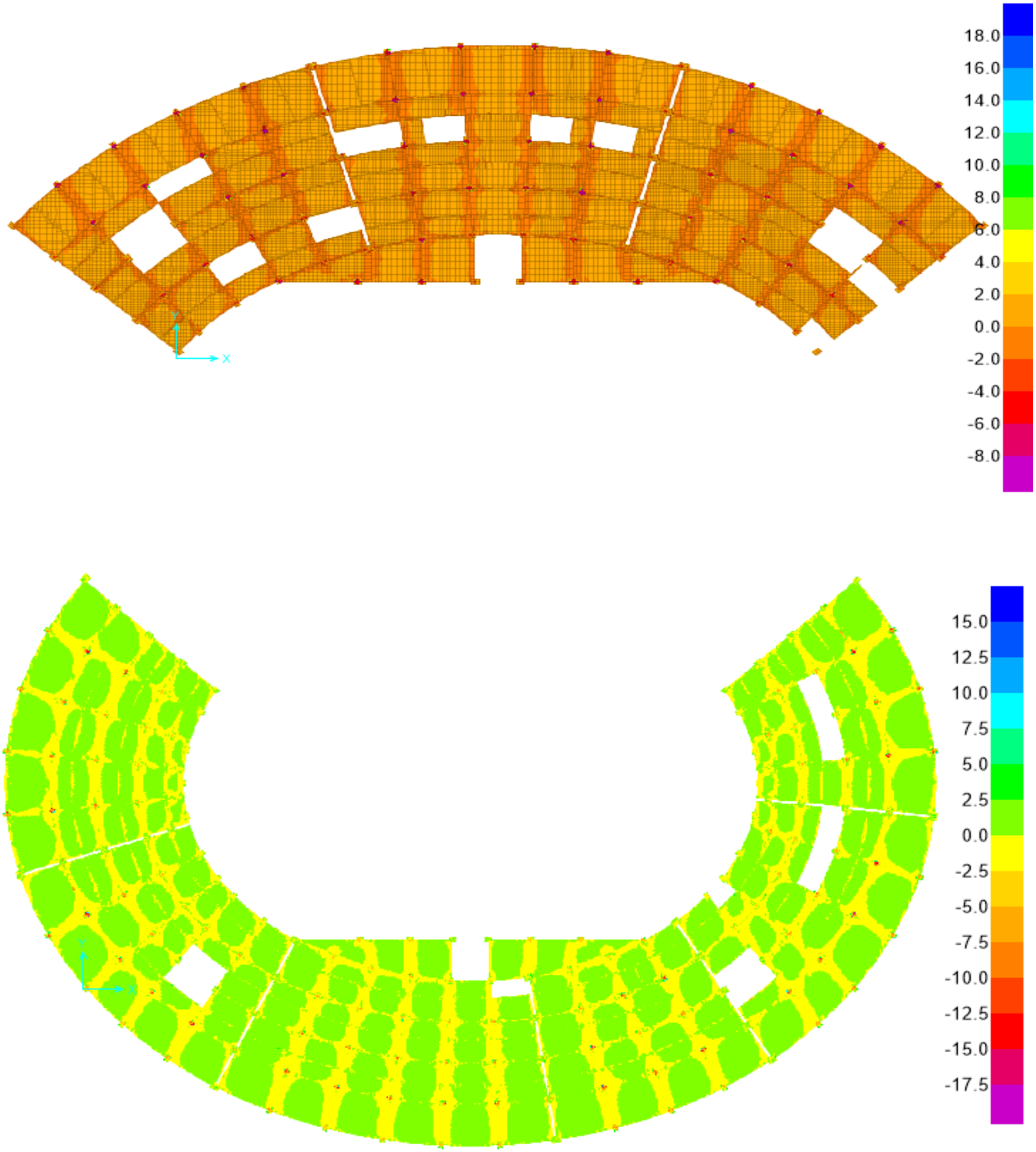
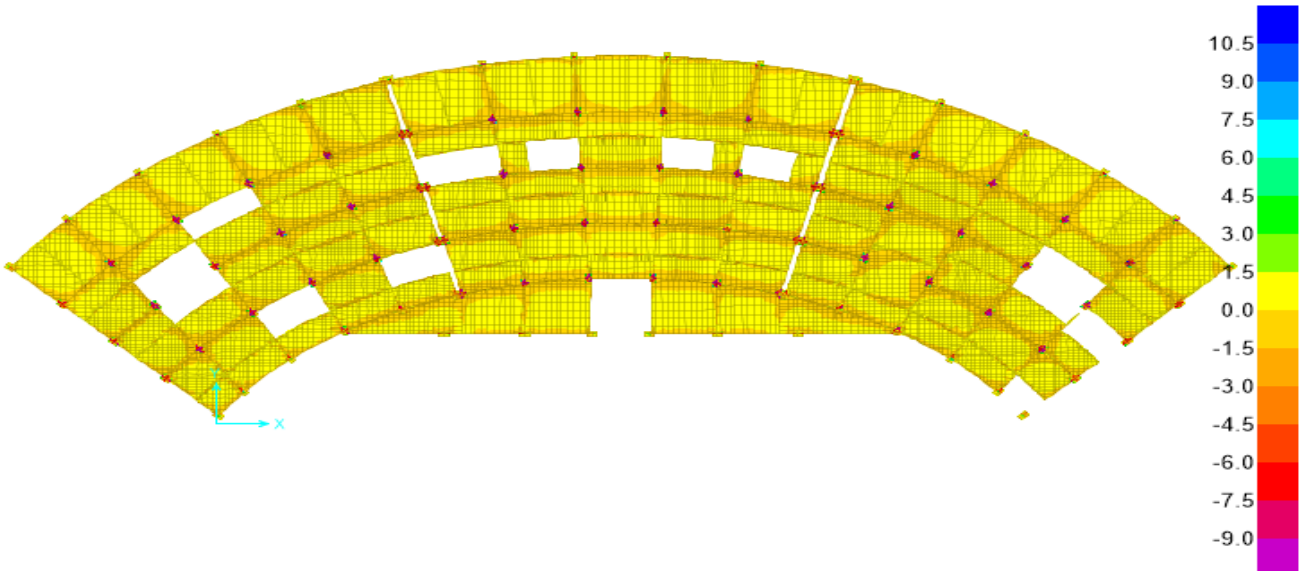


Figure 3.1: M1.1 positive



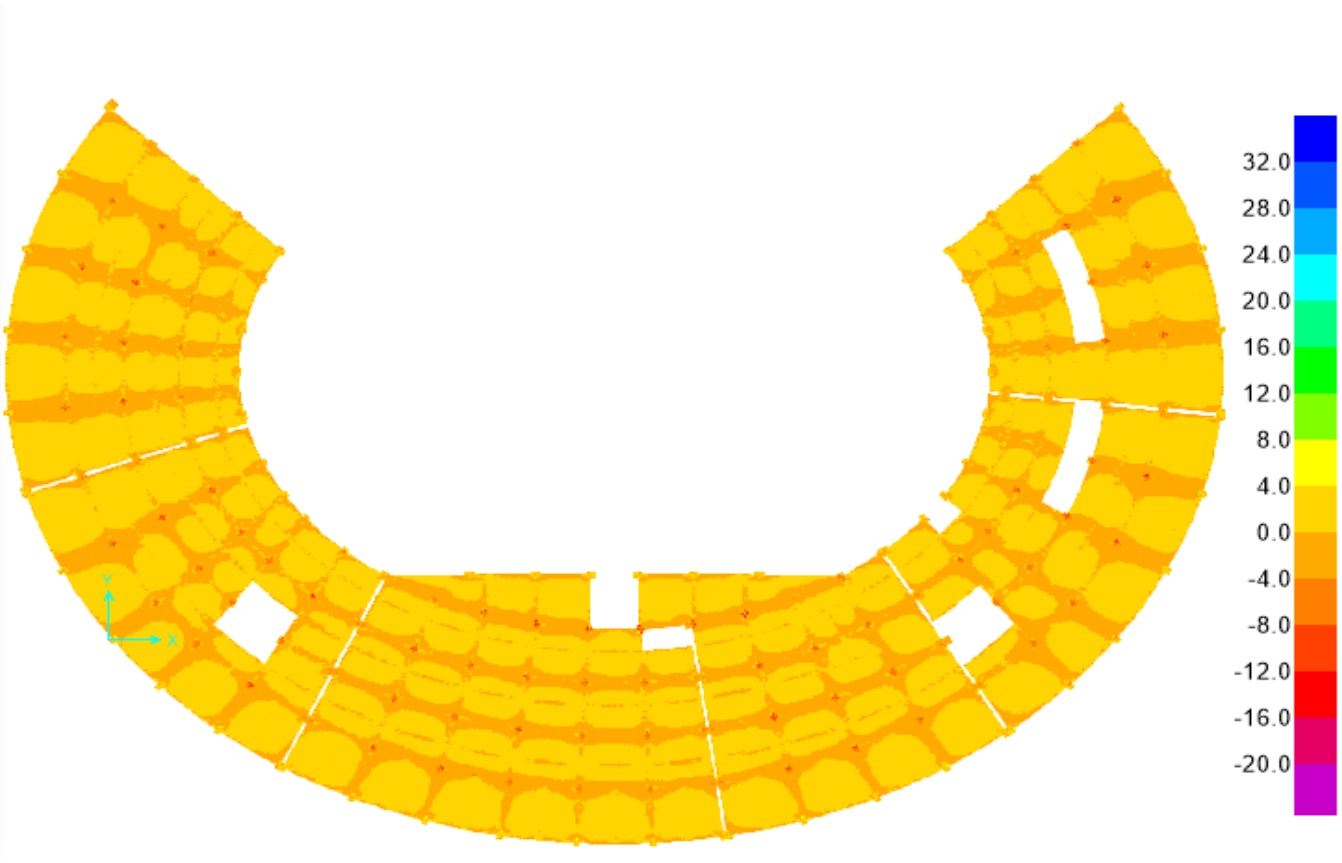


Figure 3.2: M2.2 positive

3.4.4 Design of slaps

- *Take Ts (solid slab) = 12 cm*

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529

Check Positive Moment in X Direction

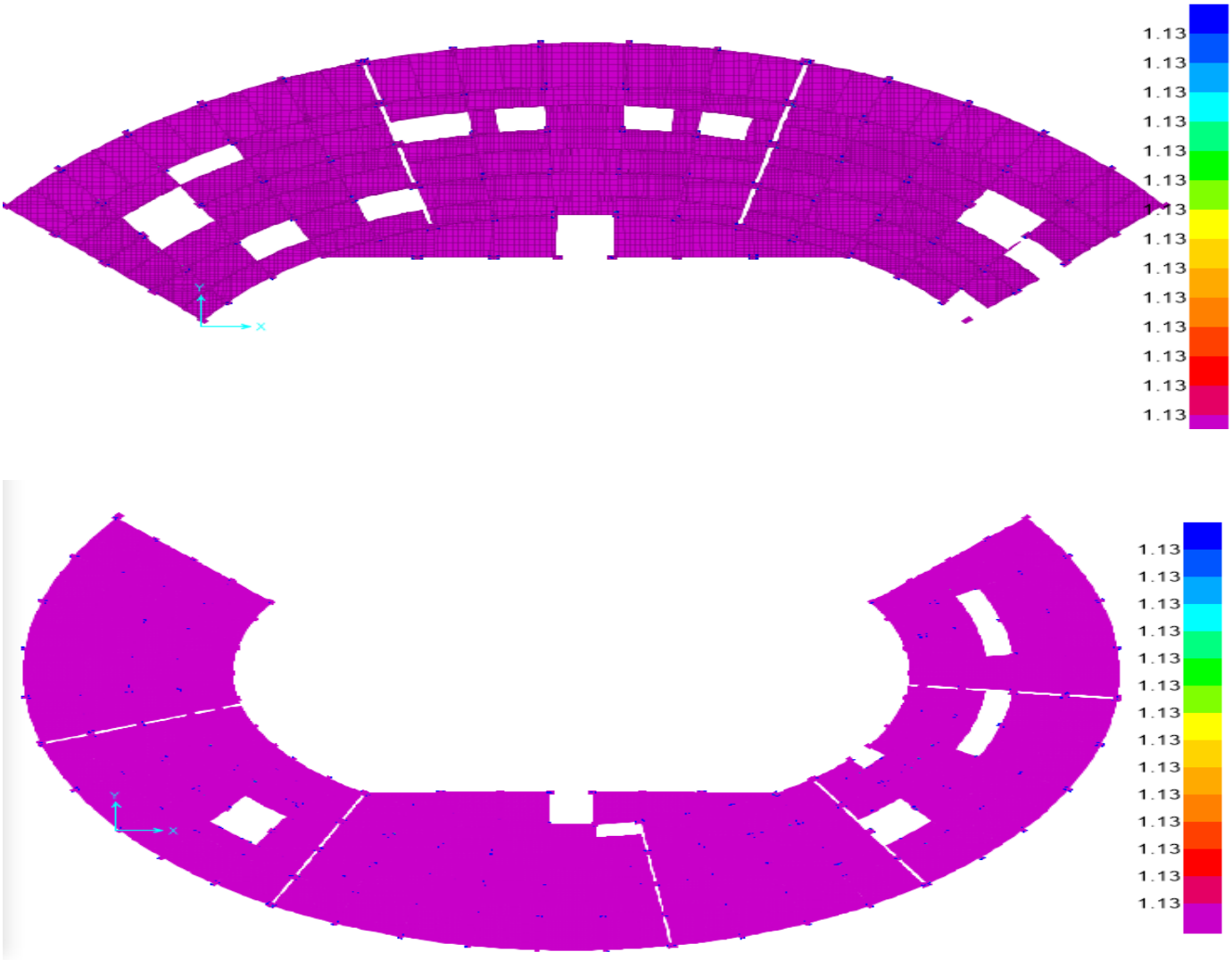
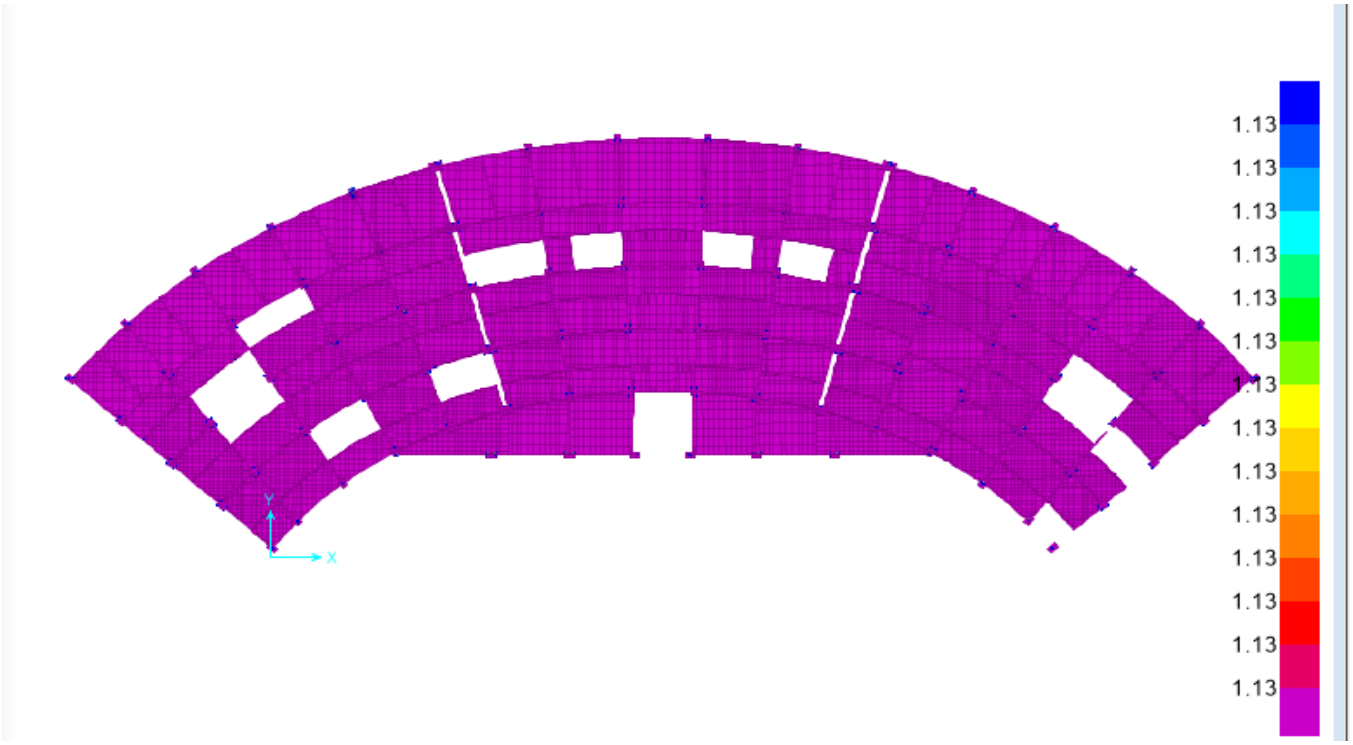


Figure 3.3: M1.1 positive with mesh

Check Positive Moment in Y Direction



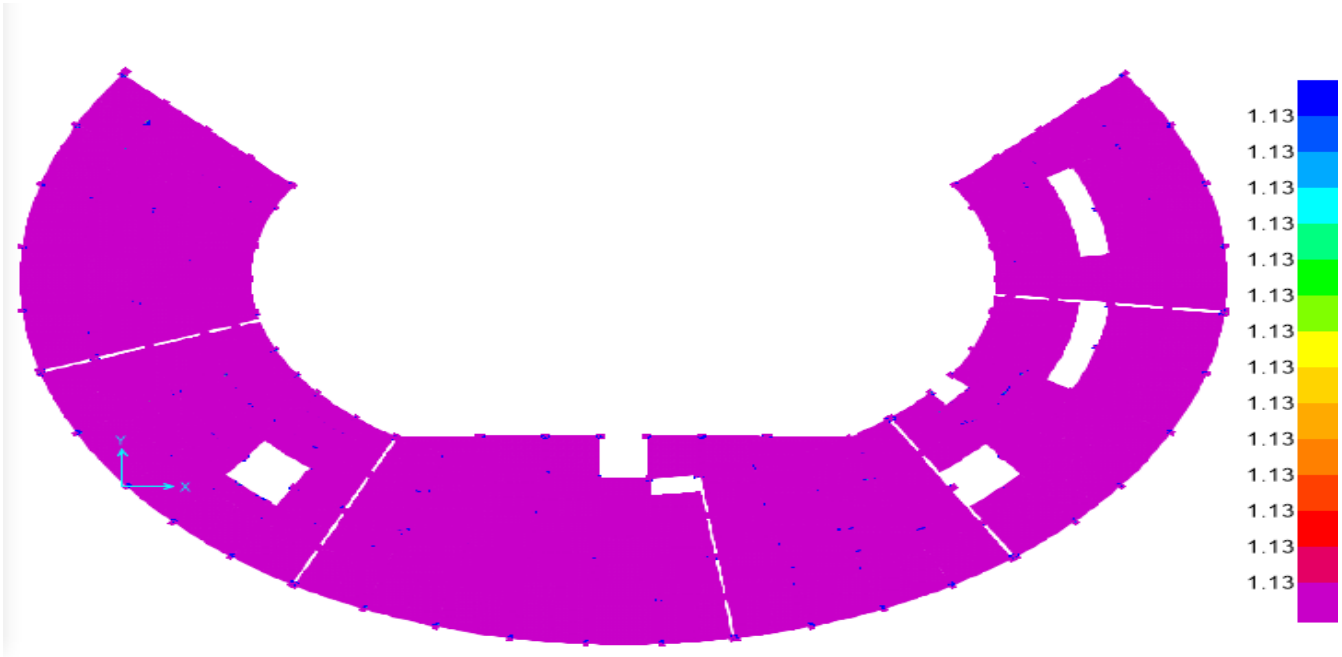
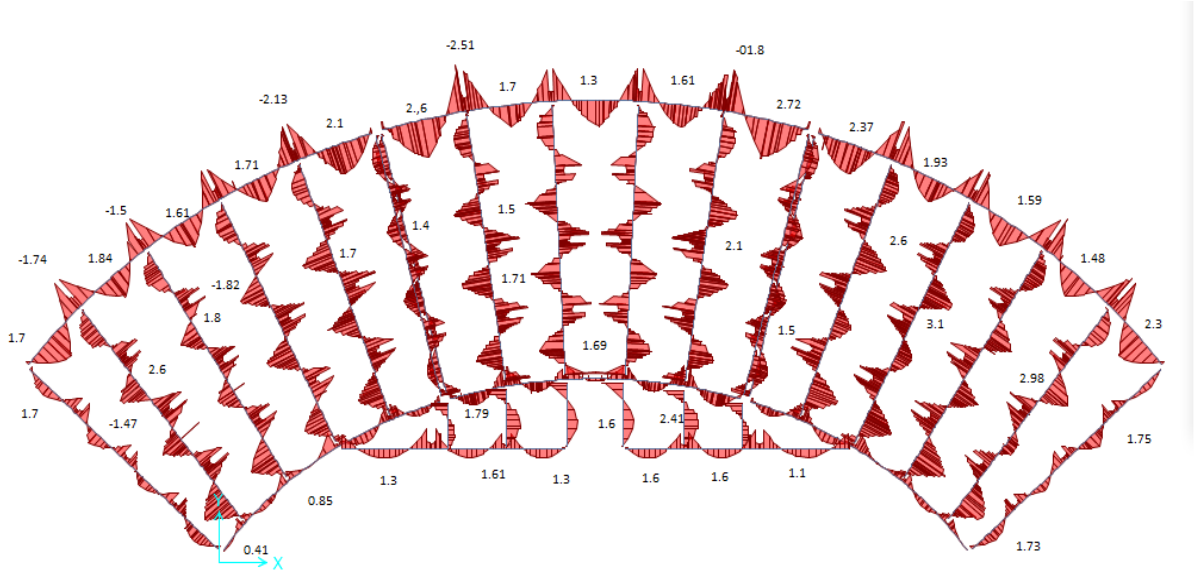
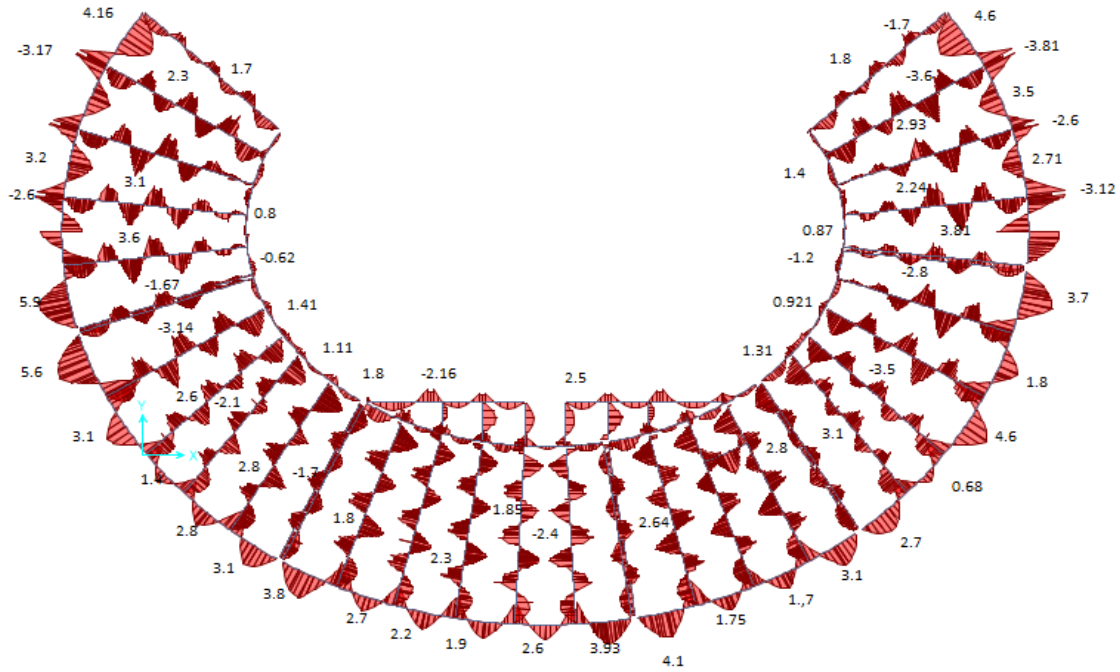


Figure 3.4: M2.2 positive with mesh

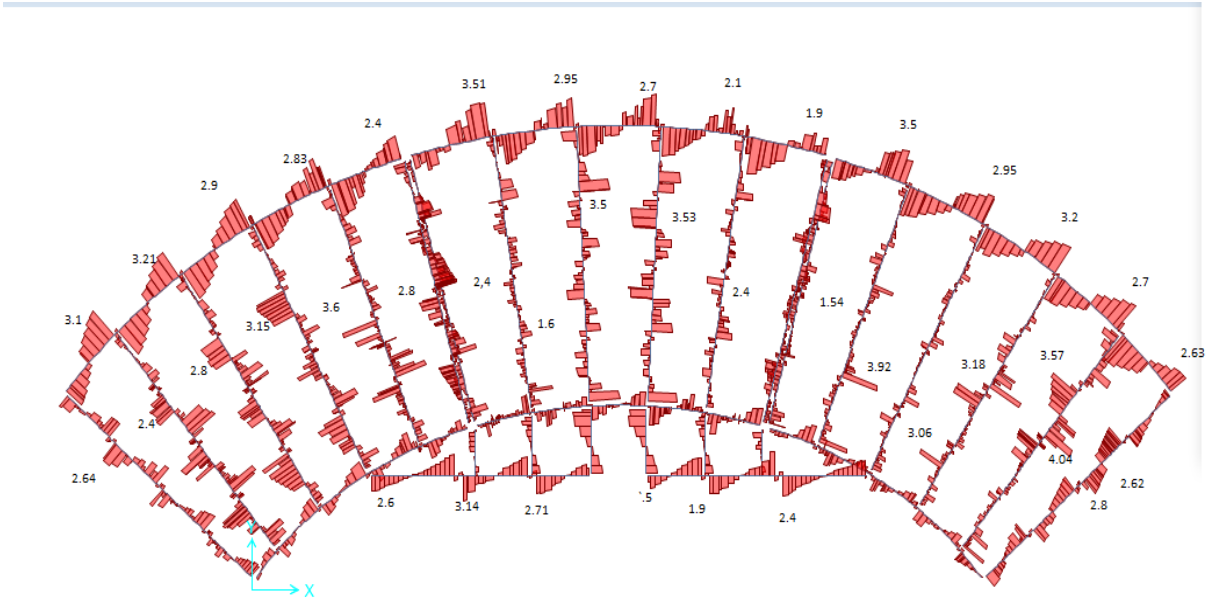
3.4.4.Design of beams

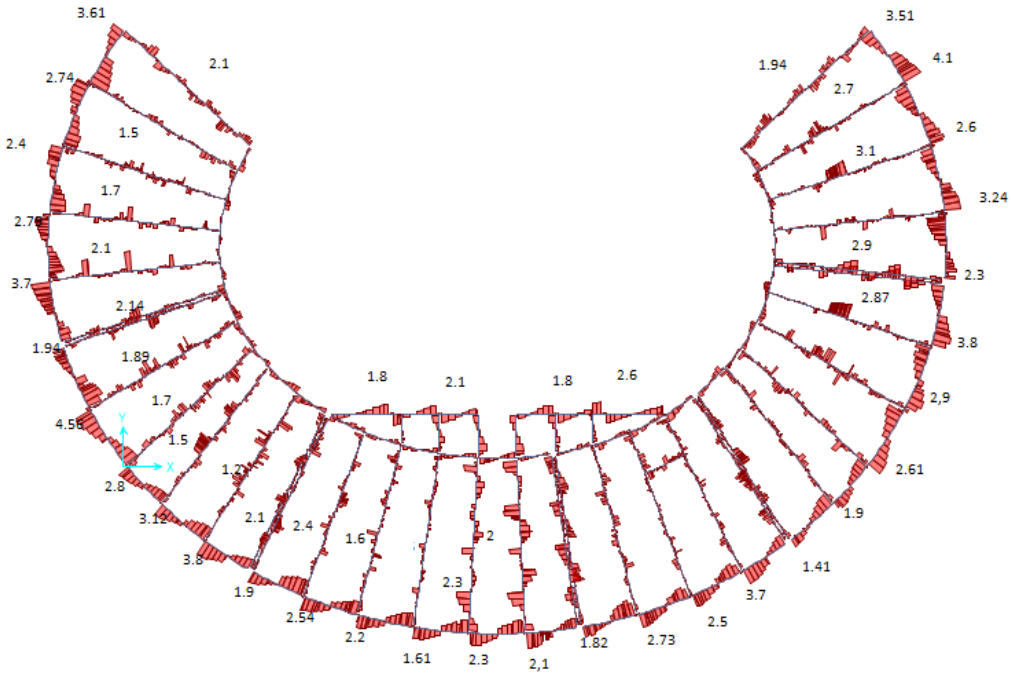
Moment of beams



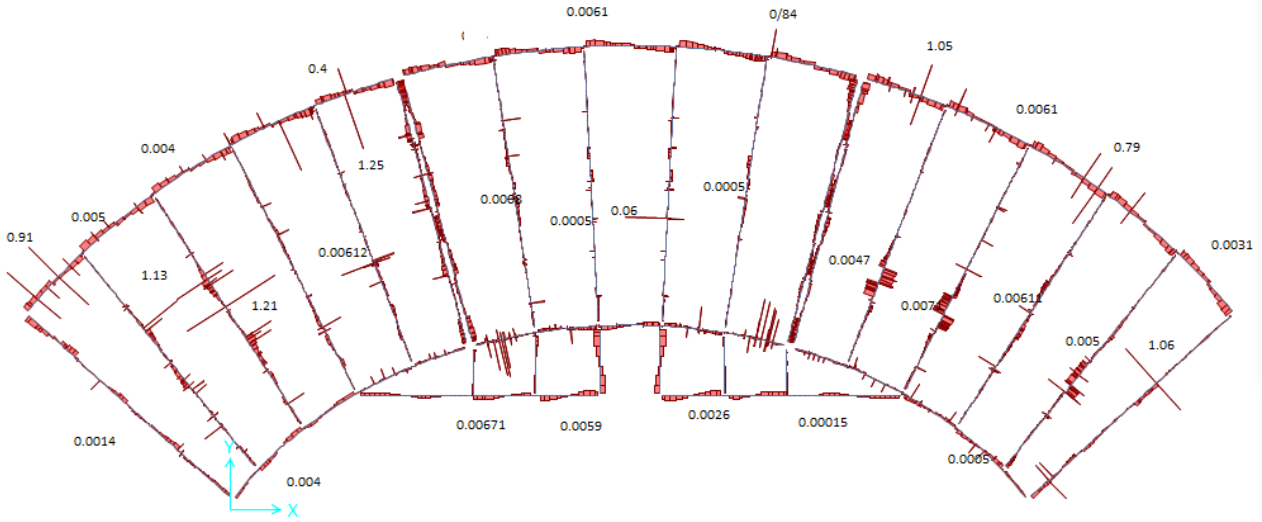


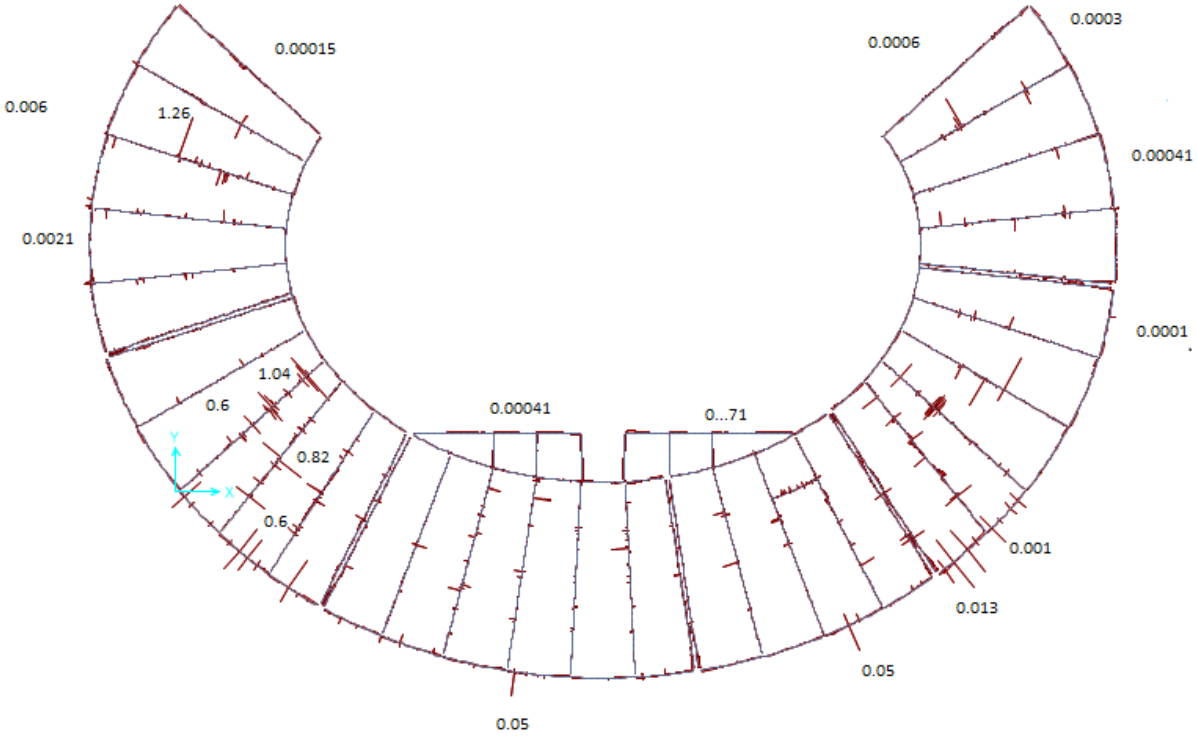
Shear of beams





Torsion of Beam





Check shear and torsion

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	2400	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
1	1.85	25	60	6.78

Due to shear	q_{cu}		Notes
	4.93	kg/cm^2	*safe*

Due to torsion	q_{tu}		Notes
	14.80	kg/cm^2	*safe*

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	3.9	8	

Due to torsion	no.	ϕ	Notes
	7.1	8	

Horizontal Rft.	no.	ϕ
	4	12

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	2400	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
2	0.63	12	60	4.79

Due to shear	q_{cu}		Notes
	7.26	kg/cm^2	*safe*

Due to torsion	q_{tu}		Notes
	21.88	kg/cm^2	*safe*

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	3.2	8	

Due to torsion	no.	ϕ	Notes
	8.0	8	

Horizontal Rft.	no.	ϕ
	4	12

Check concrete dimensions

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	6.71	25	25	60	*6.343*	*0.826*	*4.71*	*4.71*	*5 ϕ 12*	***safe***
	4.21	12	12	60	*5.548*	*0.826*	*2.26*	*2.43*	*5 ϕ 12*	***safe***

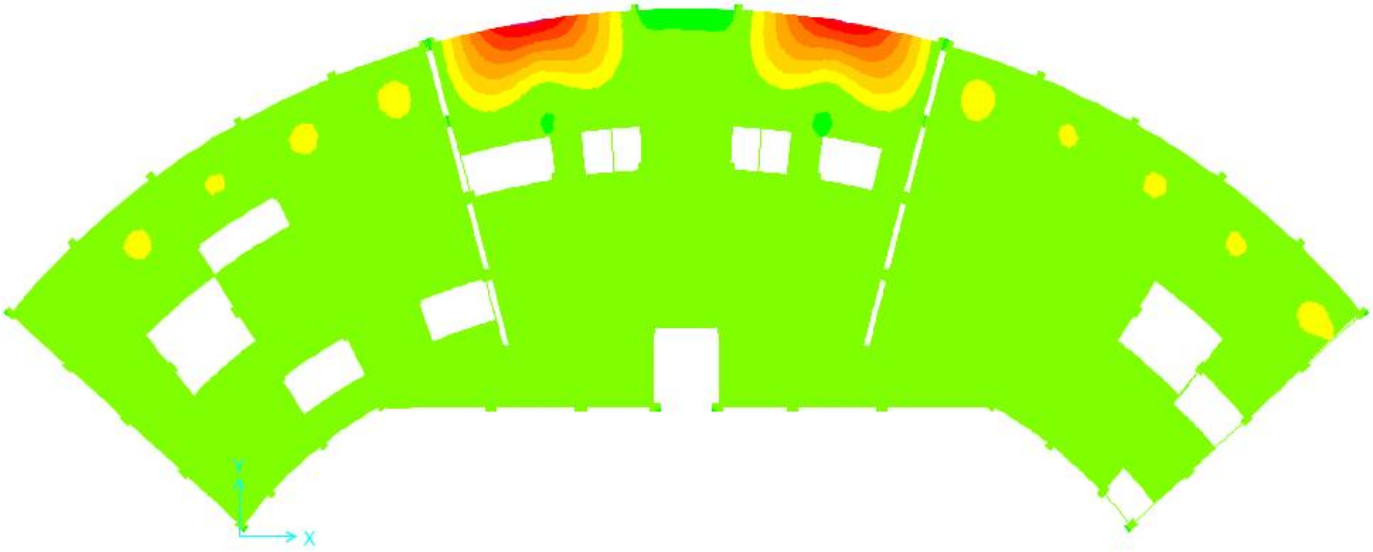
Design of beam

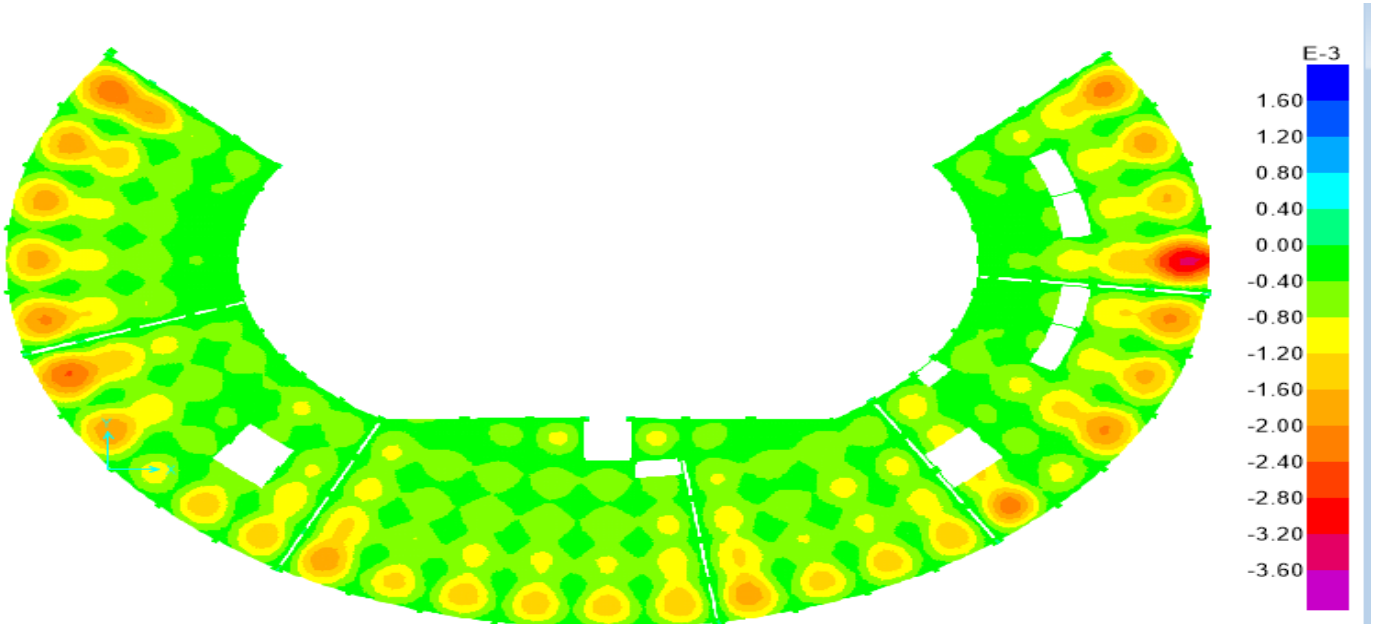
Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	6	12	678.5840133	350	600	575	0.72	0.9	8.8
B2	6	16	1206.371579	350	600	575	0.72	0.9	15.7
B3	8	16	1608.495439	350	600	575	0.72	0.9	21.0
B6	10	25	4908.738522	350	601	576	0.72	0.9	64.1
B7	12	25	5890.486226	350	600	575	0.72	0.9	76.8

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	23.51	25	60	*15.67*	*0.085*	2	*6 ϕ 8*	***safe***
	17.39	12	60	*24.15*	*0.074*	2	*6 ϕ 8*	***safe***

check of deflection





Δ max =1.2cm

Δ all = span / 250

Δ all = 370 / 250 =1.48 cm

SAFE DEFLECTION

3.4 Design of Level 5.4m

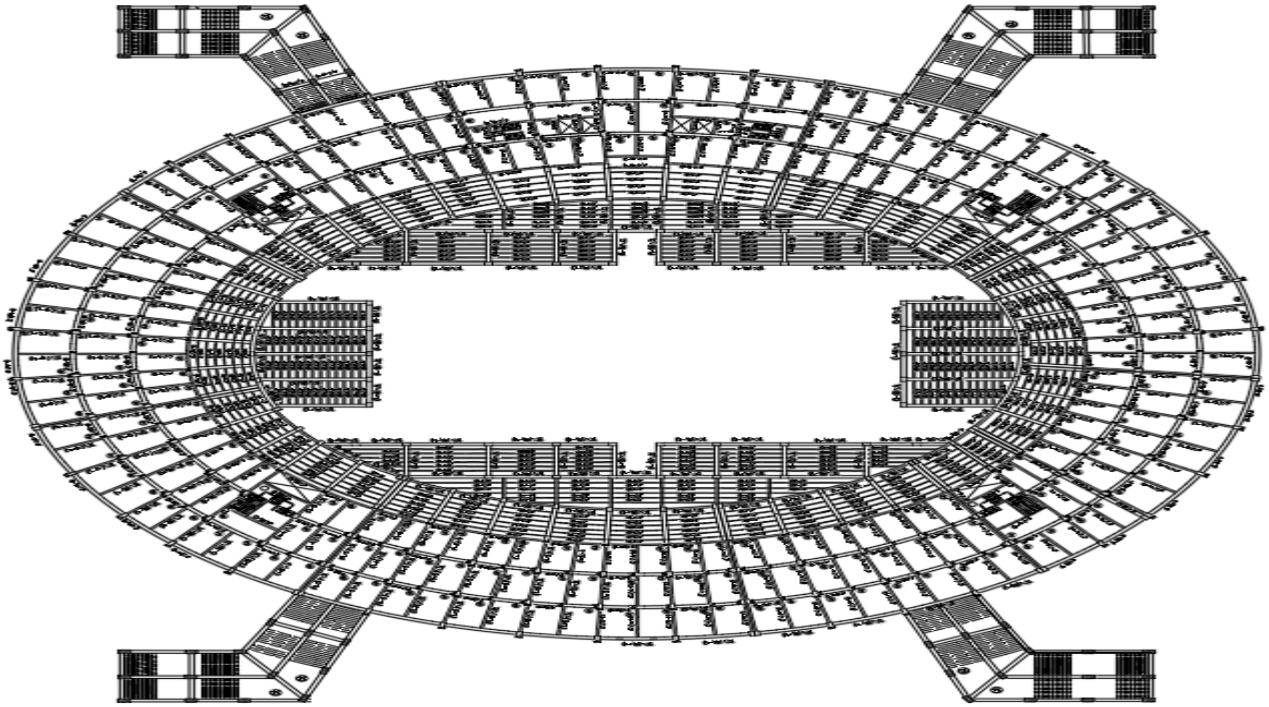
*3.4.3. **Design notes***

- The Ceiling of the first floor is designed in solid slab system

Designed on:

- Own wight calculated by safe
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2800 kg/cm²)

3.5.1 Statical system



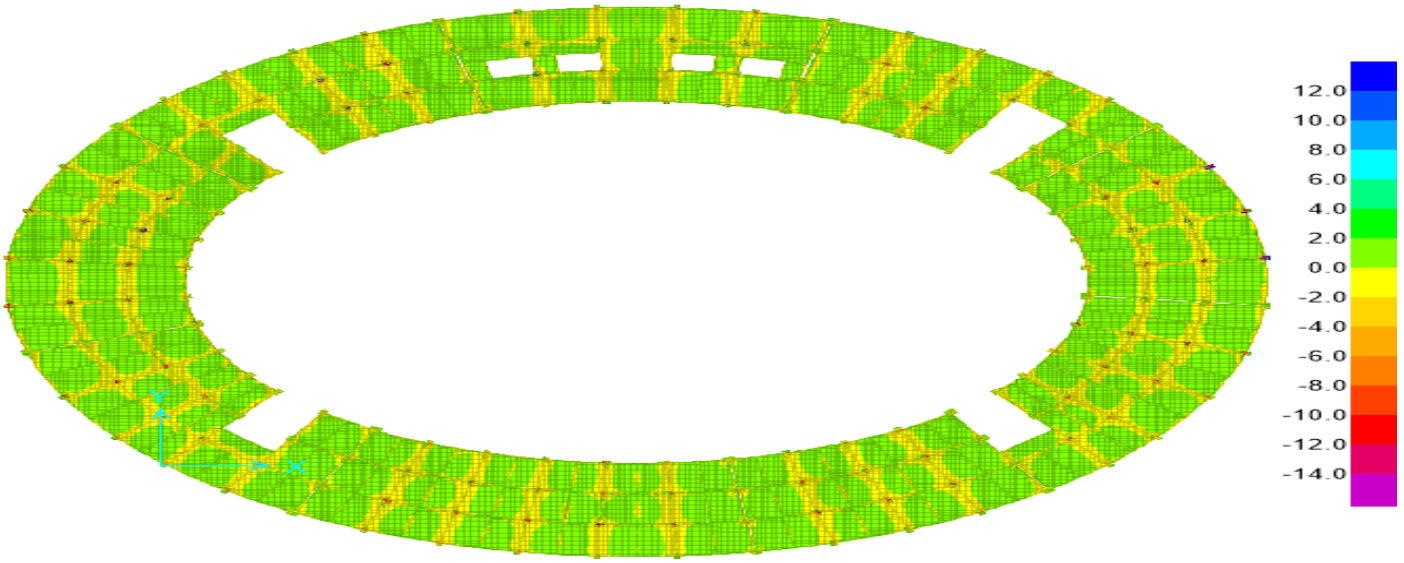


Figure 3.5: M1.1 positive

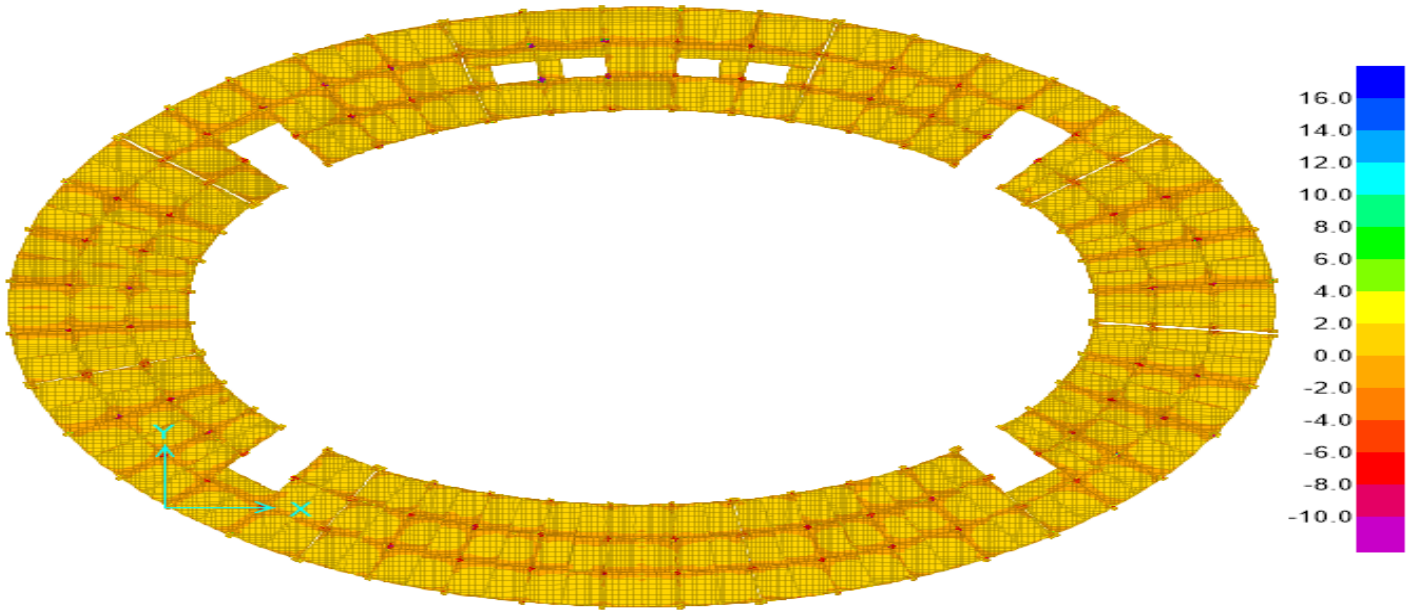


Figure 3.6: M2.2 positive

3.5.3 *Design of slabs*

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529

Take Ts (solid slab) = 12 cm

Check Positive Moment in X Direction

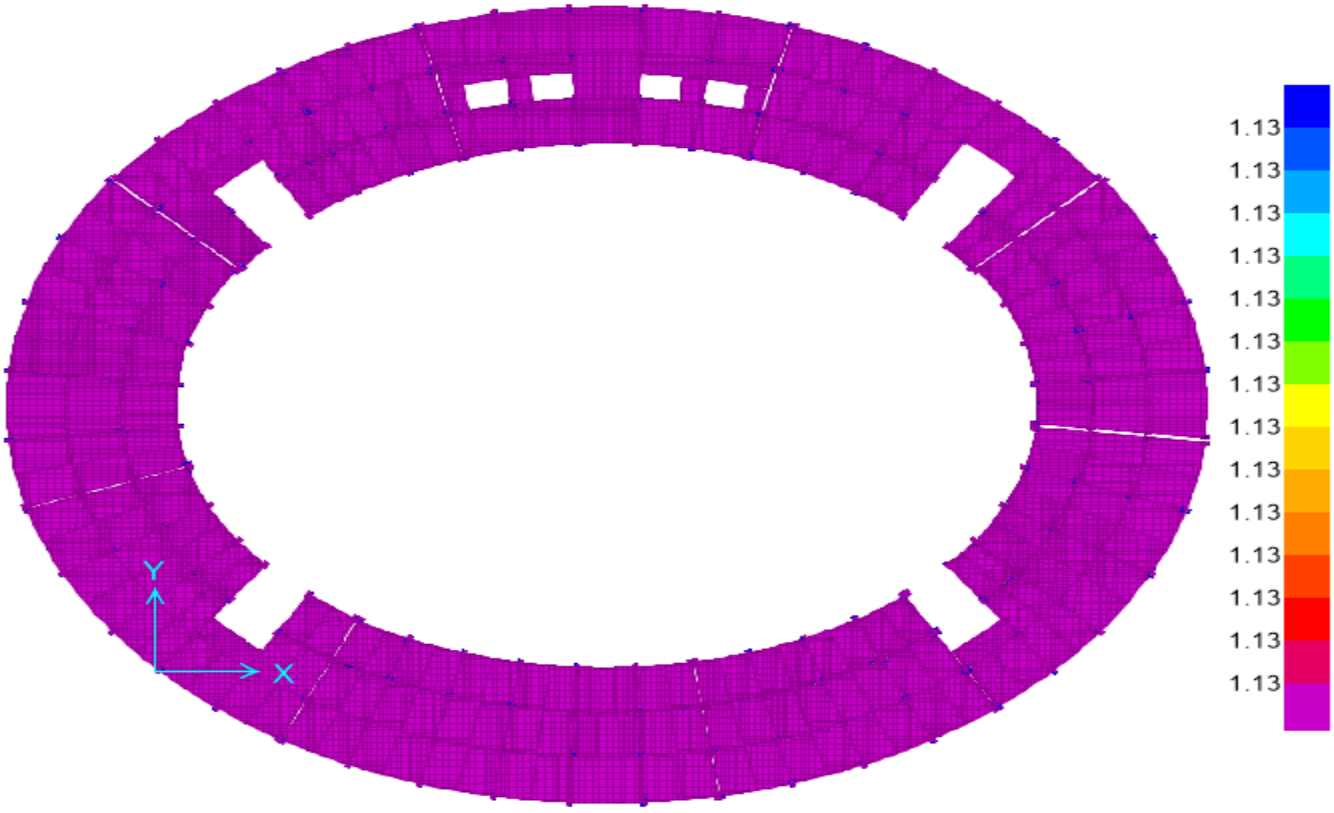


Figure 3.7: M1.1 positive

Check Positive Moment in Y Direction

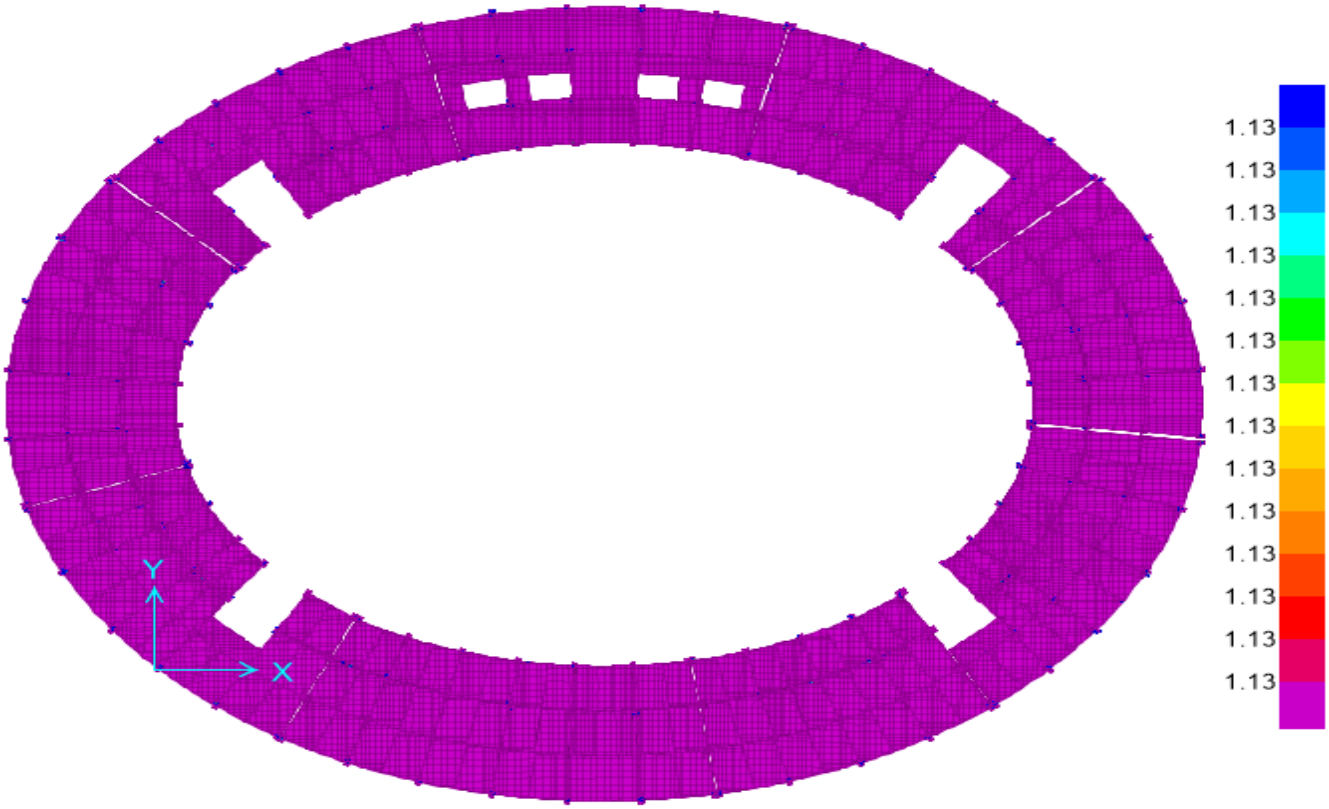
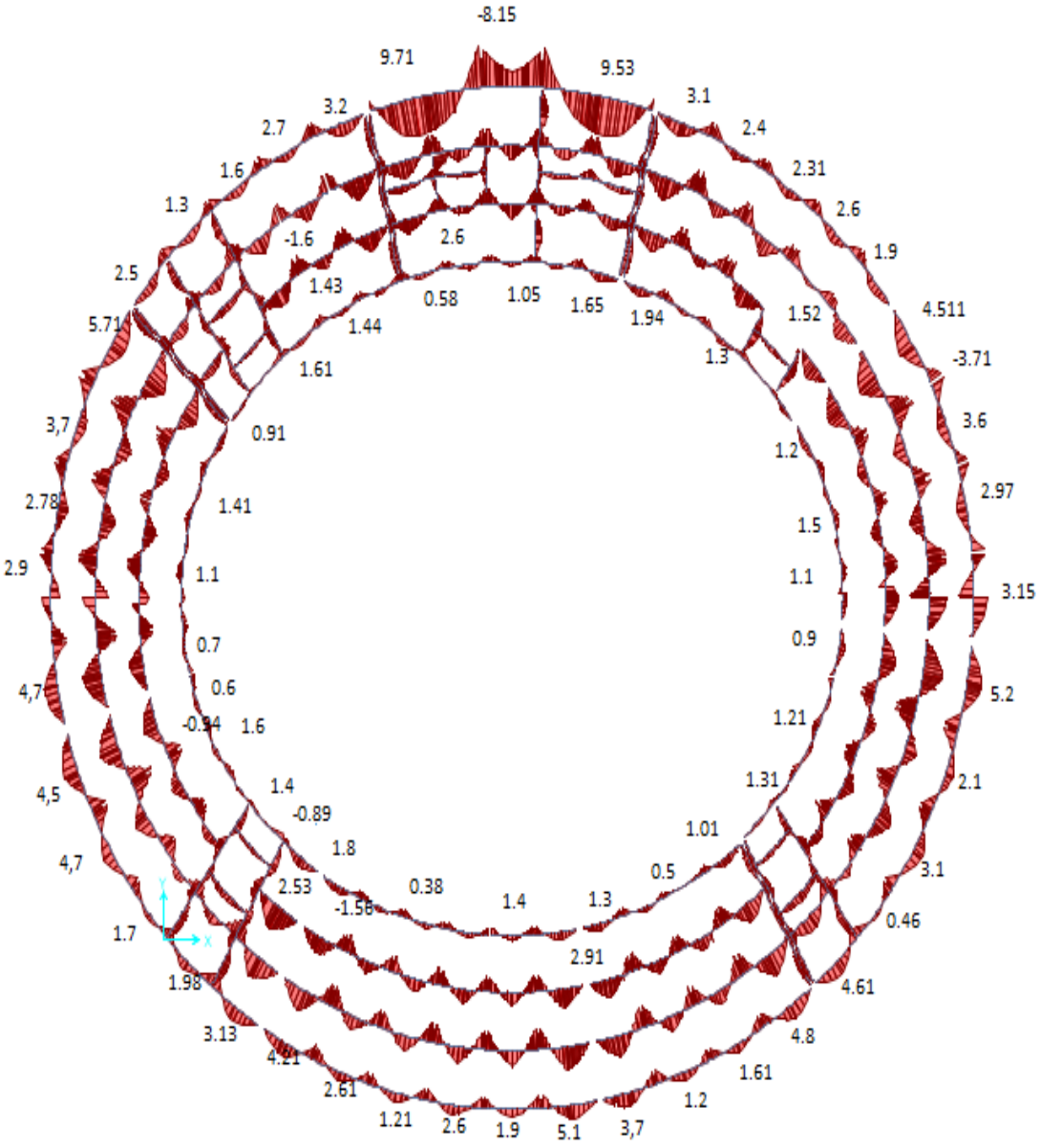
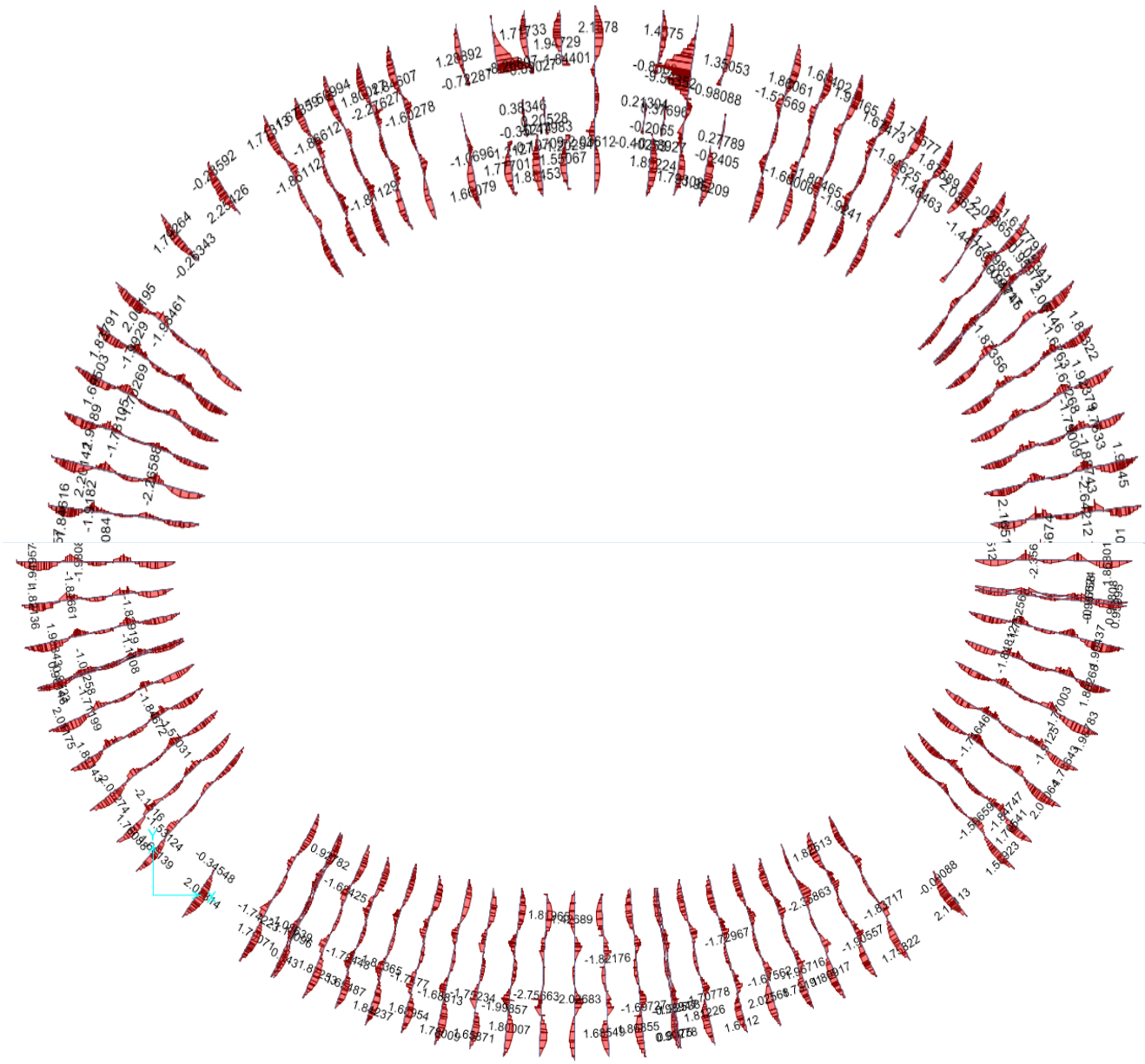


Figure 3.8: M2.2 positive

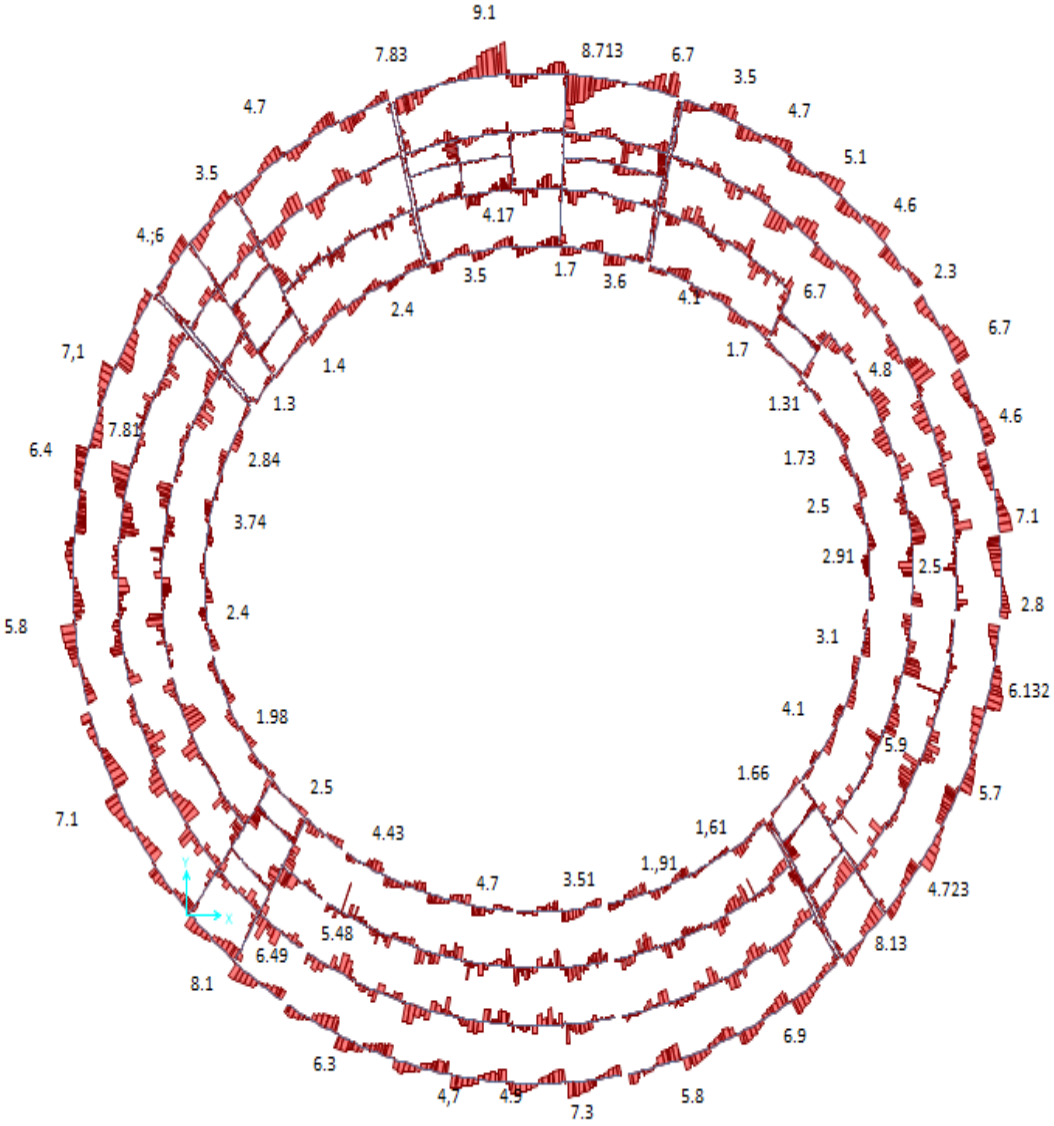
3.5.4Design of beams

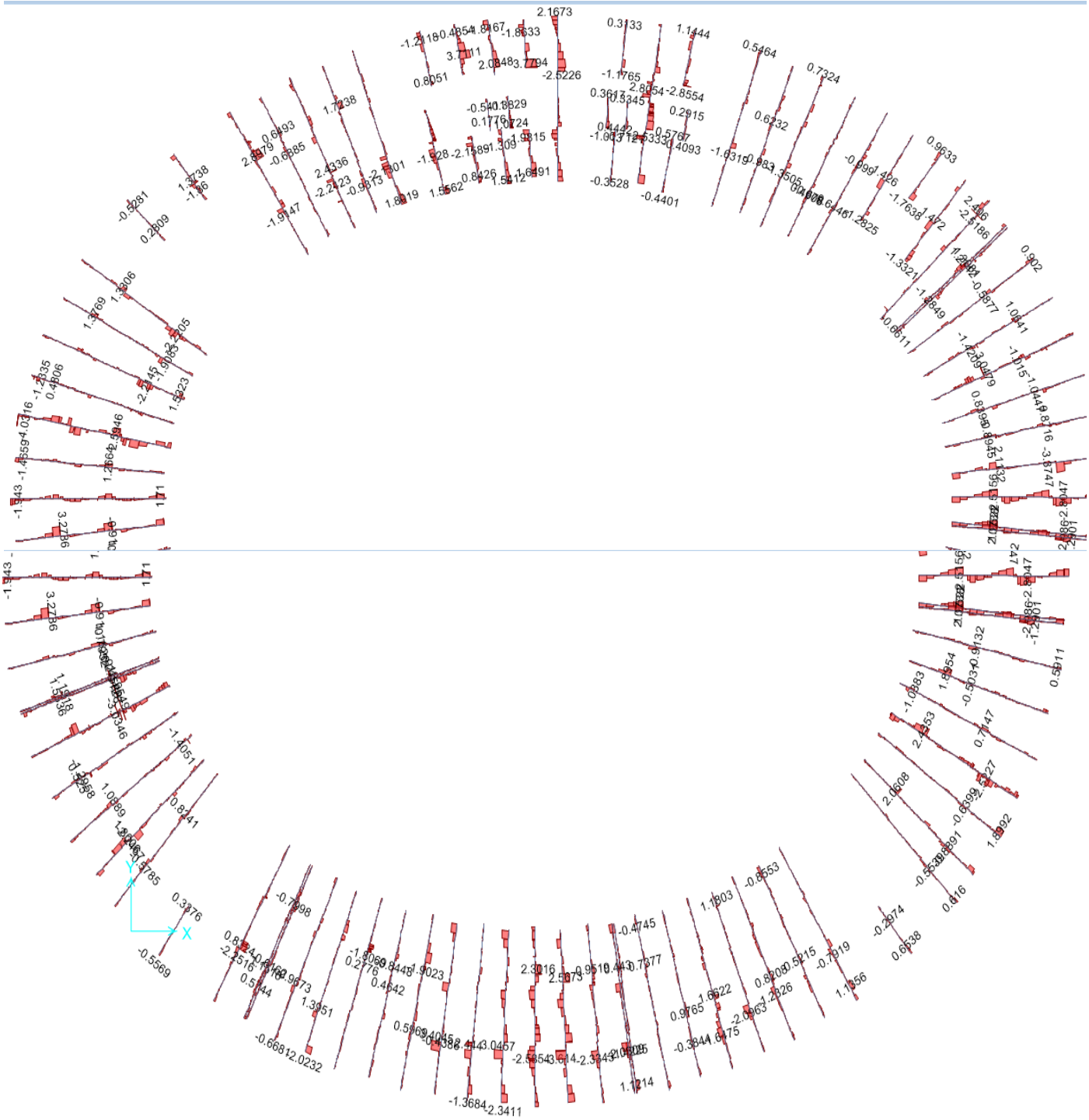
Moment of beams



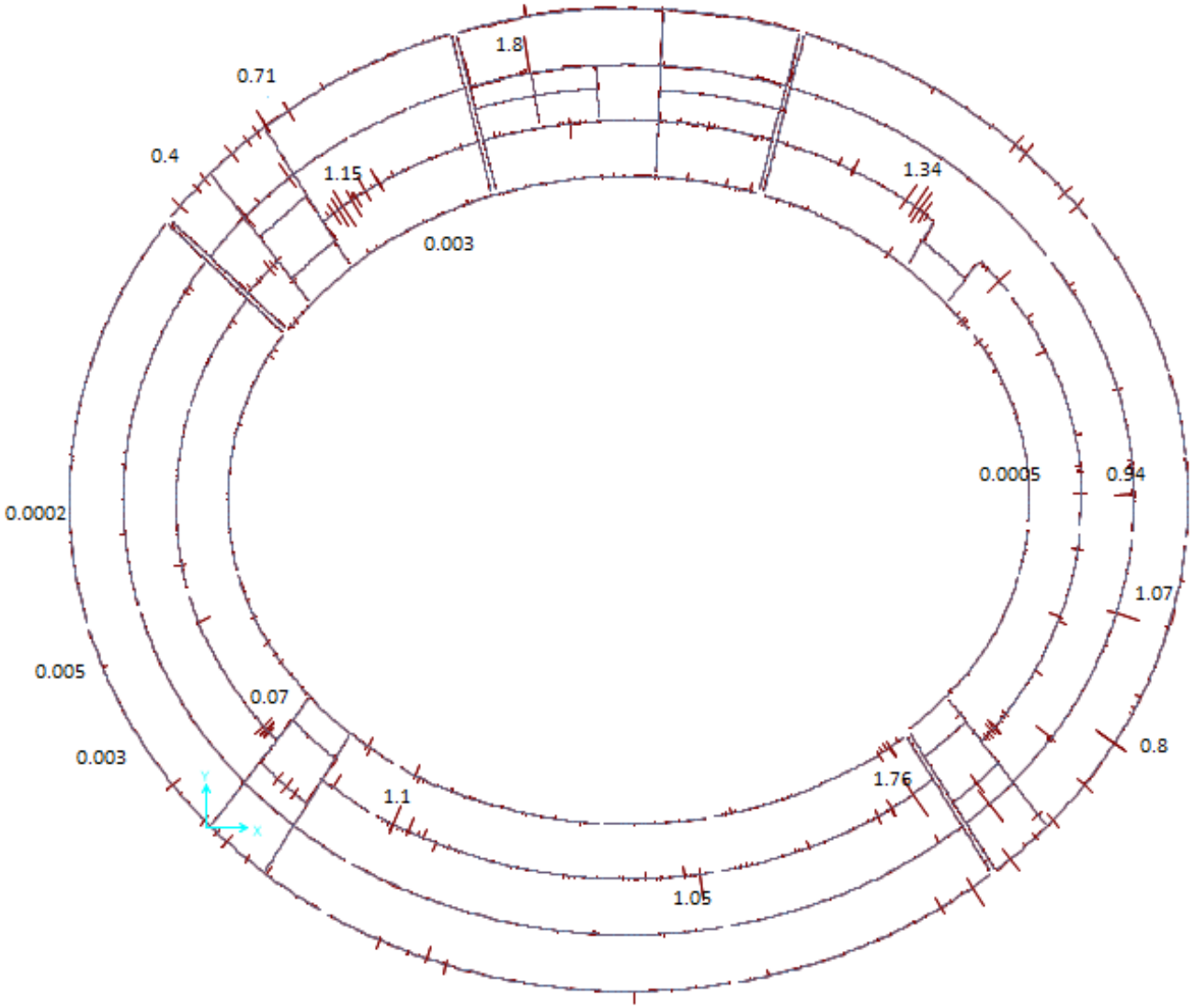


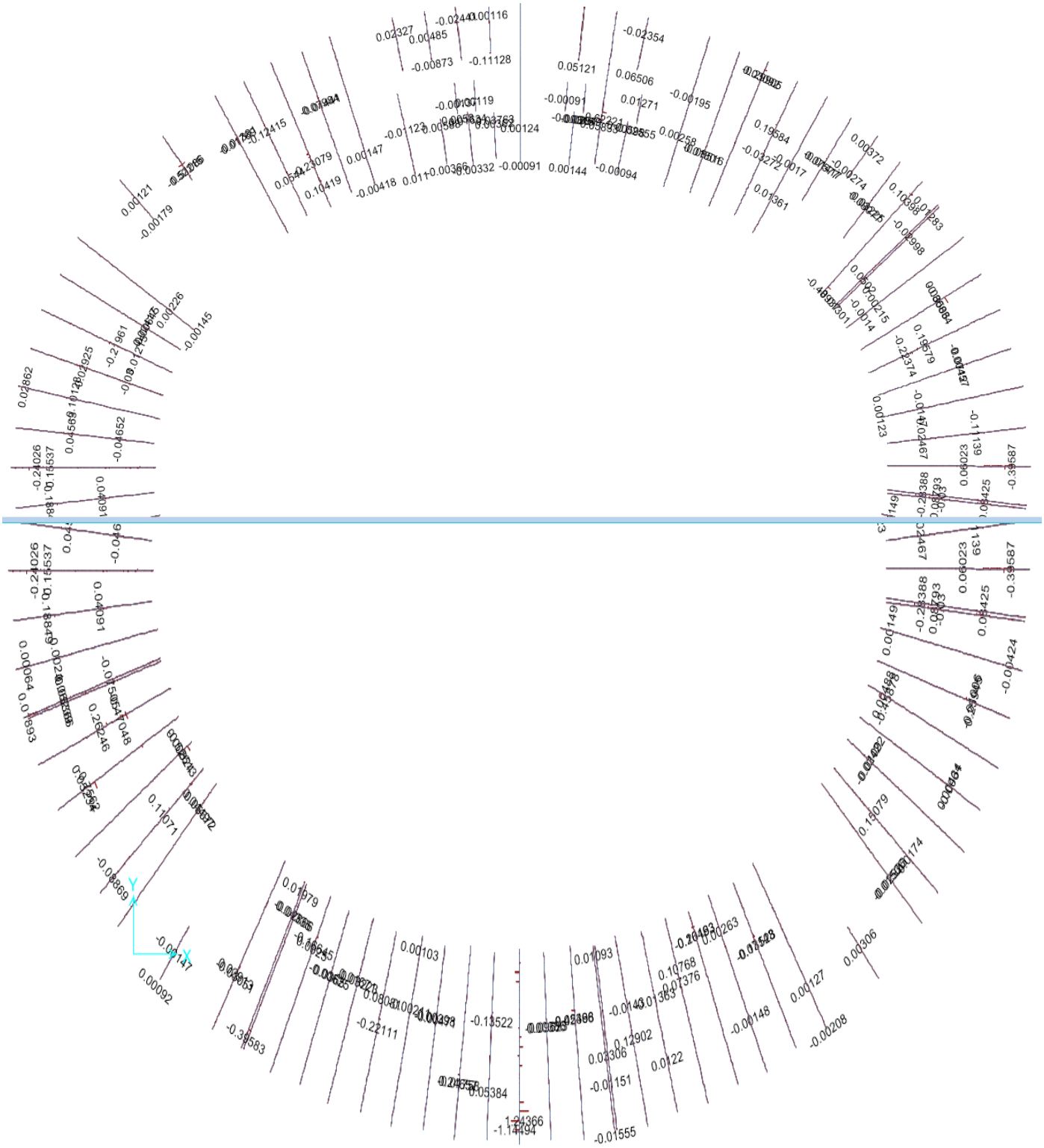
Shear of beams





Torsion of Beam





Check concrete dimensions

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Sec.	Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
	12	25	25	60	4.743	0.824	4.71	6.93	5 ϕ 12	safe
	11.51	12	12	60	3.356	0.773	2.26	7.09	5 ϕ 12	safe

Check shear and torsion

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	2400	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
1	1.8	25	60	8

Due to shear	q_{cu}	Notes
	5.82 kg/cm^2	safe

Due to torsion	q_{tu}	Notes
	14.40 kg/cm^2	safe

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	4.6	8	

Due to torsion	no.	ϕ	Notes
	6.9	8	

Horizontal Rft.	no.	ϕ
	4	12

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	2400	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
2	0.4	12	60	6.2

Due to shear	q_{cu}	Notes
	9.39 kg/cm^2	safe

Due to torsion	q_{tu}	Notes
	13.89 kg/cm^2	safe

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	3.7	8	

Due to torsion	no.	ϕ	Notes
	4.5	8	

Horizontal Rft.	no.	ϕ
	2	12

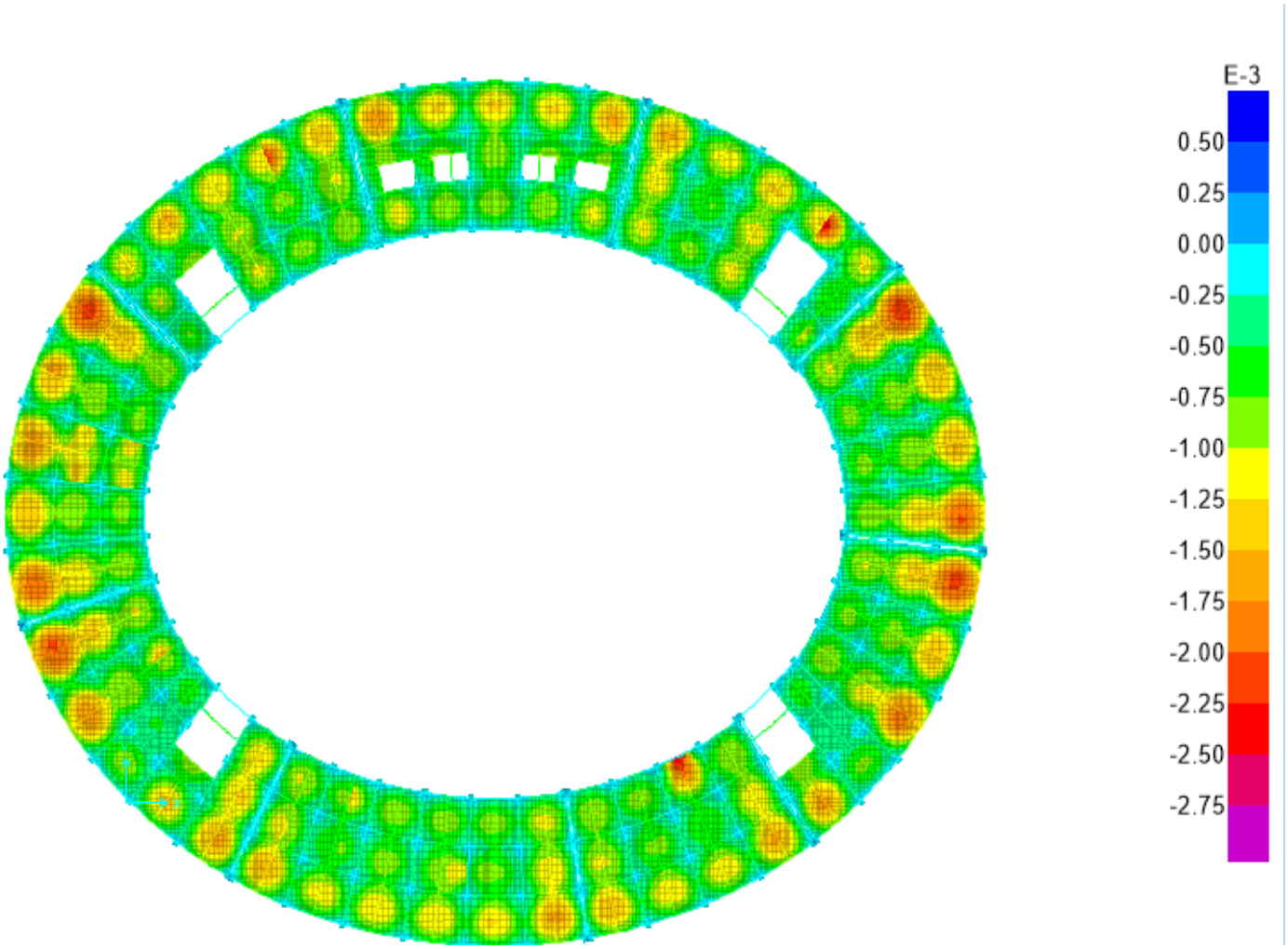
Design of beam

Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	6	12	678.5840133	350	600	575	0.72	0.9	8.8
B2	6	16	1206.371579	350	600	575	0.72	0.9	15.7
B3	8	16	1608.495439	350	600	575	0.72	0.9	21.0
B5	8	20	2513.274123	350	600	575	0.72	0.9	32.8
B6	10	25	4908.738522	350	601	576	0.72	0.9	64.1
B7	12	25	5890.486226	350	600	575	0.72	0.9	76.8

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	24.3	25	60	*16.20*	*0.090*	2	*6 ϕ 8*	*safe*
	13.82	12	60	*19.19*	*0.055*	2	*6 ϕ 8*	*safe*

check of deflection



Δ max =0.225 cm

Δ all = span / 250

Δ all = 300 / 250 =1.2 cm

SAFE DEFLECTION

3.5.Design of Level 11.4m

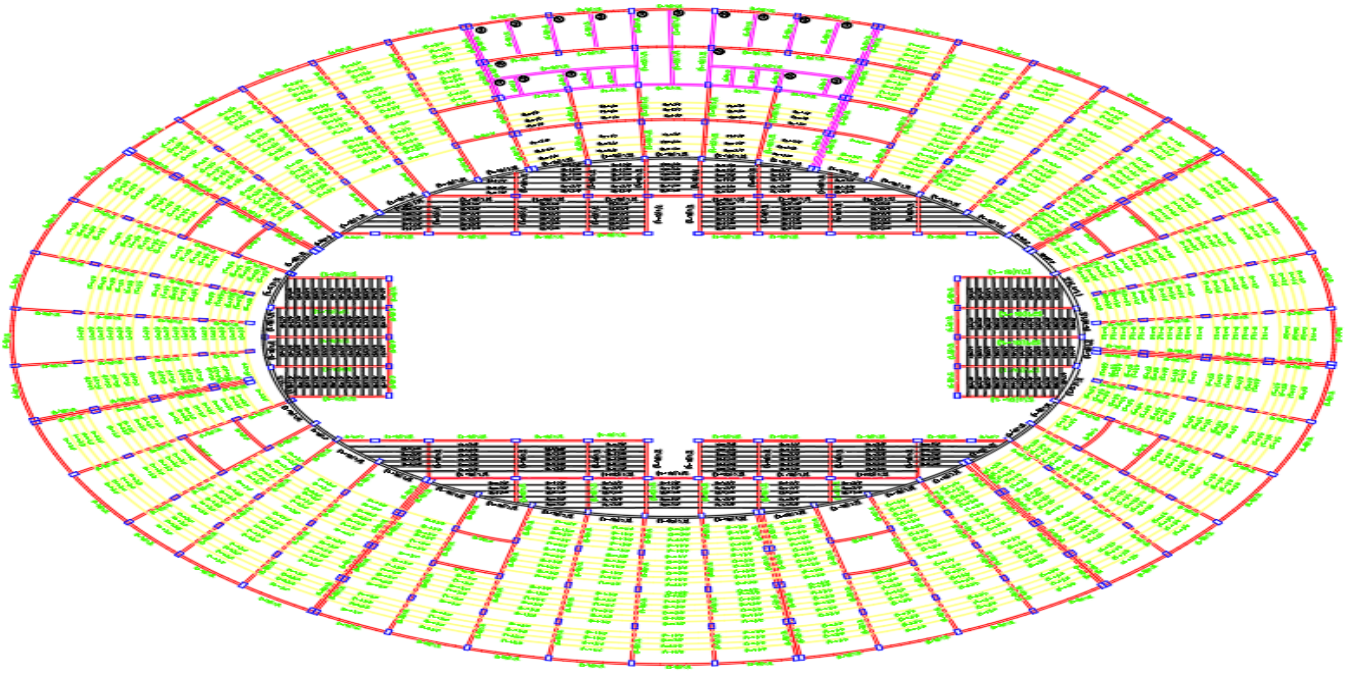
3.5.1 Design notes

- The Ceiling of the first floor is designed in solid slab system

Designed on:

- Own wight calculated by safe
- Live load = 300 kg/cm²
- Floor cover = 150 kg/cm²
- Concrete characteristics strength (Fcu = 250 kg/cm²)
- Steel characteristics strength (Fy = 3500 kg/cm²)
- Stirrups characteristic strength (Fy = 2800 kg/cm²)

3.5.2 Statical system



3.5.2 Moment of slabs



Figure 3.9: M1.1 positive



Figure 3.10: M2.2 positive

3.5.1*Design of slabs*

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	10	392.699	350	120	100	0.826	1.13529

- Take Ts (solid slab) = 12 cm

Check Positive Moment in X Direction

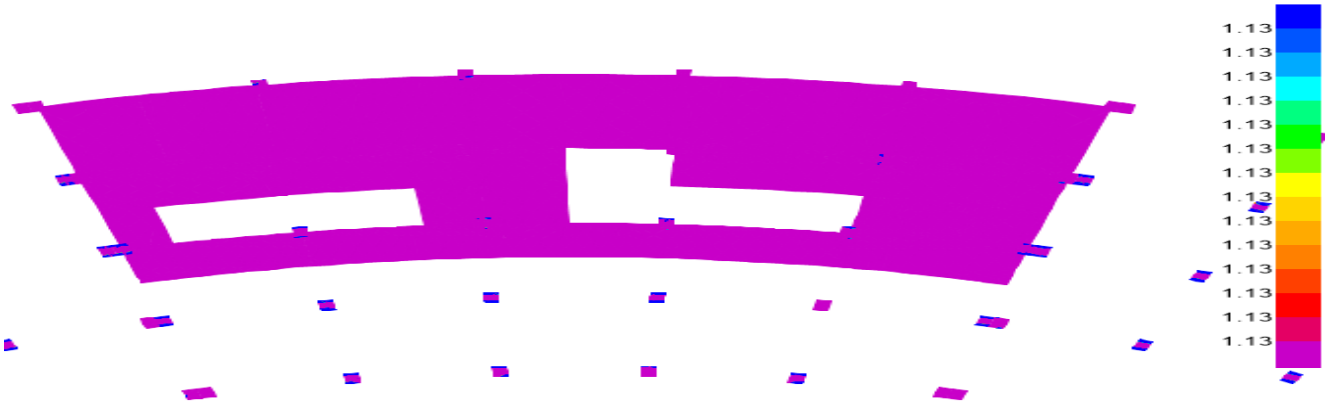


Figure 3.11: M1.1 positive

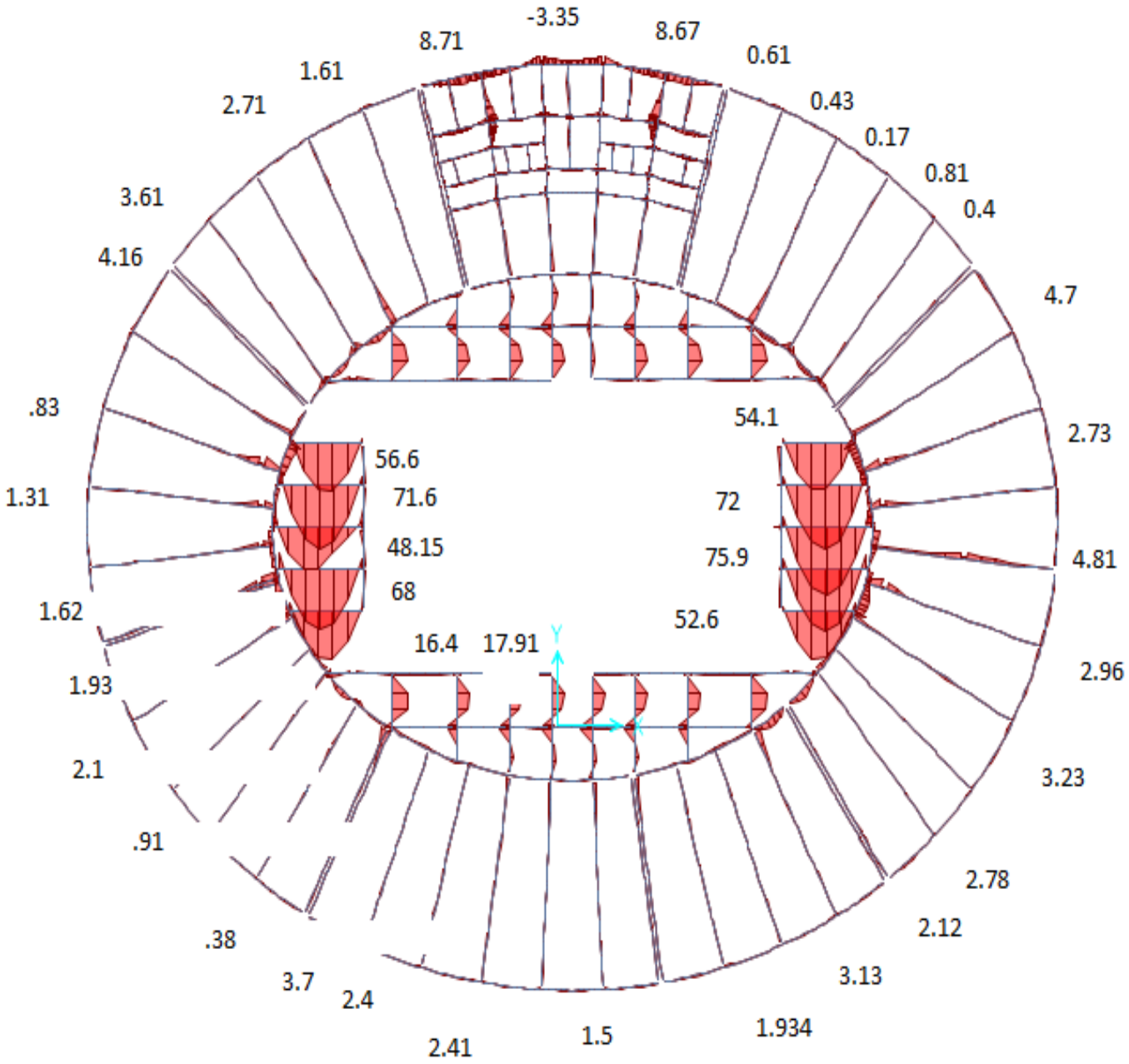
Check Positive Moment in Y Direction



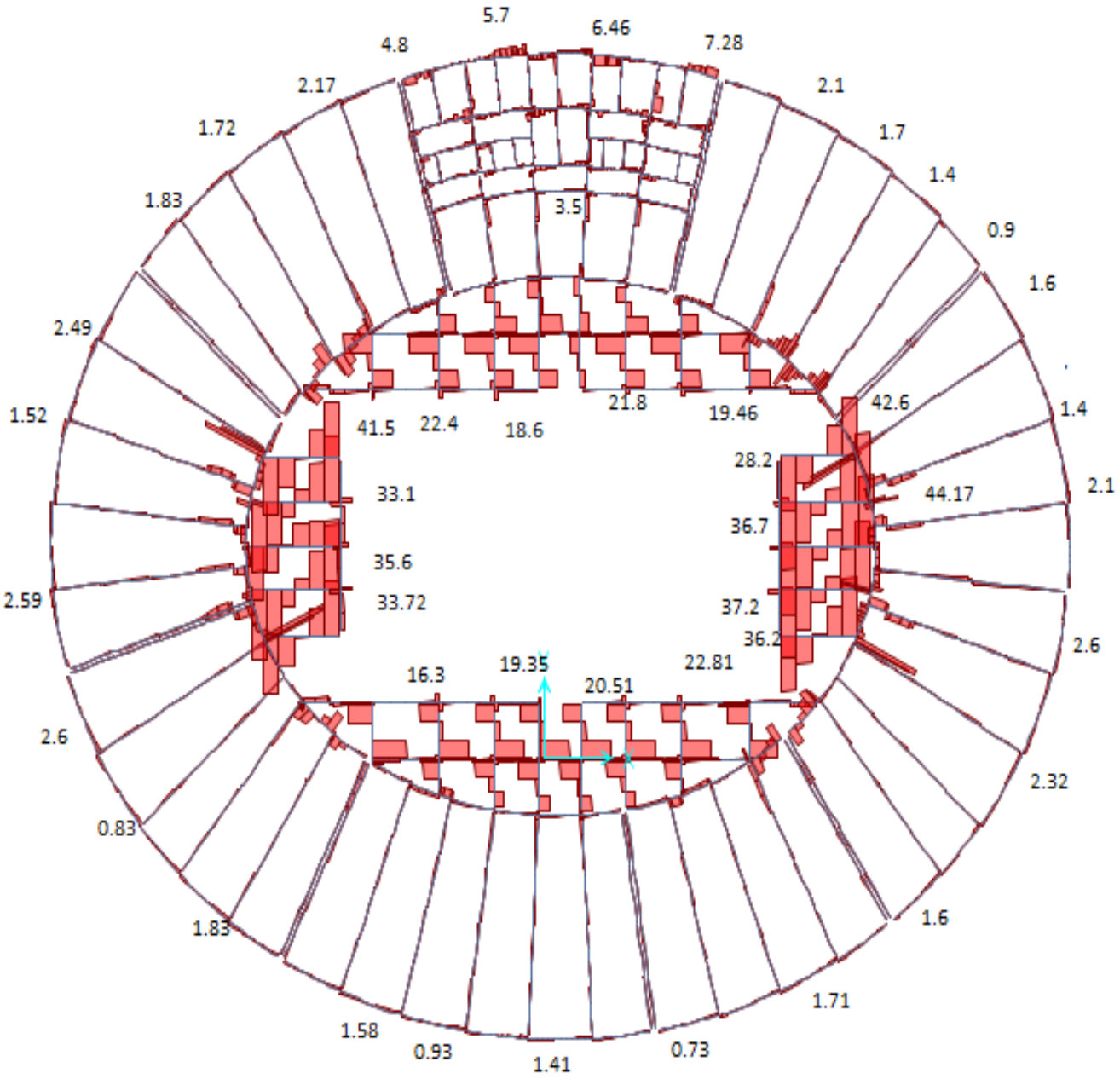
Figure 3.12: 2M2.2 positive with mesh

3.4.4.Design of beams

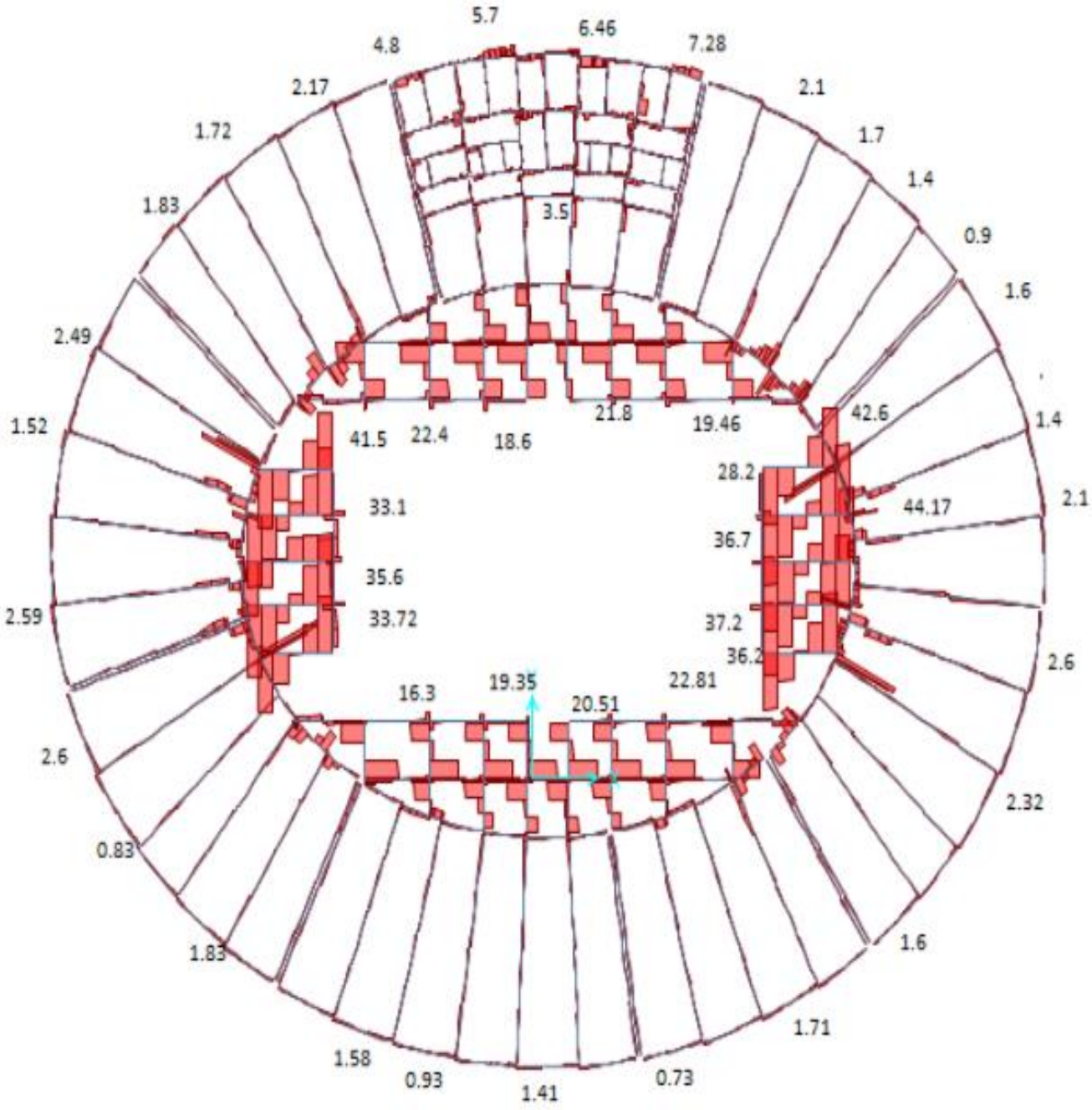
Moment of beams



Shear of beams



Torsion of Beam



Check concrete dimensions

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

R = RECTANGULAR SEC.

L = L SEC.

T = T SEC.

Ult. Moment M_u (m.t)	Breadth b (cm)	Comp.fl. B (cm)	Depth d (cm)	C1	J	As_{min} (cm^2)	Used As	Rft.	Notes
19.31	25	25	60	*3.739*	*0.794*	*4.71*	*11.58*	*5 ϕ 12*	***safe***
11.51	12	12	60	*3.356*	*0.773*	*2.26*	*7.09*	*5 ϕ 12*	***safe***

Design of beam

Main RFT		ø	As	Fy	T	d	J	Factor	Moment
Upper & Lower RFT		mm	mm2	N/mm2	mm	mm			Ton.m
B1	6	12	678.5840133	350	600	575	0.72	0.9	8.8
B2	6	16	1206.371579	350	600	575	0.72	0.9	15.7
B3	8	16	1608.495439	350	600	575	0.72	0.9	21.0
B4	7	18	1781.283035	350	600	575	0.72	0.9	23.2
B5	8	20	2513.274123	350	600	575	0.72	0.9	32.8
B6	10	25	4908.738522						
B7	12	25	5890.486226	350	600	575	0.72	0.9	76.8

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
	45	25	60	*30.00*	*0.203*	2	*6 ϕ 8*	***safe***
	13.82	12	60	*19.19*	*0.055*	2	*6 ϕ 8*	***safe***

Check shear and torsion

* Design for Torsion

* Project :

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	3500	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
1	2.41	25	60	18

Due to shear	q_{au}		Notes
	13.09	kg/cm^2	safe

Due to torsion	q_{tu}		Notes
	19.28	kg/cm^2	safe

Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	5.3	10	

Due to torsion	no.	ϕ	Notes
	4.7	10	

Horizontal Rft.	no.	ϕ
	3	16

* Design for Torsion

* Project :

Concrete	F_{cu} =	300	kg/cm^2
Concrete	q_{all} =	10.607	kg/cm^2
Stirrups	F_y =	3500	kg/cm^2
Horizontal bars	F_y =	3500	kg/cm^2

Sec.	Ult. torsional moment M_u (m.t)	Sec. dim. b (cm)	t (cm)	Ult. shear force Q_u (ton)
2	7.13	35	80	54

Due to shear	q_{au}		Notes
	20.57	kg/cm^2	safe

Due to torsion	q_{tu}		Notes
	21.83	kg/cm^2	safe

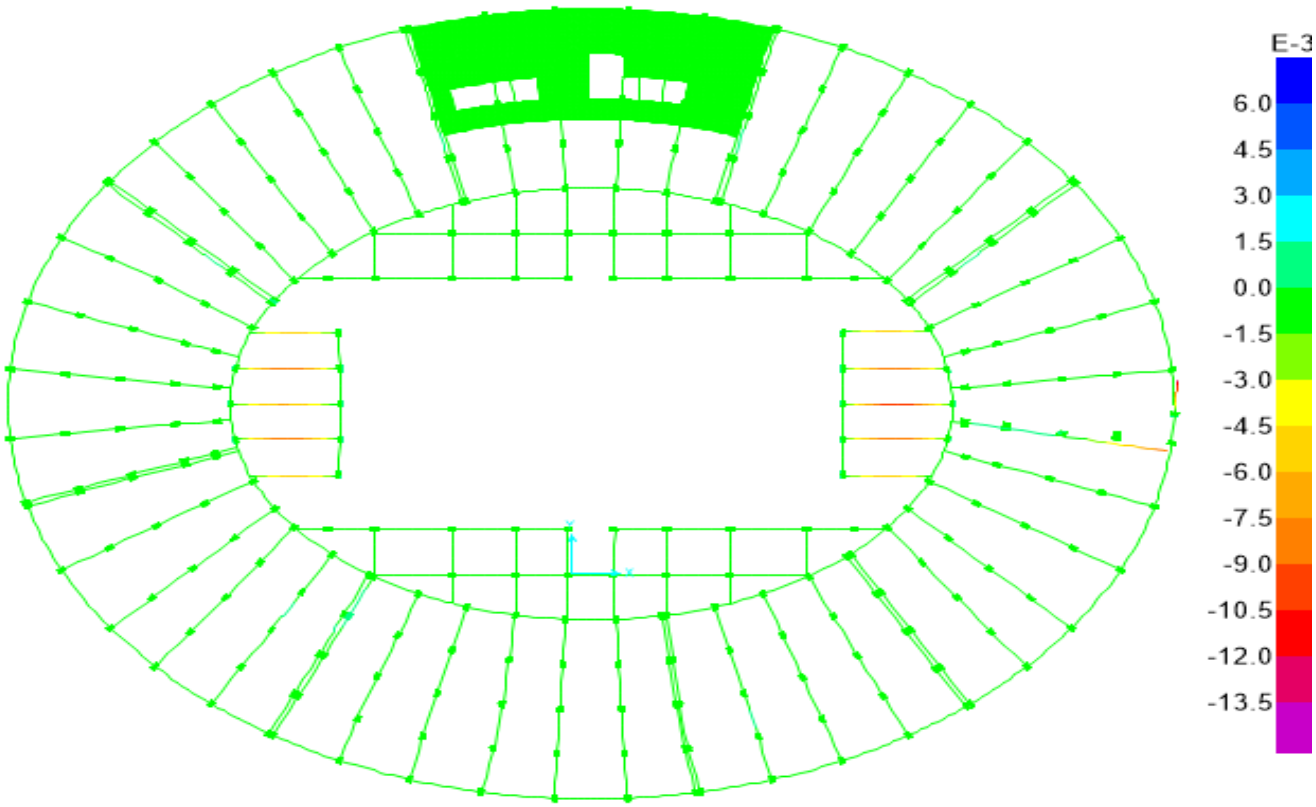
Calculation of stirrups:

Due to shear	no.	ϕ	Notes
	4.8	16	

Due to torsion	no.	ϕ	Notes
	5.1	12	

Horizontal Rft.	no.	ϕ
	5	18

check of deflection



Δ max =1.12 cm

Δ all = span / 250

Δ all = 350 / 250 =1.4 cm

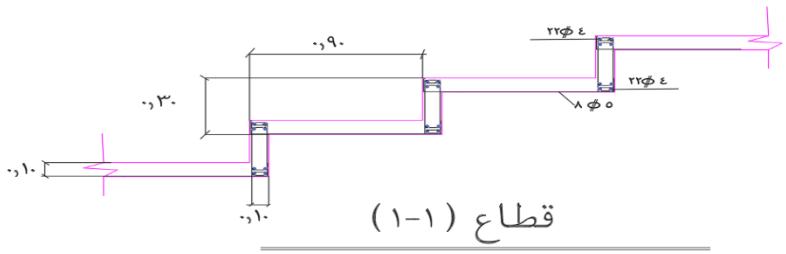
SAFE DEFLECTION

Design of saw tooth stair

Section: (1-1)

Data:

t=30cm b=10cm R=20 S=90cm
L.L=5Kn/m² F.C=3Kn/m² L=7.9m

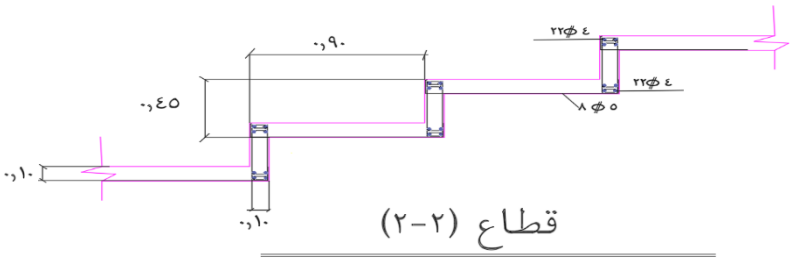


A=b*(t+s-b) =0.1*(0.3+0.8)=0.11m²
Ow = A* ɣ=0.11*25=2.75 Kn/m
Wsu=1.5*(o.w+(f.c+L.L)*S)
Wsu=1.5*(2.75+(3+5)*0.9)=15Kn/m
d=t-cover=30-3=27cm
M= Wsu* L² /8=15*7.9²/8=117.02Kn/m=11.7t.m
As= Mu/Fy*J*d=11.7*10⁵/3600*0.826*27=14.58cm²
As=4Ø22/m'
R=Wsu*L/2=1.5*7.9/2=5.93 ton

Section: (2-2)

Data:

t=45cm b=10cm R=35 S=90cm
L.L=5Kn/m² F.C=3Kn/m² L=8.5m



A=b*(t+s-b) =0.1*(0.45+0.8)=0.125m²
Ow = A* ɣ=0.125*25=3.125 Kn/m
Wsu=1.5*(o.w+(f.c+L.L)*S)
Wsu=1.5*(3.125+(3+5)*0.9)=15.5Kn/m
d=t-cover=45-3=42cm
M= Wsu* L² /8=15.5*8.5²/8=139.98Kn/m=13.98t.m
As= Mu/Fy*J*d=13.98*10⁵/3600*0.826*42=11.2cm²
As=4Ø22/m'
R=Wsu*L/2=1.55*8.5/2=6.59 ton

Weight of sawtooth

Ø=h / L = 18

Section(1-1)

Wfsa=o.w+(R/s)cosØ =0.275+(5.93/0.9)cos(18) =6.54t/m

Section(2-2)

Wfsa=o.w+(R/s)cosØ =0.3125+(6.59/0.9)cos(18) =7.27t/m

Design of frames

Design for (M,N)

FOR Frame(1)

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

Sec.	Ult. Moment M_u (m.t)	Normal N_u (t)	Breadth b (cm)	Depth d (cm)	Thick t (cm)	ecc.	C1	J	As_{min} (cm^2)	Used As	Rft.
1	61.3	-172.1	40	95	100	Small	2.794	0.719	5.70	5.70	6 ϕ 12
2	62.13	-309	40	135	140	Small	2.884	0.731	8.10	8.10	5 ϕ 16
3	40.67	-267.6	40	115	120	Small	2.907	0.733	6.90	6.90	4 ϕ 16
4	15.04	-176.8	40	75	80	Small	2.962	0.740	4.50	4.50	4 ϕ 12
5	23.97	-82.44	40	55	60	Small	2.854	0.727	6.34	6.34	6 ϕ 12
6	21.9	20.2	40	55	60	Big	4.641	0.822	6.91	17.28	7 ϕ 18
7	13.54	-20.1	40	55	60	Big	4.422	0.817	6.91	6.91	7 ϕ 12
8	45.8	-1.512	40	95	100	Big	4.827	0.826	11.94	16.43	7 ϕ 18

Design for (SHEAR)

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

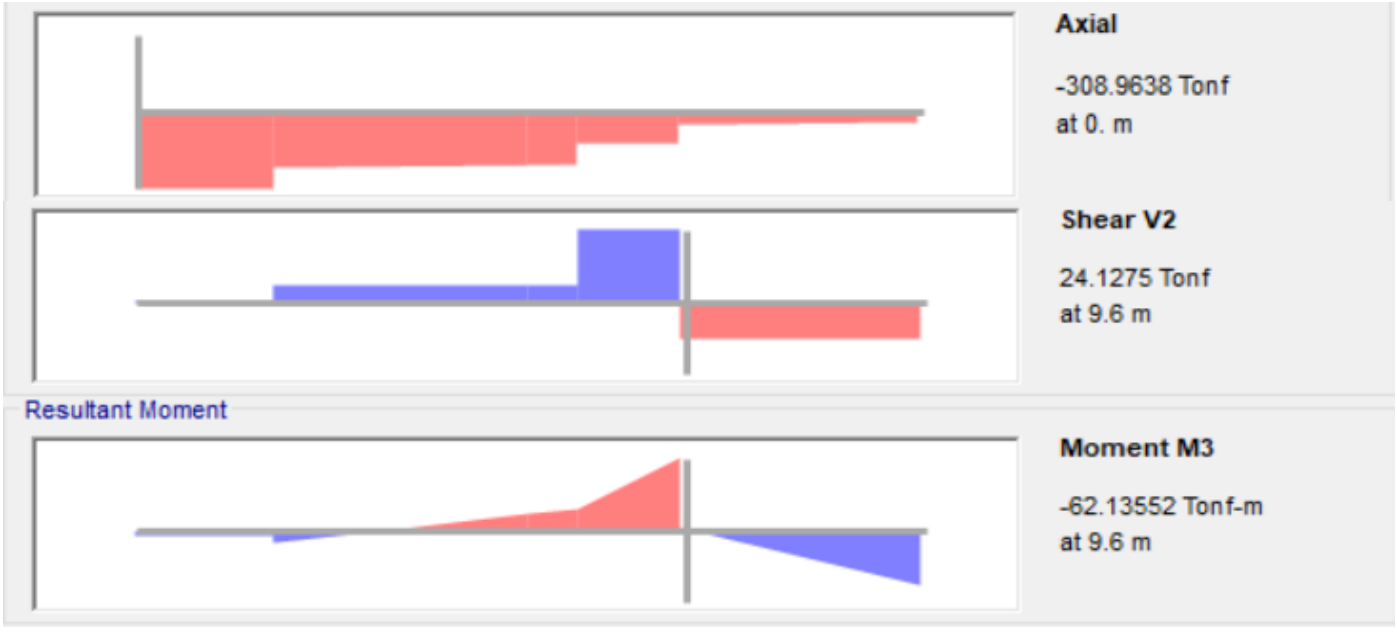
Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
1	11.95	40	95	3.14	-0.028	4	-1 ϕ 8	safe
2	24.12	40	135	4.47	-0.011	4	0 ϕ 8	safe
3	24.85	40	115	5.40	0.001	4	1 ϕ 8	safe
4	3.367	40	75	1.12	-0.055	4	-2 ϕ 8	safe
5	11.4	40	55	5.18	-0.002	4	0 ϕ 8	safe
6	40.4	40	55	18.36	0.172	4	6 ϕ 10	safe
7	26.1	40	55	11.86	0.086	4	5 ϕ 8	safe
8	11.34	40	95	2.98	-0.030	4	-1 ϕ 8	safe

FOR FRAME1

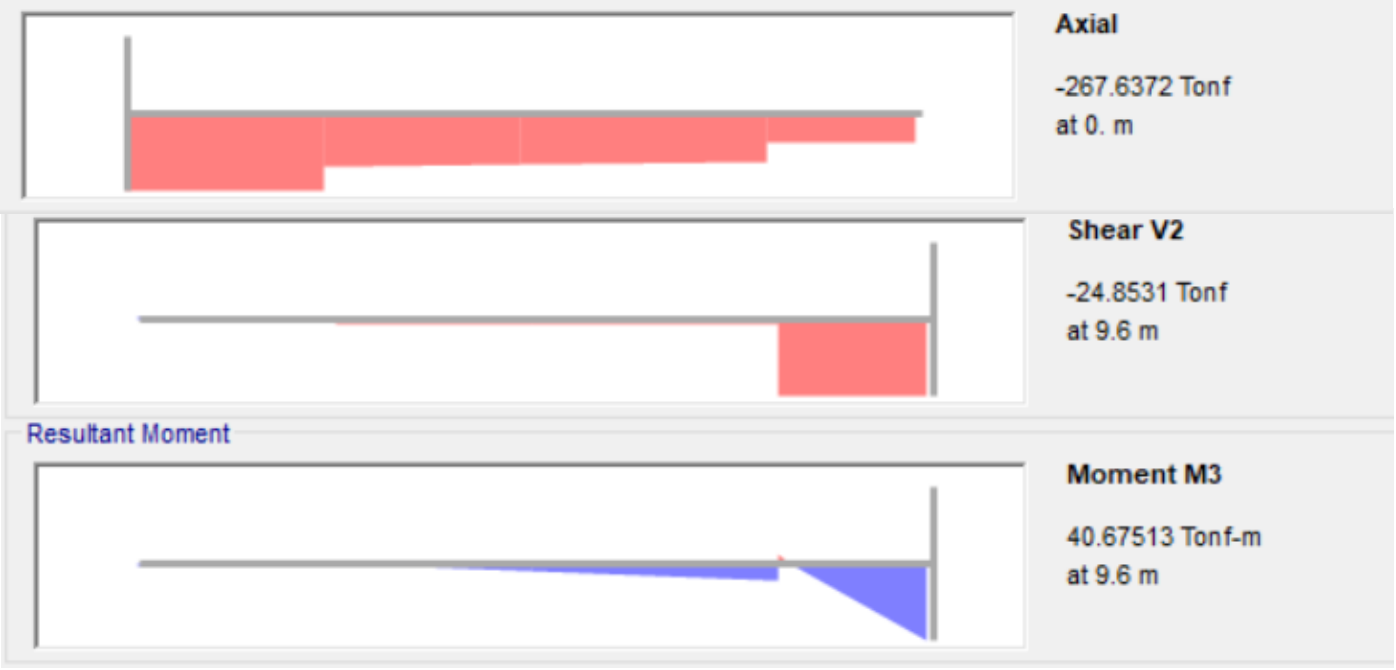
Sec 1



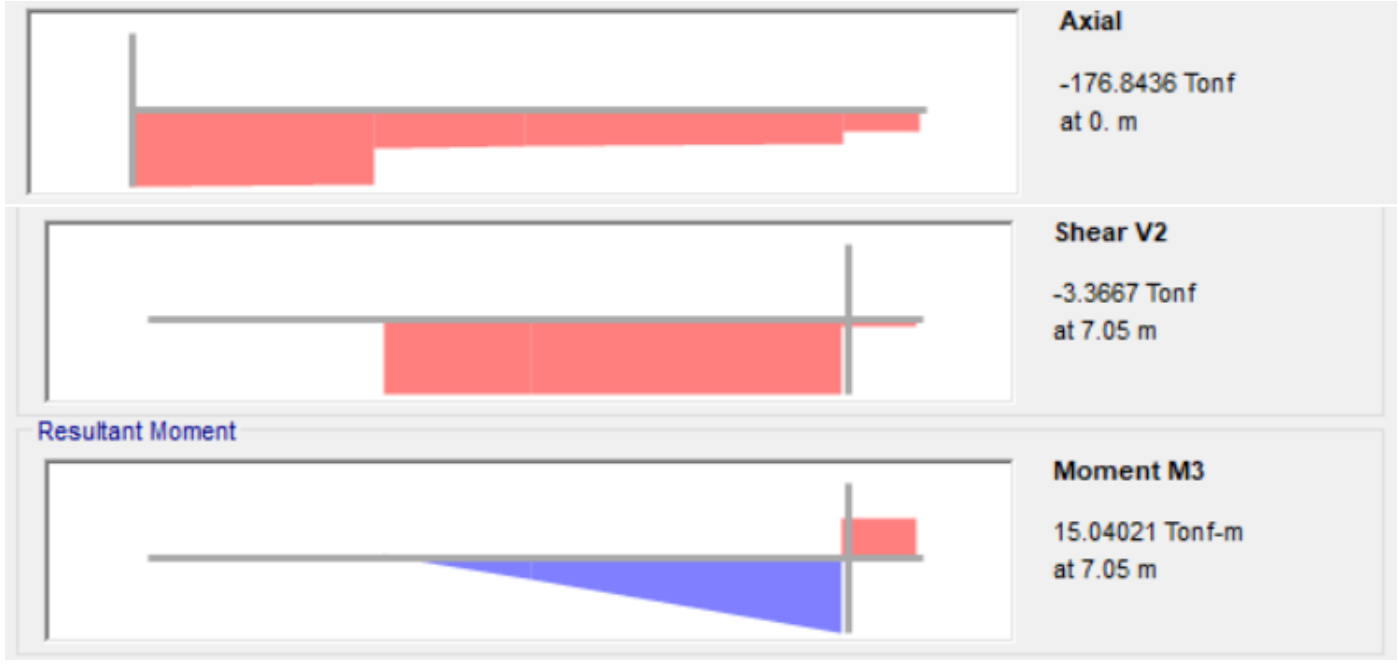
Sec 2



Sec 3


Axial
-267.6372 Tonf
at 0. m
Shear V2
-24.8531 Tonf
at 9.6 m
Resultant Moment
Moment M3
40.67513 Tonf-m
at 9.6 m

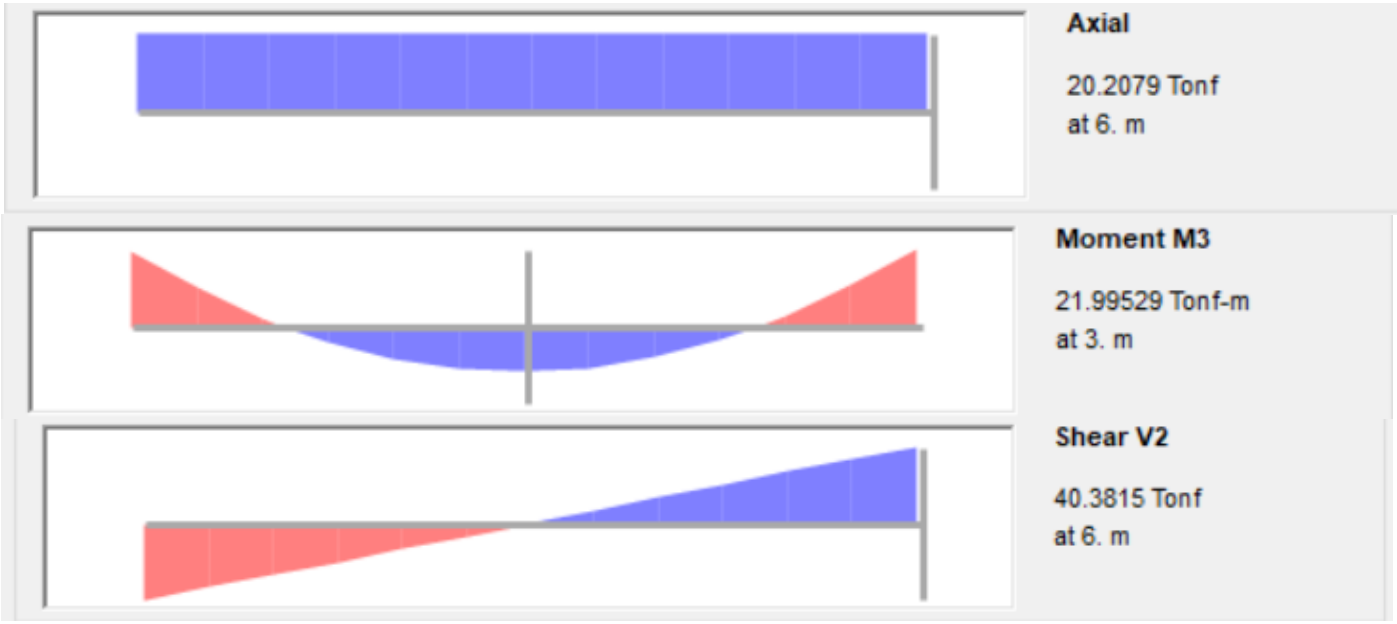
Sec 4


Axial
-176.8436 Tonf
at 0. m
Shear V2
-3.3667 Tonf
at 7.05 m
Resultant Moment
Moment M3
15.04021 Tonf-m
at 7.05 m

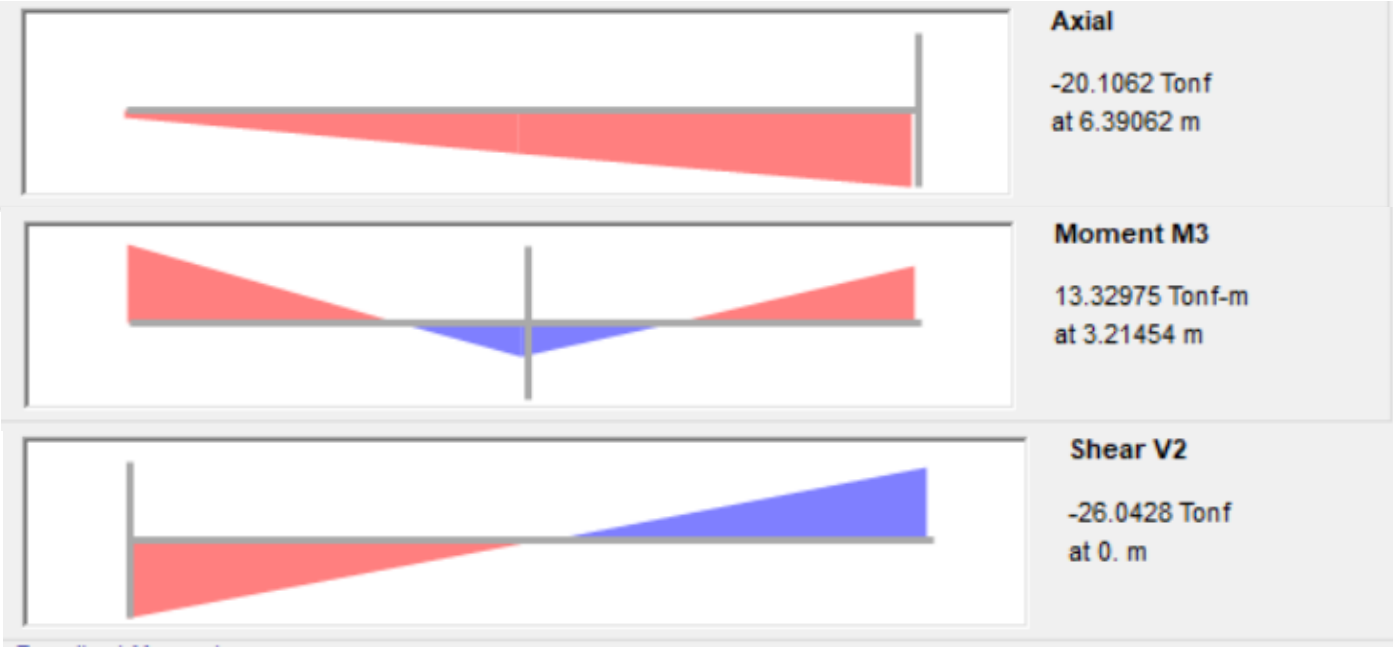
Sec 5


Axial
-82.4361 Tonf
at 0. m
Shear V2
-11.4003 Tonf
at 2.4 m
Resultant Moment
Moment M3
23.97283 Tonf-m
at 2.4 m

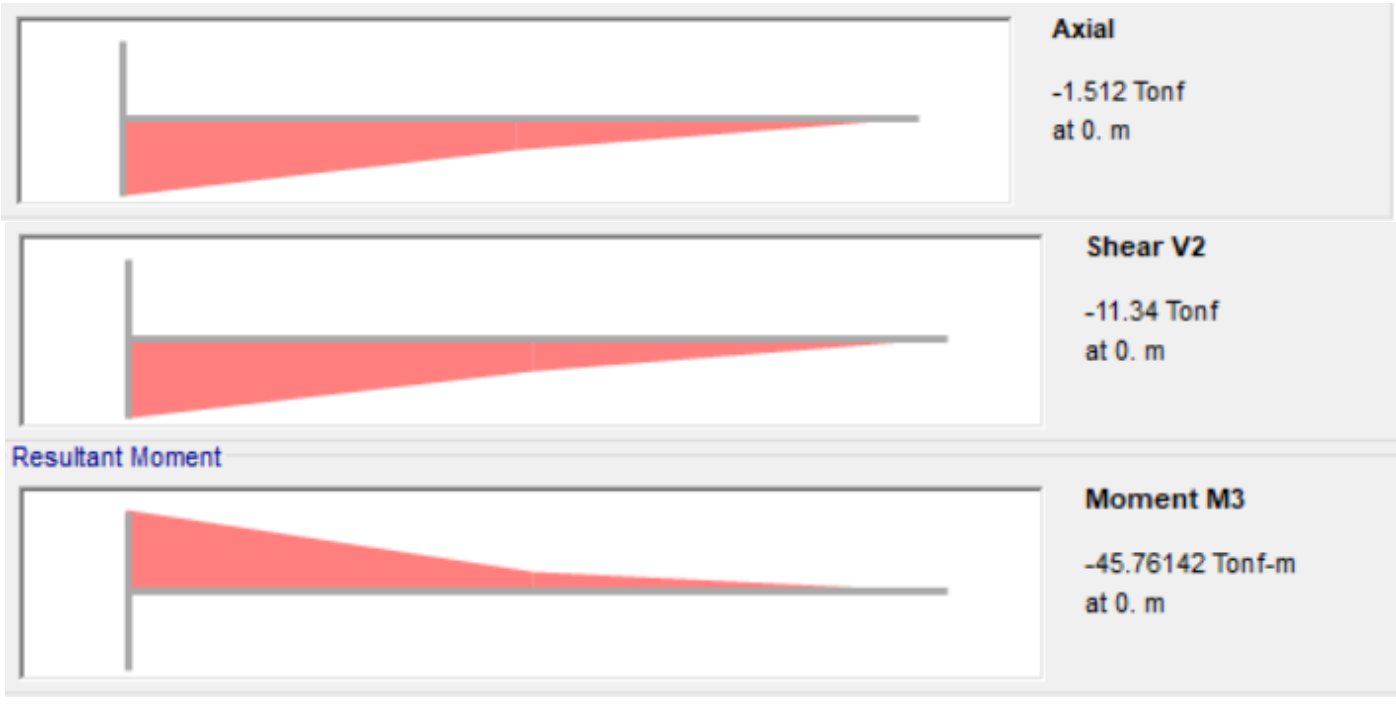
Sec 6


Axial
20.2079 Tonf
at 6. m
Moment M3
21.99529 Tonf-m
at 3. m
Shear V2
40.3815 Tonf
at 6. m

Sec 7


Axial
-20.1062 Tonf
at 6.39062 m
Moment M3
13.32975 Tonf-m
at 3.21454 m
Shear V2
-26.0428 Tonf
at 0. m

Sec 8


Axial
-1.512 Tonf
at 0. m
Shear V2
-11.34 Tonf
at 0. m
Resultant Moment
Moment M3
-45.76142 Tonf-m
at 0. m

FOR FRAME2

Design for (M,N)

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

Sec.	Ult. Moment M_u (m.t)	Normal N_u (t)	Breadth b (cm)	Depth d (cm)	Thick t (cm)	ecc.	C1	J	As_{min} (cm^2)	Used As	Rft.
1	48.62	-161	40	95	100	Small	2.991	0.743	5.70	5.70	6 ϕ 12
2	25.2	-241.6	40	95	100	Small	2.844	0.726	5.70	5.70	6 ϕ 12
3	14.35	-166.5	40	75	80	Small	3.049	0.748	4.50	4.50	4 ϕ 12
4	17.76	-71.52	40	55	60	Small	3.191	0.761	3.30	3.30	3 ϕ 12
5	14.1	9.6	40	55	60	Big	5.570	0.826	6.91	10.51	6 ϕ 16
6	15.35	-23.5	40	55	60	Big	4.136	0.809	6.91	6.91	7 ϕ 12
7	43.47	-34.32	40	75	80	Big	3.488	0.781	9.43	15.79	7 ϕ 18

Design for (SHEAR)

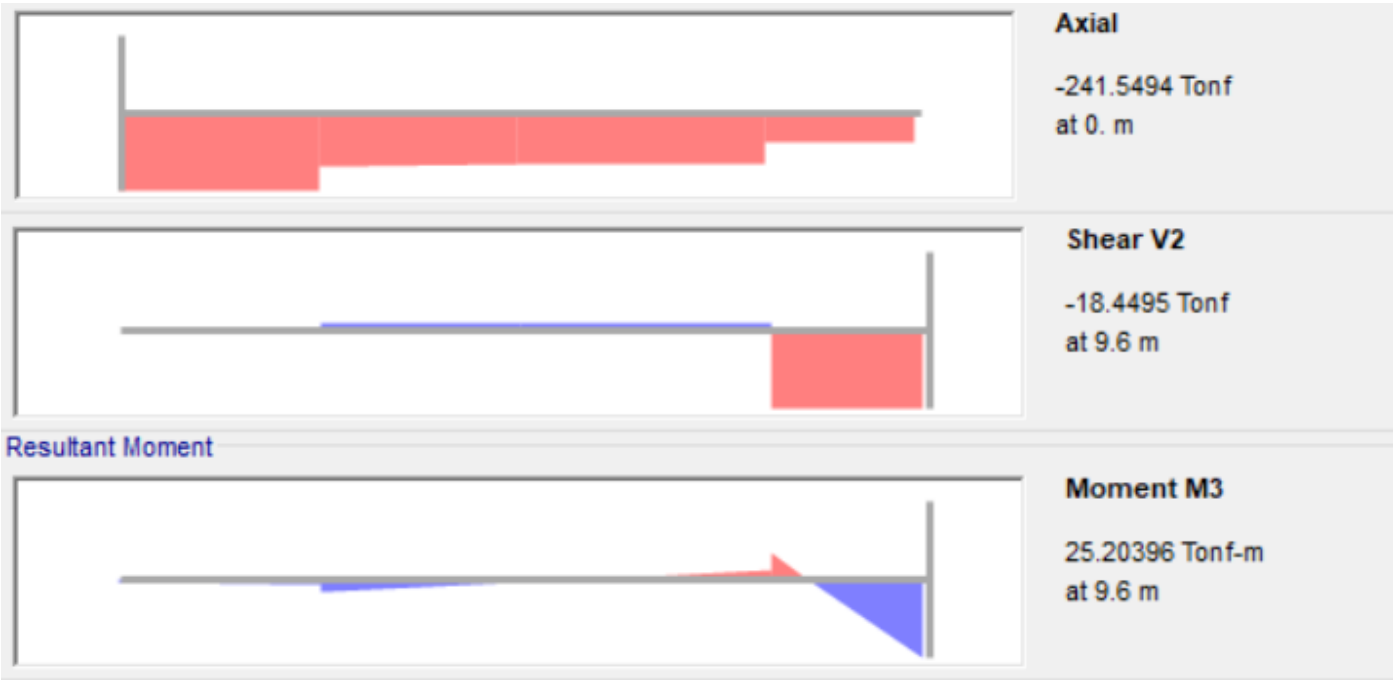
Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
1	34.32	40	95	9.03	0.049	4	3 ϕ 8	safe
2	18.45	40	95	4.86	-0.006	4	0 ϕ 8	safe
3	7.2	40	75	2.40	-0.038	4	-1 ϕ 8	safe
4	9.2	40	55	4.18	-0.015	4	0 ϕ 8	safe
5	25.66	40	55	11.66	0.084	4	5 ϕ 8	safe
6	27.1	40	55	12.32	0.092	4	5 ϕ 8	safe
7	66.02	40	75	22.01	0.220	4	7 ϕ 10	safe

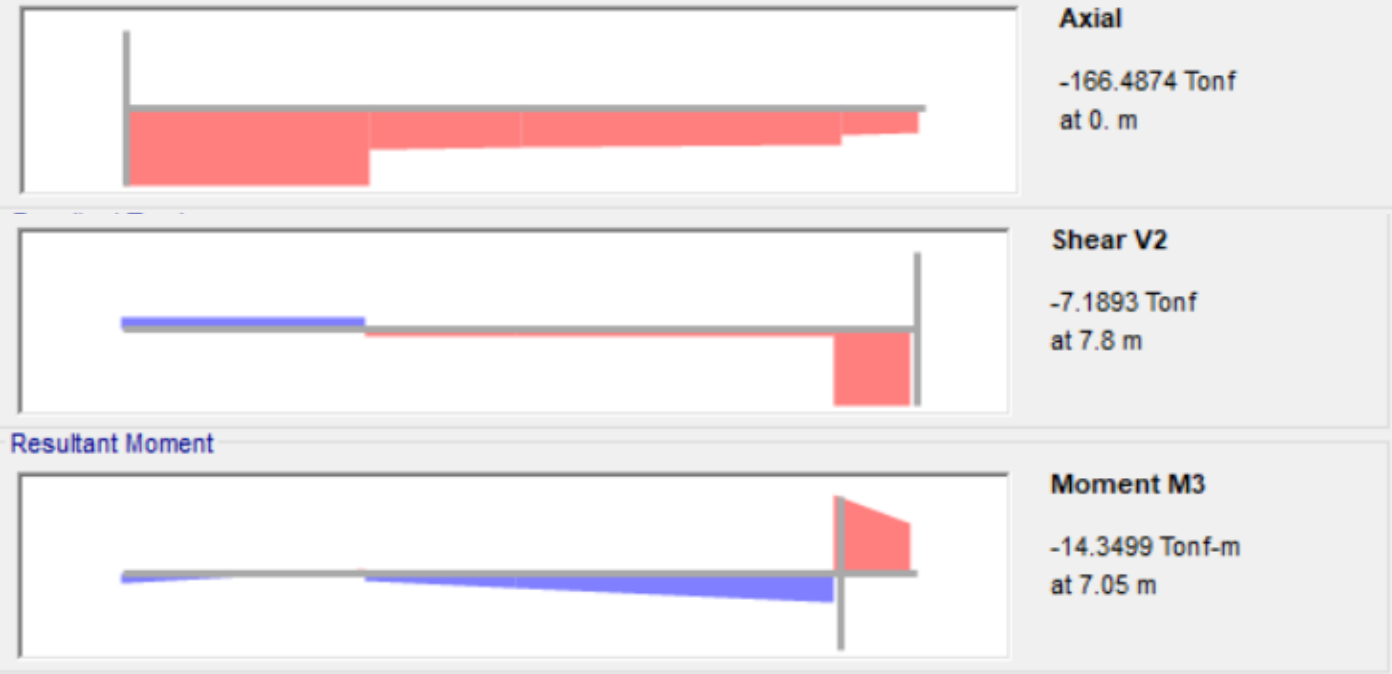
Sec 1


Axial
-161.03 Tonf
at 0. m
Shear V2
34.3202 Tonf
at 9.6 m
Resultant Moment
Moment M3
-48.62095 Tonf-m
at 9.6 m

Sec 2


Axial
-241.5494 Tonf
at 0. m
Shear V2
-18.4495 Tonf
at 9.6 m
Resultant Moment
Moment M3
25.20396 Tonf-m
at 9.6 m

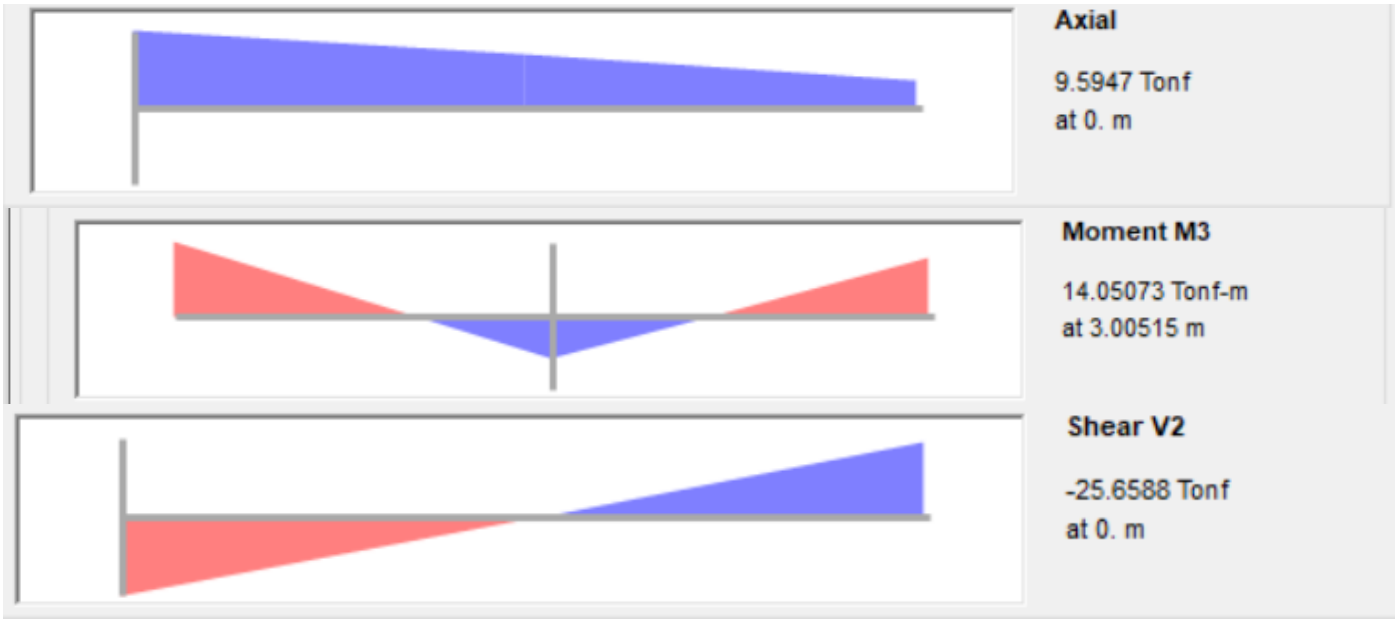
Sec 3


Axial
-166.4874 Tonf
at 0. m
Shear V2
-7.1893 Tonf
at 7.8 m
Resultant Moment
Moment M3
-14.3499 Tonf-m
at 7.05 m

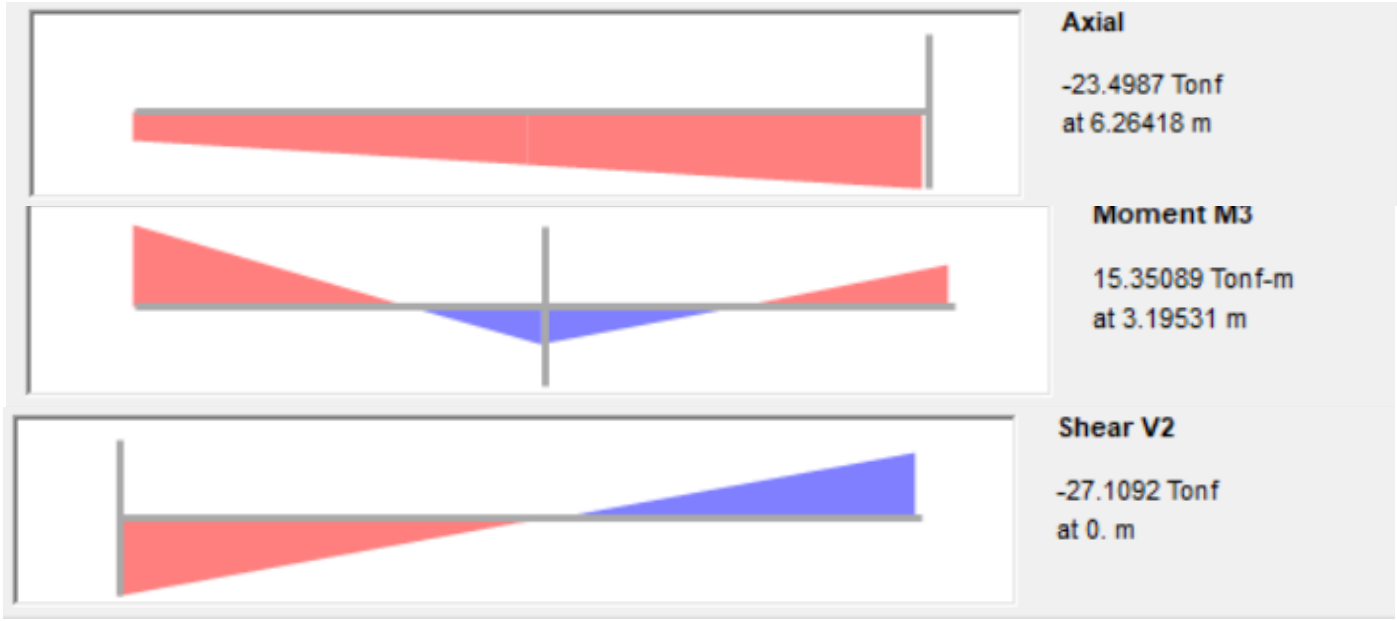
Sec 4


Axial
-71.5221 Tonf
at 0. m
Shear V2
-9.1826 Tonf
at 2.4 m
Resultant Moment
Moment M3
17.76703 Tonf-m
at 2.4 m

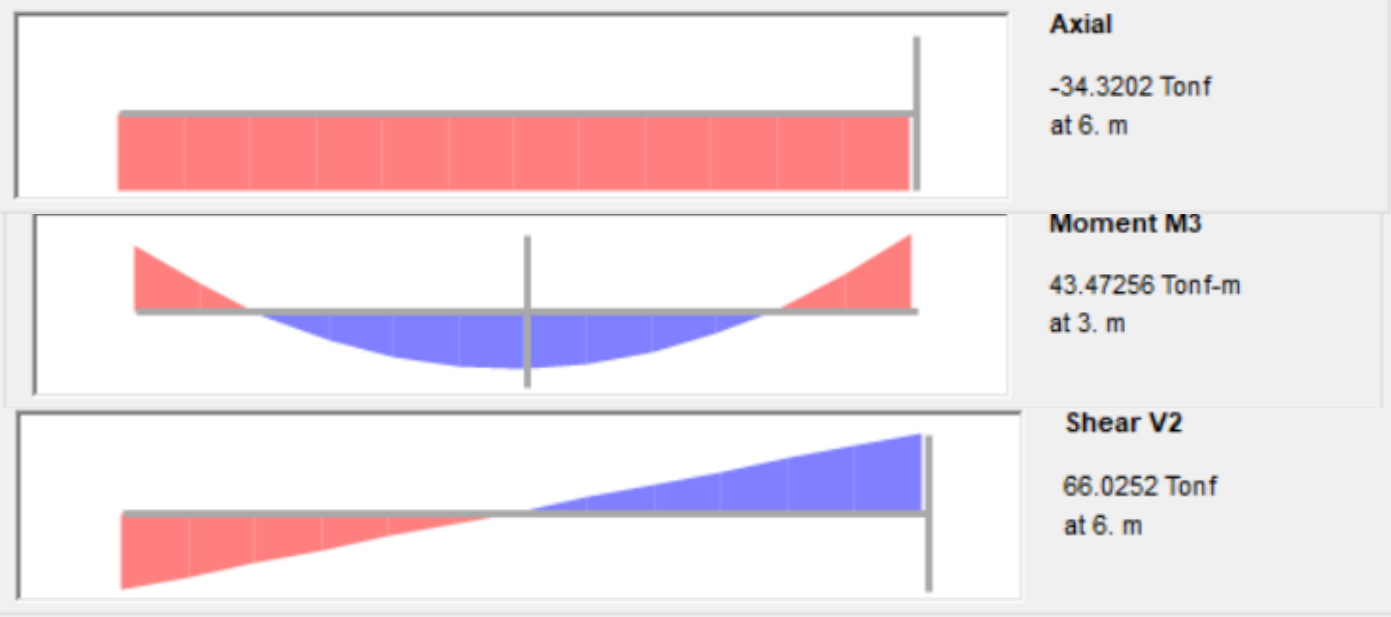
Sec 5


Axial
9.5947 Tonf
at 0. m
Moment M3
14.05073 Tonf-m
at 3.00515 m
Shear V2
-25.6588 Tonf
at 0. m

Sec 6


Axial
-23.4987 Tonf
at 6.26418 m
Moment M3
15.35089 Tonf-m
at 3.19531 m
Shear V2
-27.1092 Tonf
at 0. m

Sec 7


Axial
-34.3202 Tonf
at 6. m
Moment M3
43.47256 Tonf-m
at 3. m
Shear V2
66.0252 Tonf
at 6. m

FOR FRAME3

Design for (M,N)

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

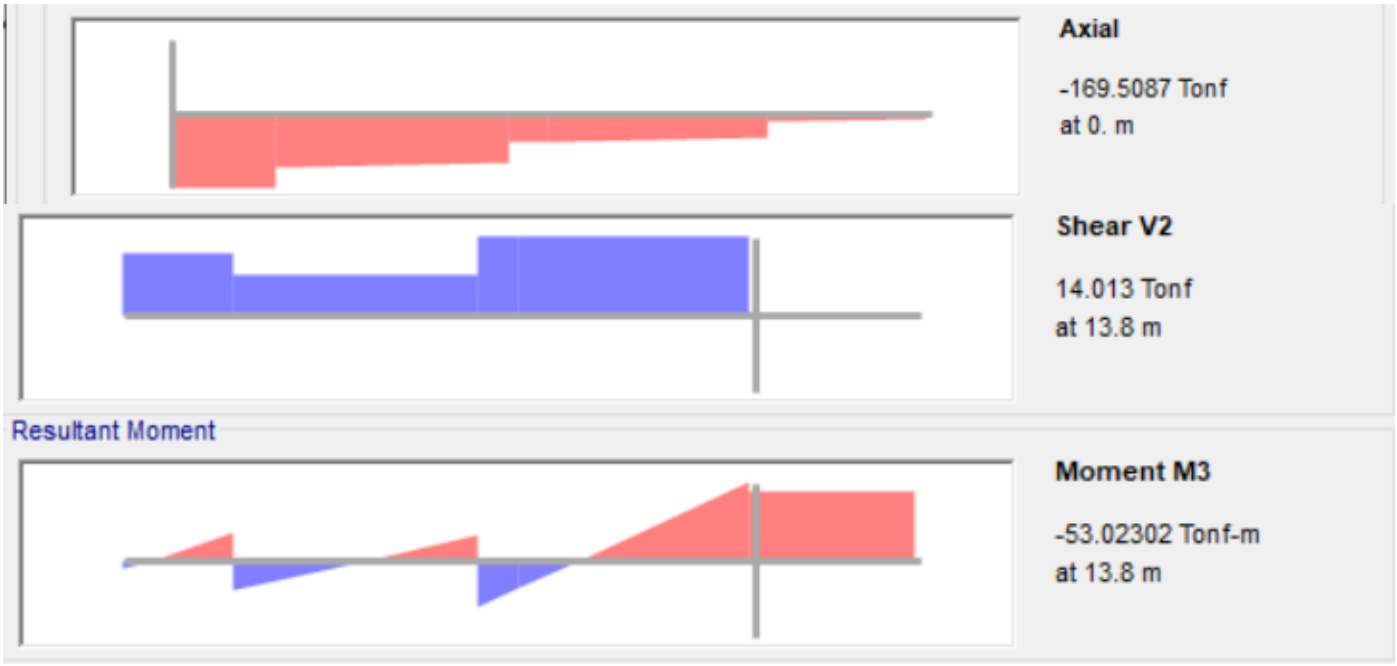
Sec.	Ult. Moment M_u (m.t)	Normal N_u (t)	Breadth b (cm)	Depth d (cm)	Thick t (cm)	ecc.	C1	J	As_{min} (cm^2)	Used As	Rft.
1	**53.02**	**-169.5**	**40**	**95**	**100**	*Small*	*2.894*	*0.732*	*5.70*	*5.70*	*6* ϕ 12
2	**7.036**	**-272**	**40**	**95**	**100**	*Small*	*2.893*	*0.732*	*5.70*	*5.70*	*6* ϕ 12
3	**3.82**	**-253.7**	**40**	**95**	**100**	*Small*	*3.030*	*0.746*	*5.70*	*5.70*	*6* ϕ 12
4	**13.92**	**-180.1**	**40**	**75**	**80**	*Small*	*2.962*	*0.739*	*4.50*	*4.50*	*4* ϕ 12
5	**11.44**	**-69.85**	40	55	60	*Small*	*3.544*	*0.784*	*3.30*	*3.30*	*3* ϕ 12
6	**15.43**	**-20.3**	40	55	60	*Big*	*4.207*	*0.811*	*6.91*	*6.91*	*4* ϕ 16
7	**37.2**	**-14.01**	40	55	60	*Big*	*2.986*	*0.742*	*6.91*	*23.89*	*8* ϕ 20
8	**45.58**	**-1.134**	40	95	100	*Big*	*4.847*	*0.826*	*11.94*	*16.41*	*7* ϕ 18

Design for (SHEAR)

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
1	14.013	**40**	**95**	*3.69*	*-0.021*	4	*-1* ϕ 8	***safe***
2	2.05	**40**	**95**	*0.54*	*-0.063*	4	*-3* ϕ 8	***safe***
3	1.16	**40**	**95**	*0.31*	*-0.066*	4	*-3* ϕ 8	***safe***
4	8.4	**40**	**75**	*2.80*	*-0.033*	4	*-1* ϕ 8	***safe***
5	46.04	40	55	*20.93*	*0.205*	4	*7* ϕ 10	***safe***
6	25.76	40	55	*11.71*	*0.084*	4	*5* ϕ 8	***safe***
7	36.93	40	55	*16.79*	*0.151*	4	*5* ϕ 10	***safe***
8	11.4	40	95	*3.00*	*-0.030*	2	*-3* ϕ 8	***safe***

Sec 1


Axial
-169.5087 Tonf
at 0. m
Shear V2
14.013 Tonf
at 13.8 m
Resultant Moment
Moment M3
-53.02302 Tonf-m
at 13.8 m

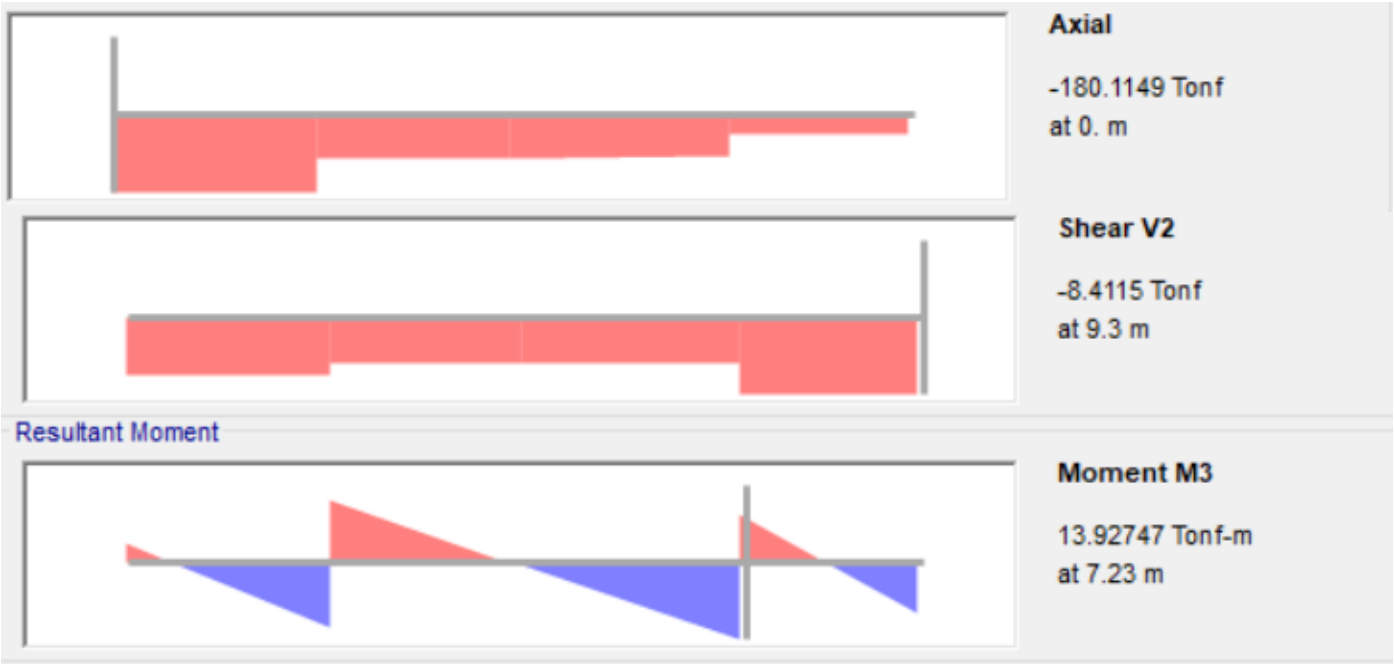
Sec 2


Axial
-271.9732 Tonf
at 0. m
Shear V2
2.0514 Tonf
at 7.8 m
Resultant Moment
Moment M3
7.03618 Tonf-m
at 12.9 m

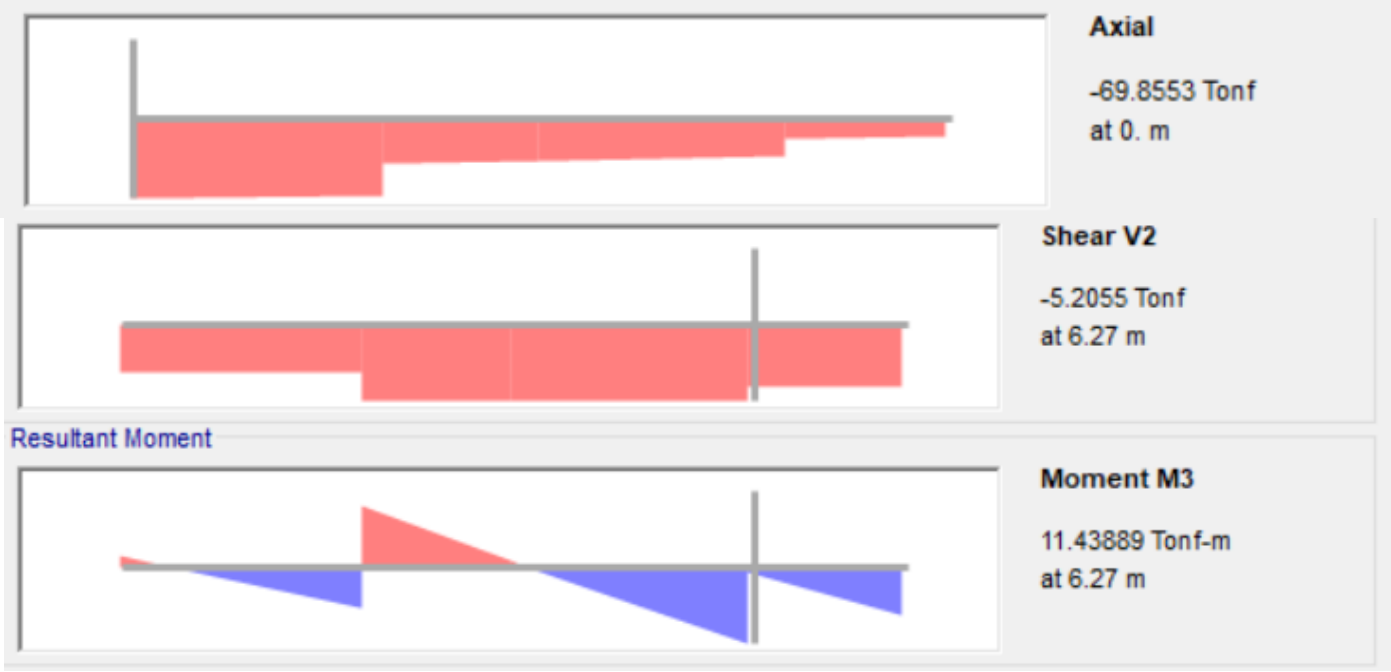
Sec 3


Axial
-253.666 Tonf
at 0. m
Shear V2
1.1631 Tonf
at 7.8 m
Resultant Moment
Moment M3
3.82237 Tonf-m
at 2.4 m

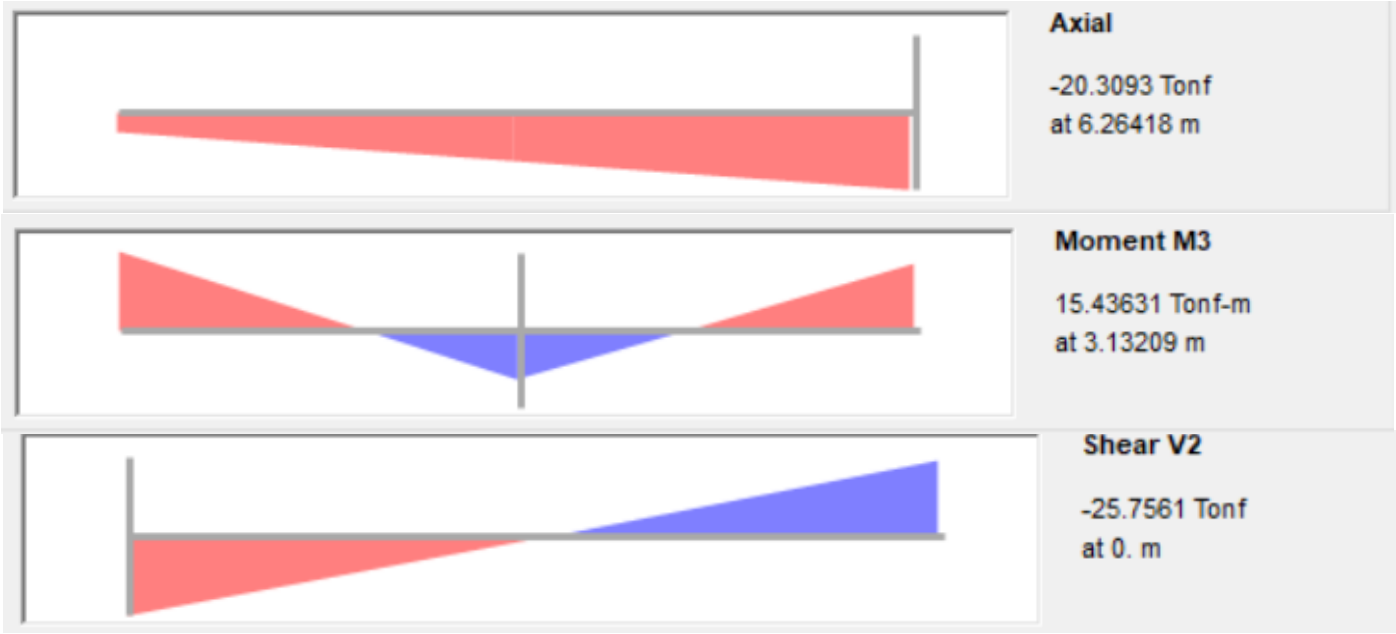
Sec 4


Axial
-180.1149 Tonf
at 0. m
Shear V2
-8.4115 Tonf
at 9.3 m
Resultant Moment
Moment M3
13.92747 Tonf-m
at 7.23 m

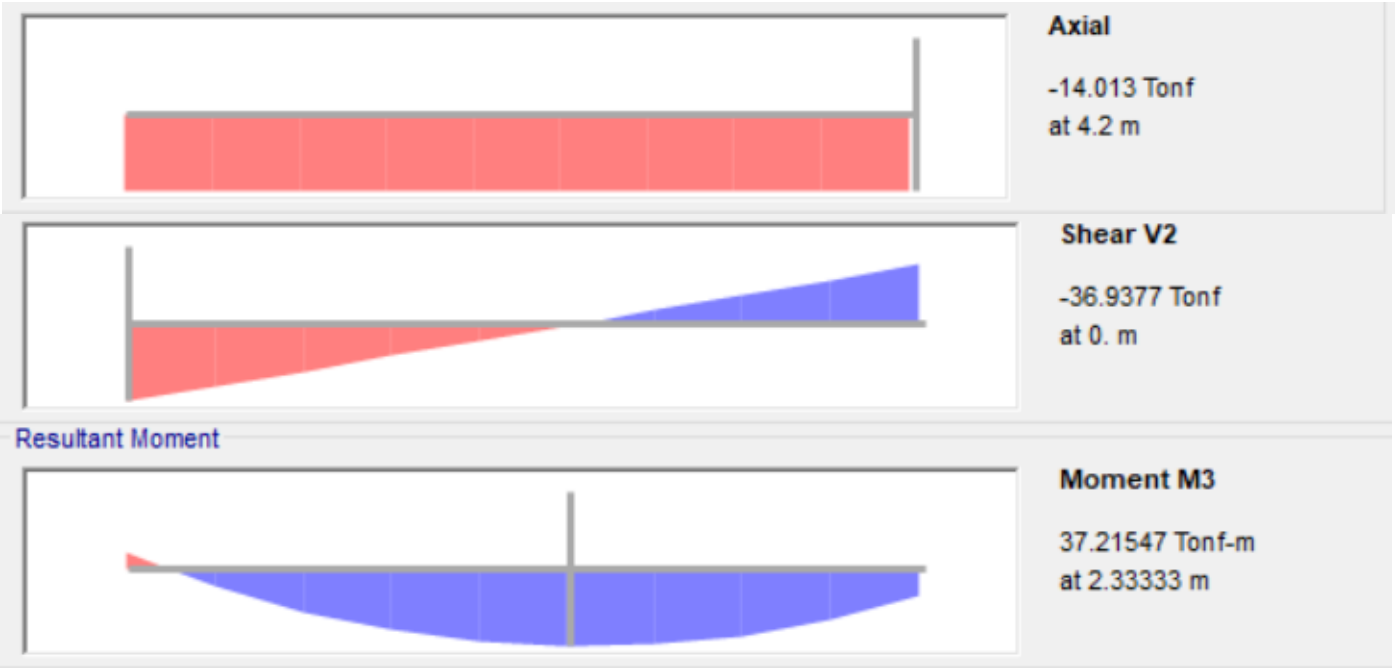
Sec 5


Axial
-69.8553 Tonf
at 0. m
Shear V2
-5.2055 Tonf
at 6.27 m
Resultant Moment
Moment M3
11.43889 Tonf-m
at 6.27 m

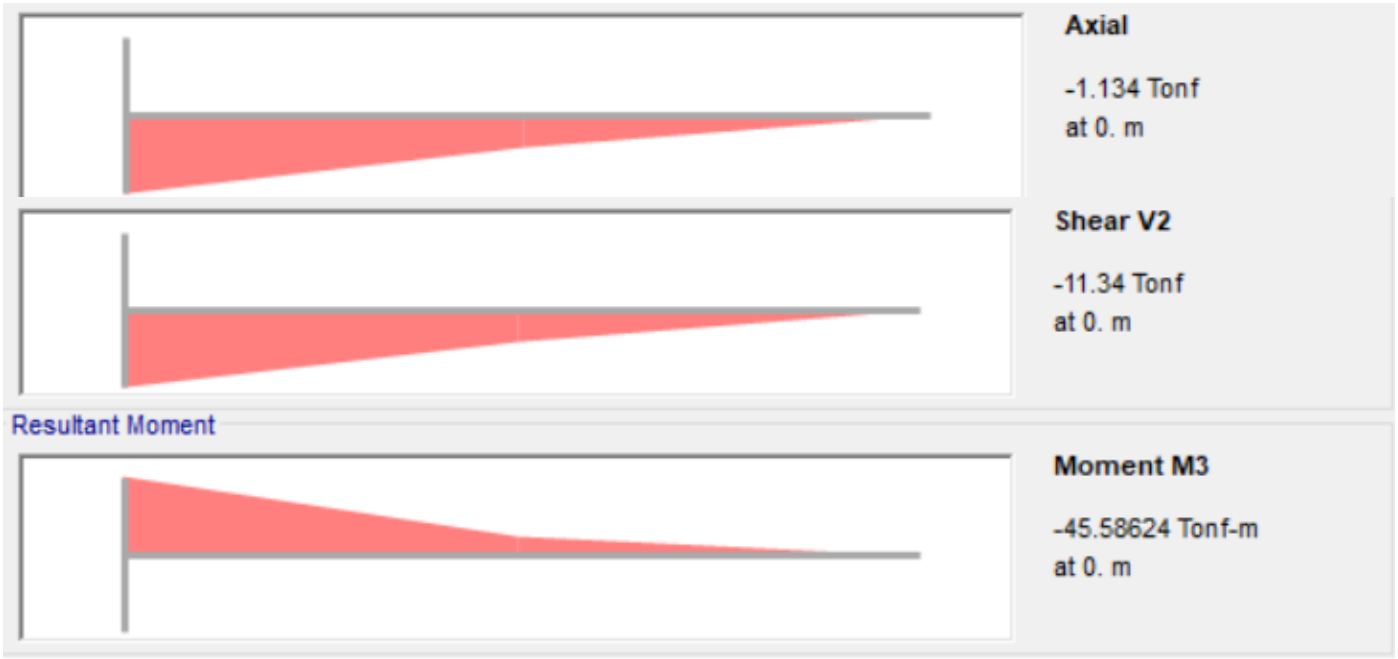
Sec 6


Axial
-20.3093 Tonf
at 6.26418 m
Moment M3
15.43631 Tonf-m
at 3.13209 m
Shear V2
-25.7561 Tonf
at 0. m

Sec7


Axial
-14.013 Tonf
at 4.2 m
Shear V2
-36.9377 Tonf
at 0. m
Resultant Moment
Moment M3
37.21547 Tonf-m
at 2.33333 m

Sec8


Axial
-1.134 Tonf
at 0. m
Shear V2
-11.34 Tonf
at 0. m
Resultant Moment
Moment M3
-45.58624 Tonf-m
at 0. m

FOR FRAME4

Design for (M,N)

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

Sec.	Ult. Moment M_u (m.t)	Normal N_u (t)	Breadth b (cm)	Depth d (cm)	Thick t (cm)	ecc.	C1	J	As_{min} (cm^2)	Used As	Rft.
1	**49.13**	**-143.2**	**40**	**95**	**100**	*Small*	*3.088*	*0.752*	*5.70*	*5.70*	*6* ϕ 12
2	**4.98**	**-255.4**	**40**	**95**	**100**	*Small*	*3.005*	*0.744*	*5.70*	*5.70*	*6* ϕ 12
3	**3.67**	**-249**	**40**	**95**	**100**	*Small*	*3.059*	*0.749*	*5.70*	*5.70*	*6* ϕ 12
4	**16.3**	**-205.8**	**40**	**95**	**100**	*Small*	*3.153*	*0.758*	*5.70*	*5.70*	*6* ϕ 12
5	**23.5**	**-86.1**	40	55	60	*Small*	*2.839*	*0.725*	*5.27*	*5.27*	*5* ϕ 12
6	**21.4**	**5.78**	40	55	60	*Big*	*4.265*	*0.813*	*6.91*	*14.65*	*8* ϕ 16
7	**23.5**	**-16.01**	40	55	60	*Big*	*3.633*	*0.789*	*6.91*	*12.85*	*7* ϕ 16
8	**45.76**	**-1.512**	40	95	100	*Big*	*4.829*	*0.826*	*11.94*	*16.41*	*7* ϕ 18

Design for (SHEAR)

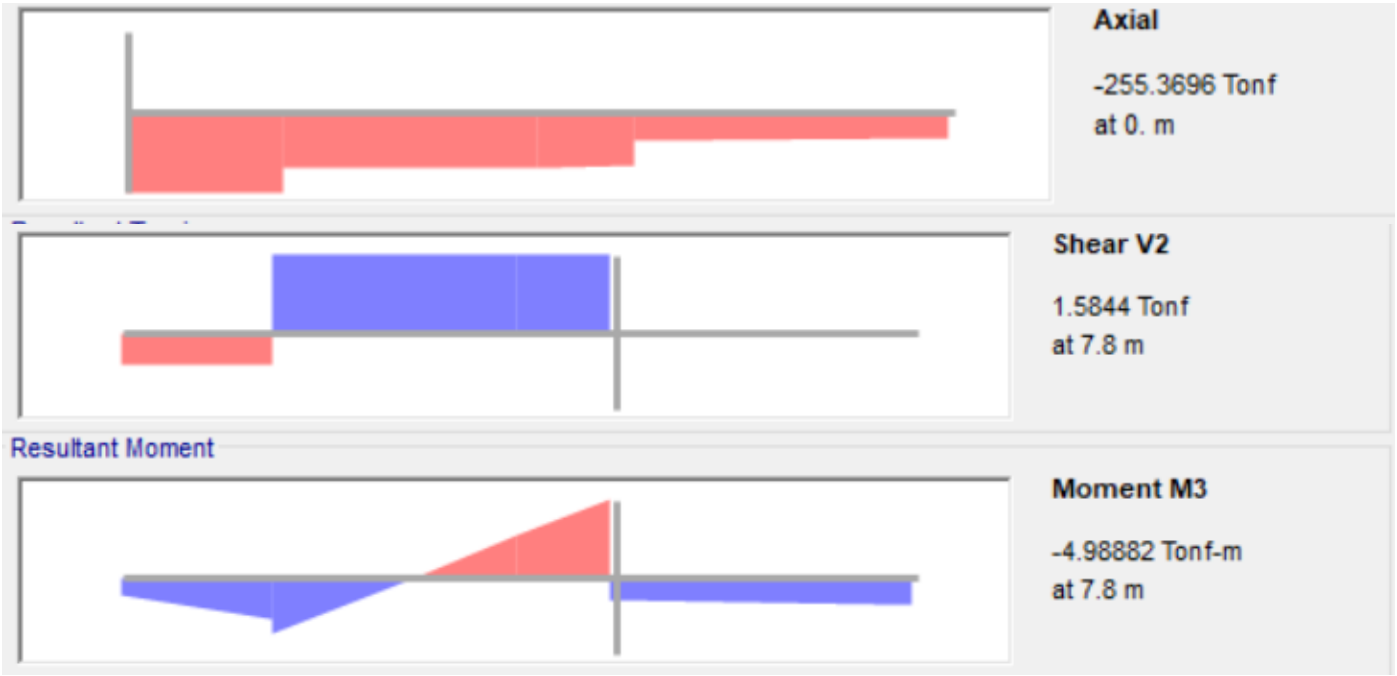
Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
1	12.6	40	95	*3.32*	*-0.026*	4	*-1* ϕ 8	***safe***
2	1.58	40	95	*0.42*	*-0.064*	4	*-3* ϕ 8	***safe***
3	1.457	40	95	*0.38*	*-0.065*	4	*-3* ϕ 8	***safe***
4	6.367	40	95	*1.68*	*-0.048*	4	*-2* ϕ 8	***safe***
5	9.57	40	55	*4.35*	*-0.013*	4	*0* ϕ 8	***safe***
6	41.9	40	55	*19.05*	*0.181*	4	*6* ϕ 10	***safe***
7	38.9	40	55	*17.68*	*0.163*	4	*6* ϕ 10	***safe***
8	11.34	40	95	*2.98*	*-0.030*	4	*-1* ϕ 8	***safe***

Sec 1


Axial
-143.1876 Tonf
at 0. m
Shear V2
12.6303 Tonf
at 13.8 m
Resultant Moment
Moment M3
-49.12923 Tonf-m
at 13.8 m

Sec 2


Axial
-255.3696 Tonf
at 0. m
Shear V2
1.5844 Tonf
at 7.8 m
Resultant Moment
Moment M3
-4.98882 Tonf-m
at 7.8 m

Sec 3


Axial
-249.0669 Tonf
at 0. m
Shear V2
1.4573 Tonf
at 7.2 m
Resultant Moment
Moment M3
-3.67235 Tonf-m
at 7.2 m

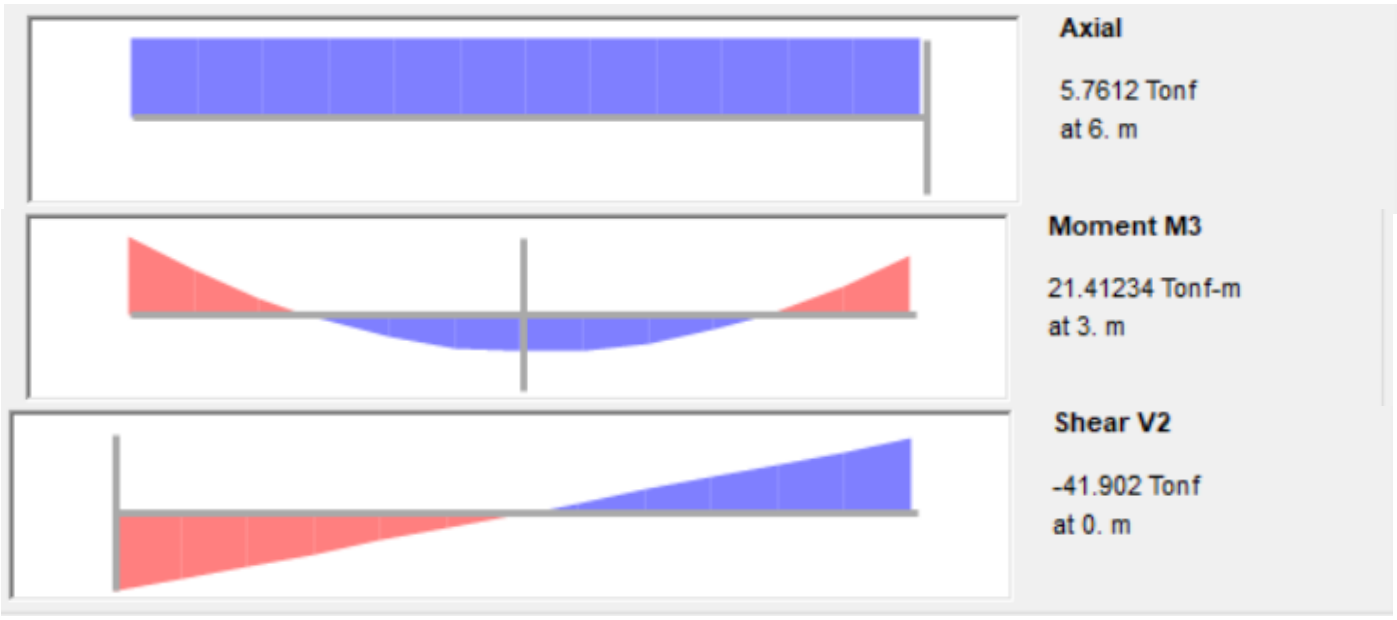
Sec 4


Axial
-205.8169 Tonf
at 0. m
Shear V2
-6.367 Tonf
at 9.3 m
Resultant Moment
Moment M3
-16.25922 Tonf-m
at 7.2 m

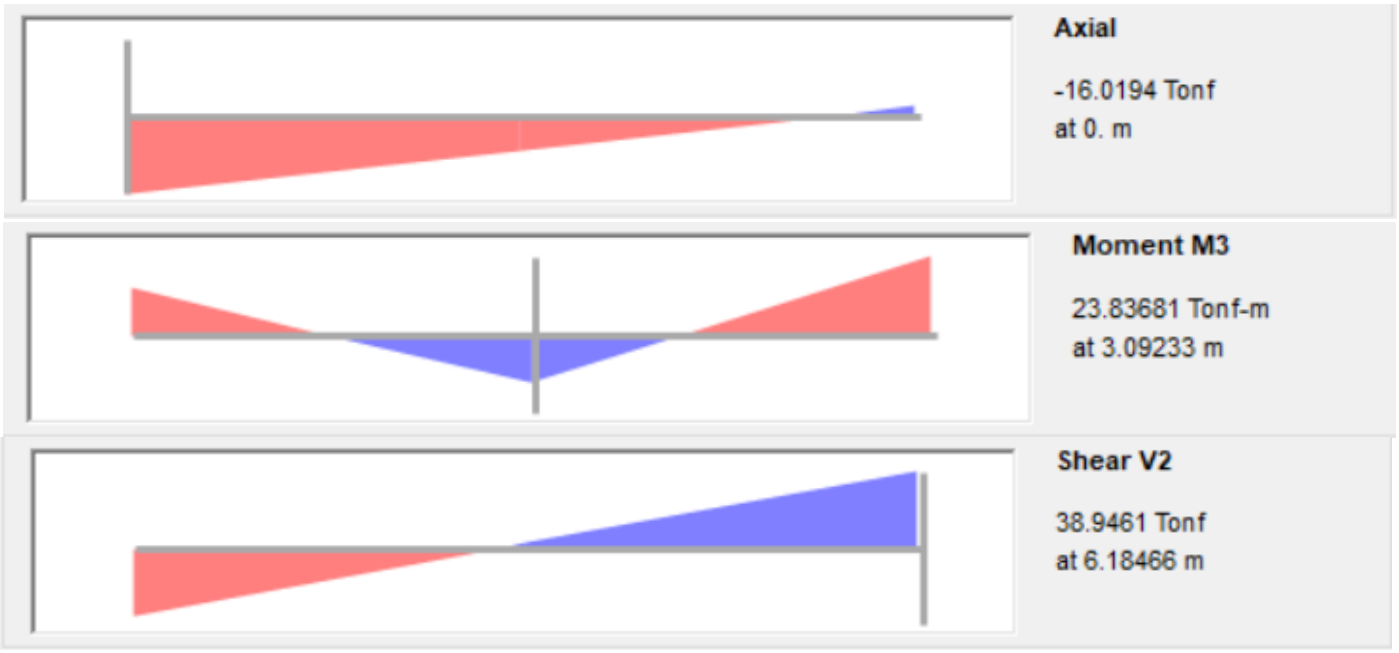
Sec 5


Axial
-86.0844 Tonf
at 0. m
Shear V2
-9.5717 Tonf
at 2.4 m
Resultant Moment
Moment M3
23.52195 Tonf-m
at 7.8 m

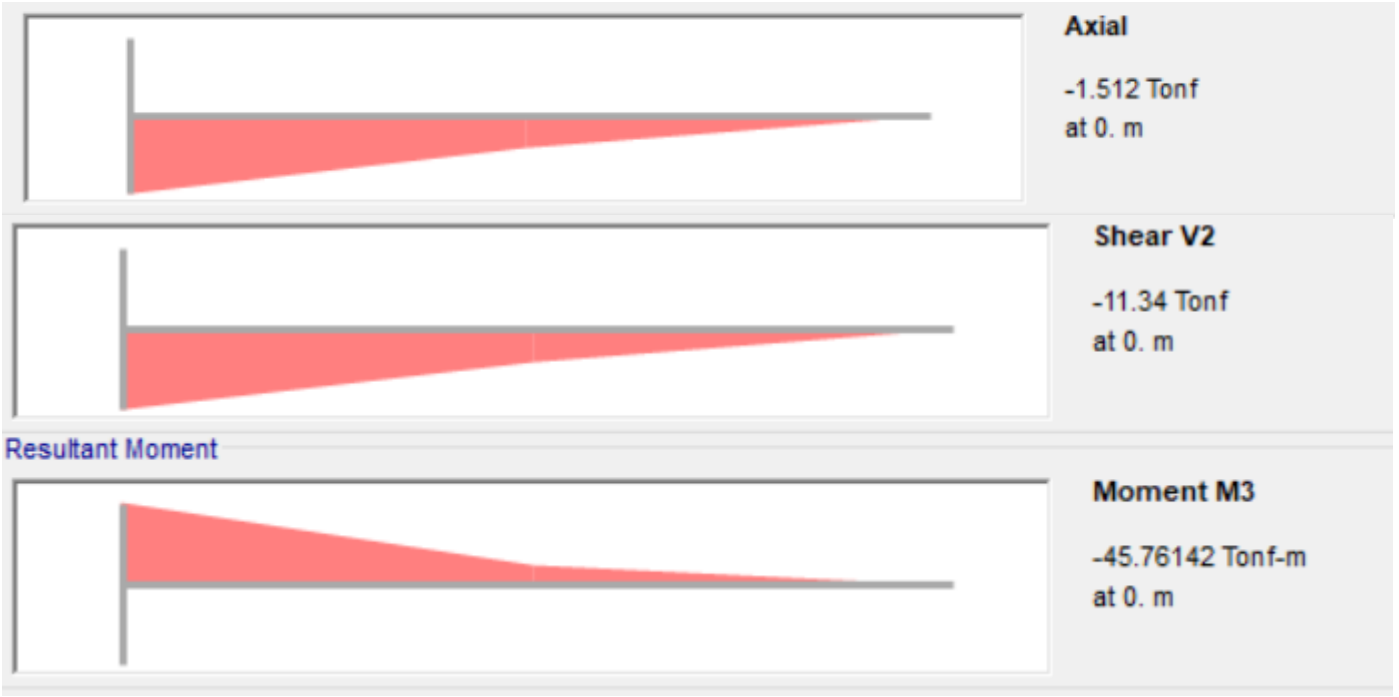
Sec 6


Axial
5.7612 Tonf
at 6. m
Moment M3
21.41234 Tonf-m
at 3. m
Shear V2
-41.902 Tonf
at 0. m

Sec 7


Axial
-16.0194 Tonf
at 0. m
Moment M3
23.83681 Tonf-m
at 3.09233 m
Shear V2
38.9461 Tonf
at 6.18466 m

Sec 8


Axial
-1.512 Tonf
at 0. m
Shear V2
-11.34 Tonf
at 0. m
Resultant Moment
Moment M3
-45.76142 Tonf-m
at 0. m

FOR FRAME5

Design for (M,N)

Concrete F_{cu} =	300	kg/cm^2
Steel F_y =	3500	kg/cm^2

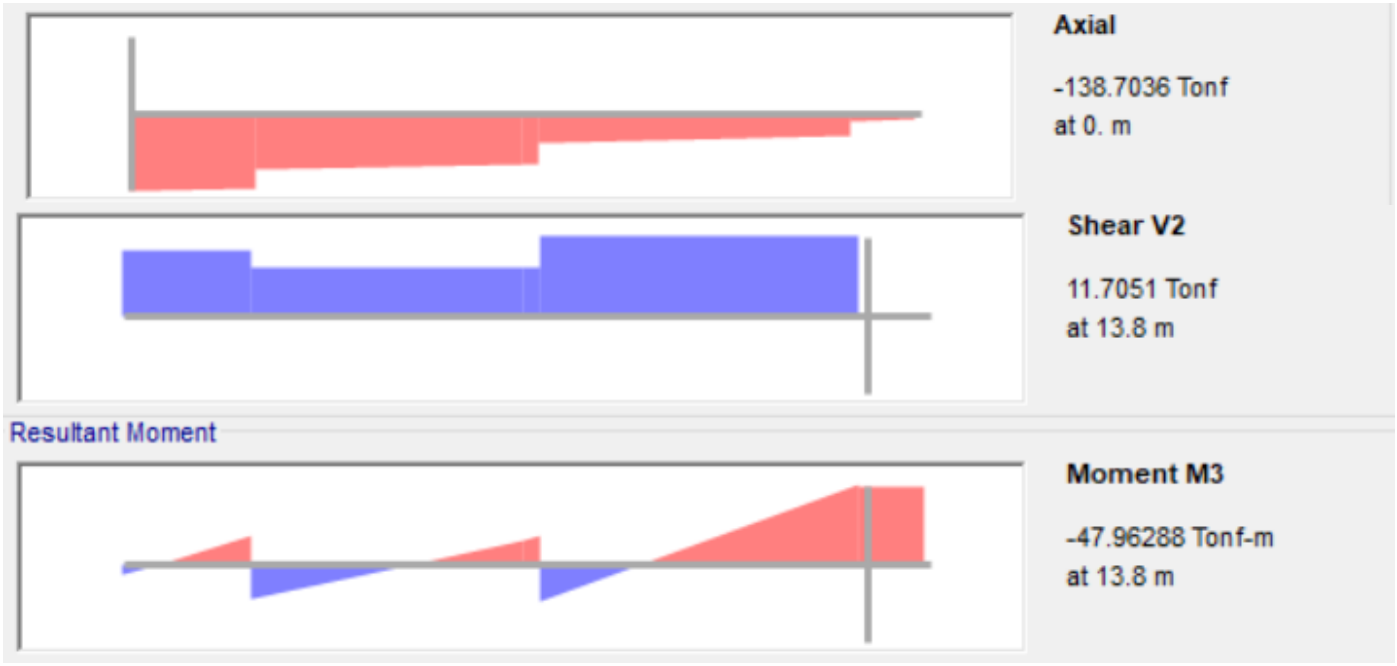
Sec.	Ult. Moment M_u (m.t)	Normal N_u (t)	Breadth b (cm)	Depth d (cm)	Thick t (cm)	ecc.	C1	J	As_{min} (cm^2)	Used As	Rft.
1	**47.96**	**-138.7**	**40**	**95**	**100**	*Small*	*3.132*	*0.756*	*5.70*	*5.70*	*6* ϕ 12
2	**4.73**	**-250.1**	**40**	**95**	**100**	*Small*	*3.039*	*0.747*	*5.70*	*5.70*	*6* ϕ 12
3	**4.09**	**-241.2**	**40**	**95**	**100**	*Small*	*3.101*	*0.753*	*5.70*	*5.70*	*6* ϕ 12
4	**19.9**	**-204.9**	**40**	**95**	**100**	*Small*	*3.108*	*0.754*	*5.70*	*5.70*	*6* ϕ 12
5	**21.2**	**-84.78**	40	55	60	*Small*	*2.926*	*0.736*	*3.30*	*3.30*	*3* ϕ 12
6	**22.75**	**-14.95**	40	55	60	*Big*	*3.702*	*0.792*	*6.91*	*12.46*	*7* ϕ 16
7	**45.76**	**-1.512**	40	95	100	*Big*	*4.829*	*0.826*	*11.94*	*16.41*	*7* ϕ 18

Design for (SHEAR)

Concrete F_{cu} =	300	kg/cm^2
Concrete q_{all} =	10.607	kg/cm^2
Stirrups F_y =	3500	kg/cm^2

Sec.	Ult. Shear Q_u (ton)	Breadth b (cm)	Depth d (cm)	q_u (kg/cm^2)	As / S	no. of bran.	Stirrups	Notes
1	11.7	40	**95**	*3.08*	*-0.029*	4	*-1* ϕ 8	***safe***
2	1.72	40	**95**	*0.45*	*-0.064*	4	*-3* ϕ 8	***safe***
3	1.72	40	**95**	*0.45*	*-0.064*	4	*-3* ϕ 8	***safe***
4	5.85	40	**95**	*1.54*	*-0.049*	4	*-2* ϕ 8	***safe***
5	9.96	40	55	*4.53*	*-0.010*	4	*0* ϕ 8	***safe***
6	39.97	40	55	*18.17*	*0.169*	4	*6* ϕ 10	***safe***
7	11.34	40	95	*2.98*	*-0.030*	4	*-1* ϕ 8	***safe***

Sec 1


Axial
-138.7036 Tonf
at 0. m
Shear V2
11.7051 Tonf
at 13.8 m
Resultant Moment
Moment M3
-47.96288 Tonf-m
at 13.8 m

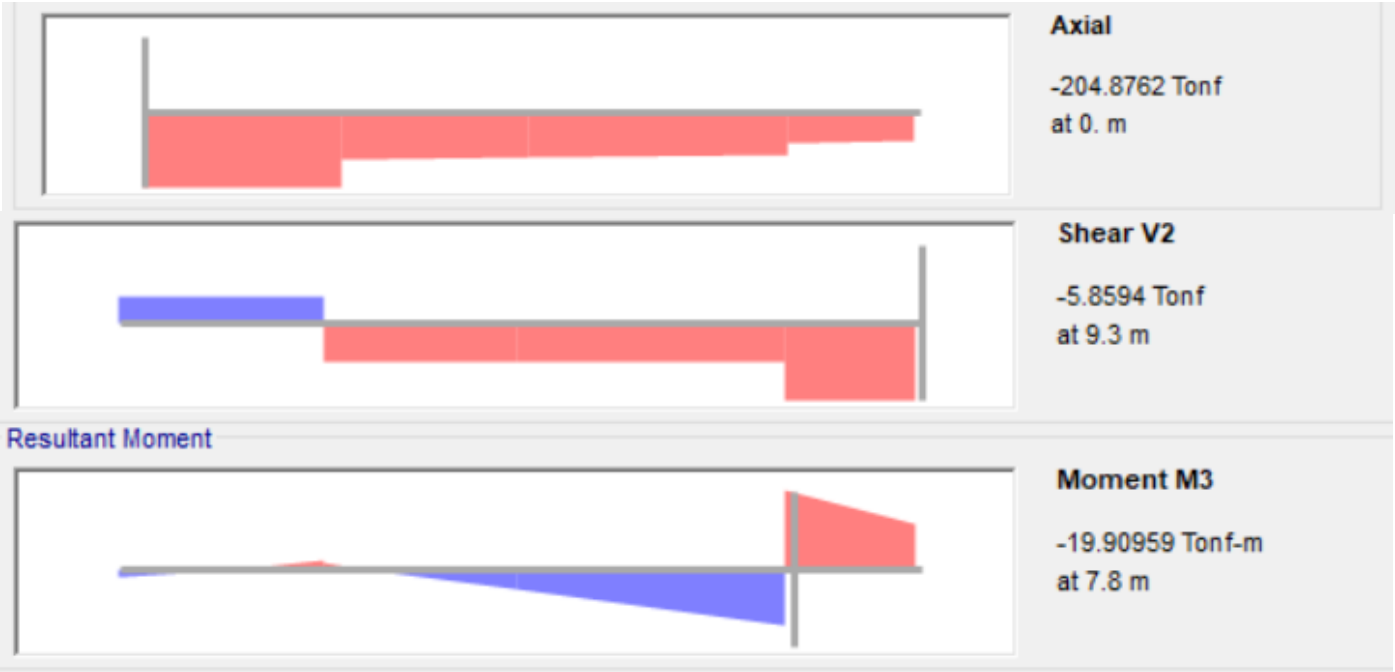
Sec 2


Axial
-250.593 Tonf
at 0. m
Shear V2
1.7142 Tonf
at 7.8 m
Resultant Moment
Moment M3
4.72462 Tonf-m
at 2.4 m

Sec 3


Axial
-241.2266 Tonf
at 0. m
Shear V2
1.7198 Tonf
at 10.8 m
Resultant Moment
Moment M3
-4.09339 Tonf-m
at 10.8 m

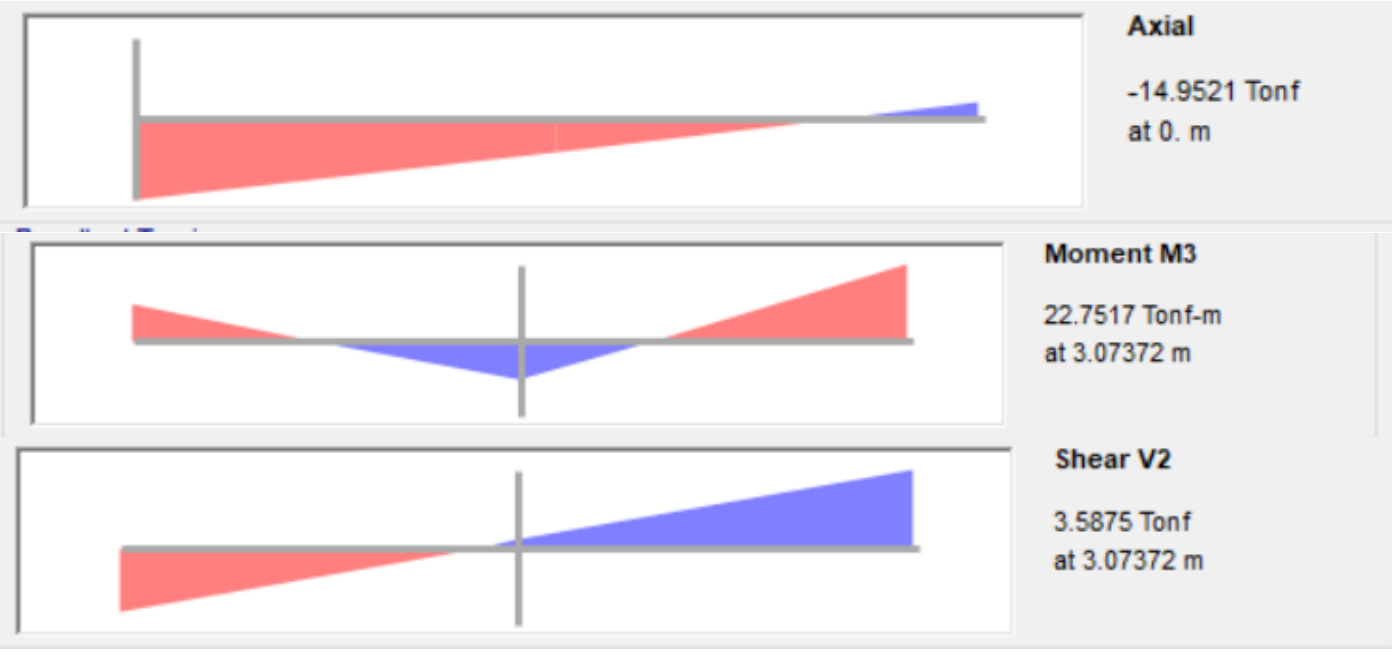
Sec 4


Axial
-204.8762 Tonf
at 0. m
Shear V2
-5.8594 Tonf
at 9.3 m
Resultant Moment
Moment M3
-19.90959 Tonf-m
at 7.8 m

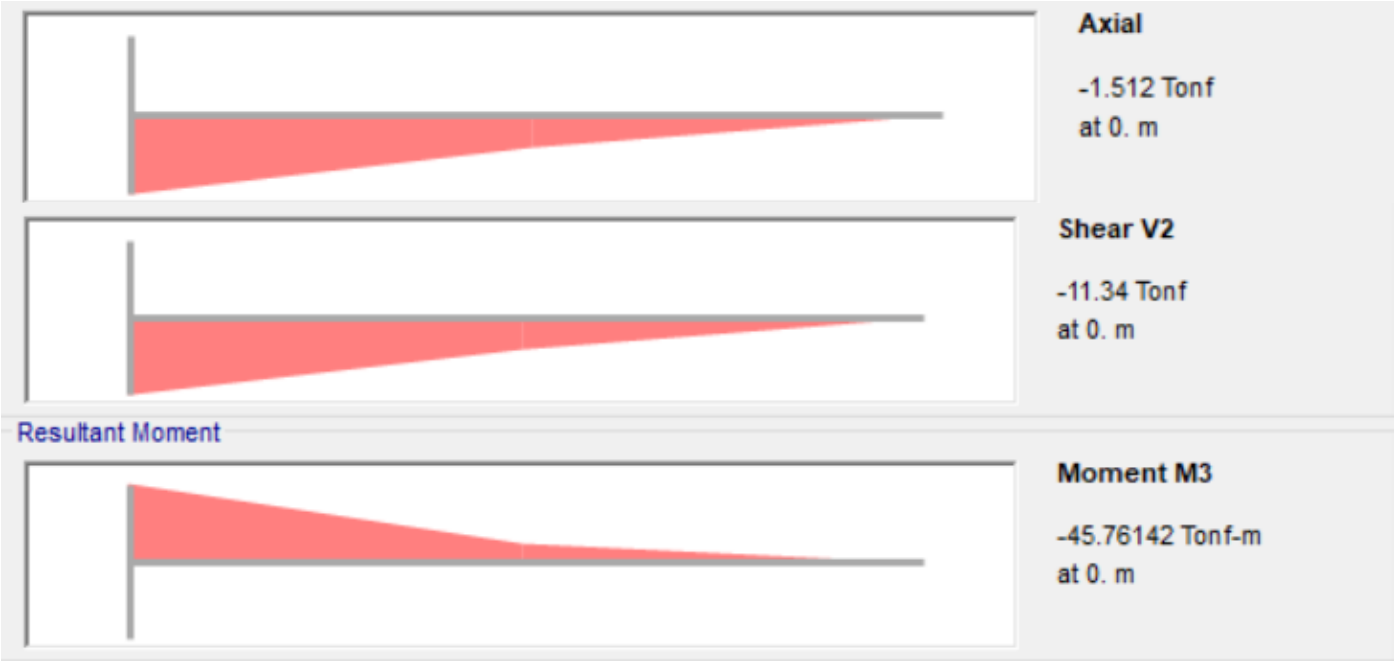
Sec 5


Axial
-84.7644 Tonf
at 0. m
Shear V2
-9.9685 Tonf
at 2.4 m
Resultant Moment
Moment M3
21.1465 Tonf-m
at 7.8 m

Sec 6

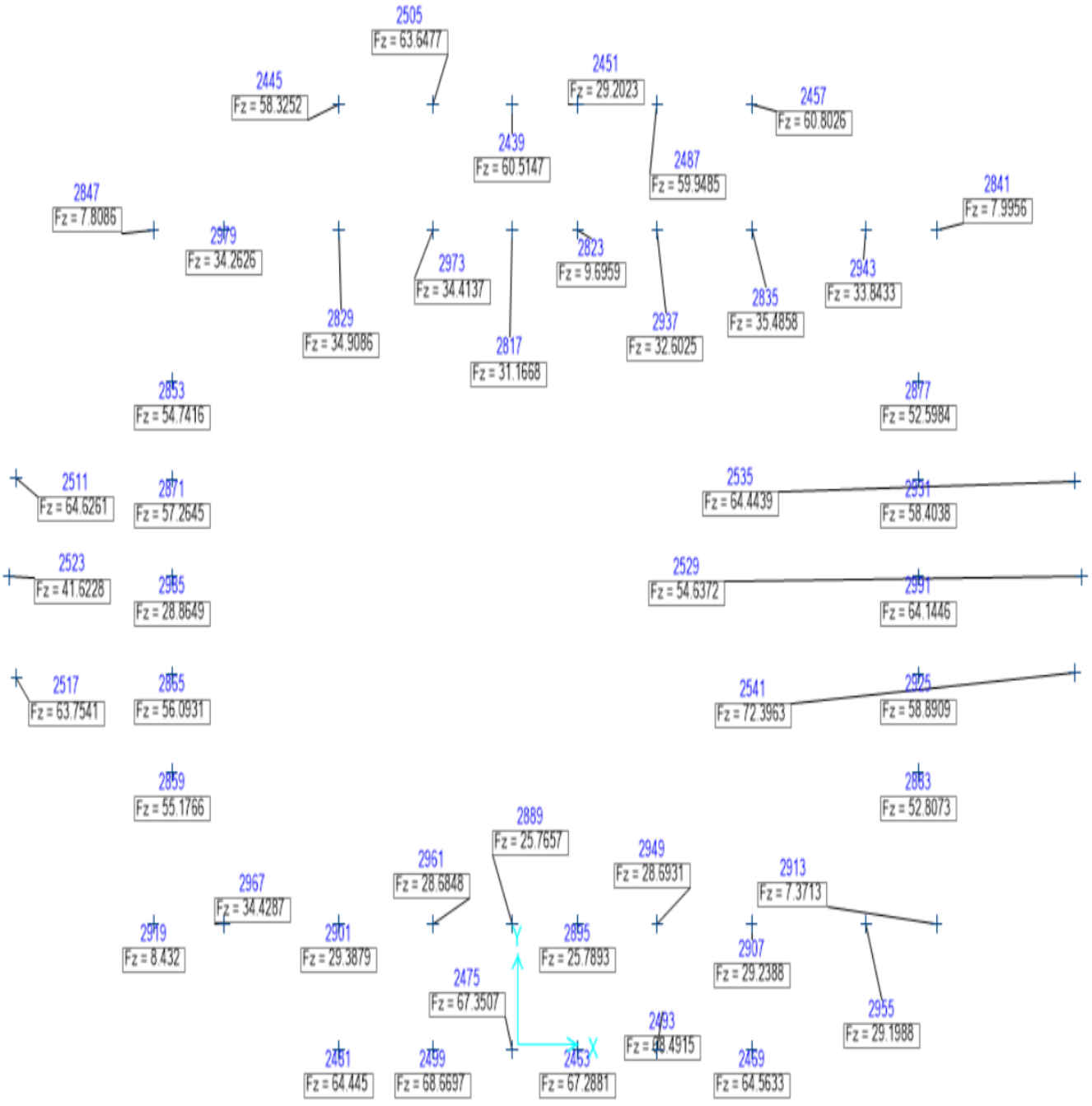

Axial
-14.9521 Tonf
at 0. m
Moment M3
22.7517 Tonf-m
at 3.07372 m
Shear V2
3.5875 Tonf
at 3.07372 m

Sec 7


Axial
-1.512 Tonf
at 0. m
Shear V2
-11.34 Tonf
at 0. m
Resultant Moment
Moment M3
-45.76142 Tonf-m
at 0. m

Design of columns

Column of sawtooth

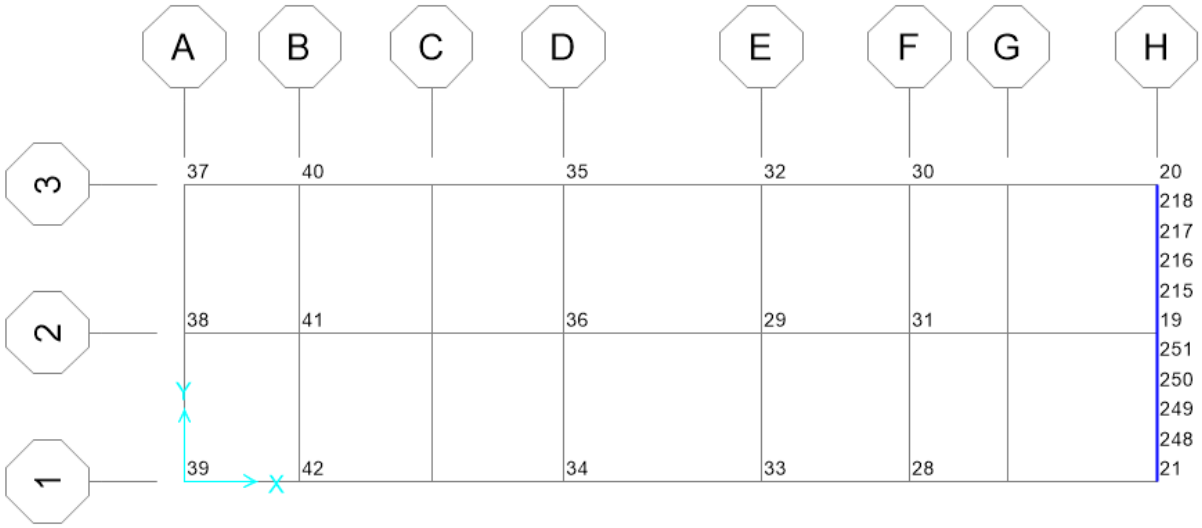


Fcu=	300	Kg/cm2	Number Of Floors =	1	
Fy=	3500	Kg/cm2	μ =	1.0%	

Coulmn	R	Total R	AC	b	t	As	Ø	n	RFT	
	ton	ton	cm2	cm	cm	cm2				
2913	7.37	8.107	63.11405	30	40	12	16	6	6Ø16	
2847	7.8	8.58	66.79642	30	40	12	16	6	6Ø16	
2841	8	8.8	68.50915	30	40	12	16	6	6Ø16	
2919	8.43	9.273	72.19151	30	40	12	16	6	6Ø16	
2823	9.7	10.67	83.06734	30	40	12	16	6	6Ø16	
2889	25.76	28.336	220.5995	30	40	12	16	6	6Ø16	
2895	25.78	28.358	220.7707	30	40	12	16	6	6Ø16	
2961	28.68	31.548	245.6053	30	40	12	16	6	6Ø16	
2949	28.7	31.57	245.7766	30	40	12	16	6	6Ø16	
2985	28.86	31.746	247.1467	30	40	12	16	6	6Ø16	
2451	29.2	32.12	250.0584	30	40	12	16	6	6Ø16	
2955	29.2	32.12	250.0584	30	40	12	16	6	6Ø16	
2907	29.23	32.153	250.3153	30	40	12	16	6	6Ø16	
2901	29.38	32.318	251.5998	30	40	12	16	6	6Ø16	
2817	31.16	34.276	266.8431	30	40	12	16	6	6Ø16	
2937	32.6	35.86	279.1748	30	40	12	16	6	6Ø16	
2943	33.84	37.224	289.7937	30	40	12	16	6	6Ø16	columns1
2979	34.32	37.752	293.9042	30	40	12	16	6	6Ø16	
2973	34.4	37.84	294.5893	30	40	12	16	6	6Ø16	
2967	34.4	37.84	294.5893	30	40	12	16	6	6Ø16	
2829	34.9	38.39	298.8712	30	40	12	16	6	6Ø16	
2835	35.48	39.028	303.8381	30	40	12	16	6	6Ø16	
2877	52.59	57.849	450.362	30	40	12	16	6	6Ø16	
2883	52.81	58.091	452.246	30	40	12	16	6	6Ø16	
2853	54.71	60.181	468.5169	30	40	12	16	6	6Ø16	
2859	55.17	60.687	472.4562	30	40	12	16	6	6Ø16	
2865	56.1	61.71	480.4204	30	40	12	16	6	6Ø16	
2871	57.2	62.92	489.8404	30	40	12	16	6	6Ø16	

2445	58.32	64.152	499.4317	30	40	12	16	6	6Ø16	
2931	58.4	64.24	500.1168	30	40	12	16	6	6Ø16	
2925	58.9	64.79	504.3986	30	40	12	16	6	6Ø16	
2487	59.9	65.89	512.9622	30	40	12	16	6	6Ø16	
2439	60.5	66.55	518.1004	30	40	12	16	6	6Ø16	
2457	60.8	66.88	520.6695	30	40	12	16	6	6Ø16	
2505	63.64	70.004	544.9903	30	40	12	16	6	6Ø16	
2991	64.14	70.554	549.2721	30	40	12	16	6	6Ø16	
2481	64.44	70.884	551.8412	30	40	12	16	6	6Ø16	
2469	64.57	71.027	552.9545	30	40	12	16	6	6Ø16	
2463	67.28	74.008	576.1619	30	40	12	16	6	6Ø16	
2475	67.35	74.085	576.7614	30	40	12	16	6	6Ø16	
2493	68.5	75.35	586.6096	30	40	12	16	6	6Ø16	
2499	68.66	75.526	587.9798	30	40	12	16	6	6Ø16	
2445	58.32	64.152	499.4317	30	40	12	16	6	6Ø16	
2505	63.64	70.004	544.9903	30	40	12	16	6	6Ø16	
2439	60.5	66.55	518.1004	30	40	12	16	6	6Ø16	
2451	29.2	32.12	250.0584	30	40	12	16	6	6Ø16	
2487	59.9	65.89	512.9622	30	40	12	16	6	6Ø16	
2457	60.8	66.88	520.6695	30	40	12	16	6	6Ø16	
2847	7.8	8.58	66.79642	30	40	12	16	6	6Ø16	
2979	34.32	37.752	293.9042	30	40	12	16	6	6Ø16	
2829	34.9	38.39	298.8712	30	40	12	16	6	6Ø16	columns1
2973	34.4	37.84	294.5893	30	40	12	16	6	6Ø16	
2817	31.16	34.276	266.8431	30	40	12	16	6	6Ø16	
2823	9.7	10.67	83.06734	30	40	12	16	6	6Ø16	
2937	32.6	35.86	279.1748	30	40	12	16	6	6Ø16	
2835	35.48	39.028	303.8381	30	40	12	16	6	6Ø16	
2943	33.84	37.224	289.7937	30	40	12	16	6	6Ø16	
2841	8	8.8	68.50915	30	40	12	16	6	6Ø16	
2853	54.71	60.181	468.5169	30	40	12	16	6	6Ø16	
2871	57.2	62.92	489.8404	30	40	12	16	6	6Ø16	
2985	28.86	31.746	247.1467	30	40	12	16	6	6Ø16	
2865	56.1	61.71	480.4204	30	40	12	16	6	6Ø16	
2859	55.17	60.687	472.4562	30	40	12	16	6	6Ø16	
2877	52.59	57.849	450.362	30	40	12	16	6	6Ø16	
2931	58.4	64.24	500.1168	30	40	12	16	6	6Ø16	
2991	64.14	70.554	549.2721	30	40	12	16	6	6Ø16	
2925	58.9	64.79	504.3986	30	40	12	16	6	6Ø16	
2883	52.81	58.091	452.246	30	40	12	16	6	6Ø16	
2919	8.43	9.273	72.19151	30	40	12	16	6	6Ø16	
2967	34.4	37.84	294.5893	30	40	12	16	6	6Ø16	
2901	29.38	32.318	251.5998	30	40	12	16	6	6Ø16	
2961	28.68	31.548	245.6053	30	40	12	16	6	6Ø16	
2889	25.76	28.336	220.5995	30	40	12	16	6	6Ø16	
2895	25.78	28.358	220.7707	30	40	12	16	6	6Ø16	columns1
2949	28.7	31.57	245.7766	30	40	12	16	6	6Ø16	
2907	29.23	32.153	250.3153	30	40	12	16	6	6Ø16	
2955	29.2	32.12	250.0584	30	40	12	16	6	6Ø16	
2913	7.37	8.107	63.11405	30	40	12	16	6	6Ø16	
2481	64.44	70.884	551.8412	30	40	12	16	6	6Ø16	
2499	68.66	75.526	587.9798	30	40	12	16	6	6Ø16	
2475	67.35	74.085	576.7614	30	40	12	16	6	6Ø16	
2463	67.28	74.008	576.1619	30	40	12	16	6	6Ø16	
2493	68.5	75.35	586.6096	30	40	12	16	6	6Ø16	
2469	64.57	71.027	552.9545	30	40	12	16	6	6Ø16	

Column of of stairs



Fcu=	300	Kg/cm2		Number Of Floors =	1	
Fy=	3500	Kg/cm2		μ =	1.0%	

Coulmn	R	Total R	AC	b	t	As	Ø	n	RFT	
	ton	ton	cm2	cm	cm	cm2				
19	2.7835	3.06185	23.8369	30	30	9	16	6	6Ø16	
20	3.6184	3.98024	30.98669	30	30	9	16	6	6Ø16	
21	3.6187	3.98057	30.98926	30	30	9	16	6	6Ø16	
28	15.9779	17.57569	136.829	30	30	9	16	6	6Ø16	
29	15.3067	16.83737	131.0811	30	30	9	16	6	6Ø16	
30	15.9615	17.55765	136.6886	30	30	9	16	6	6Ø16	
31	21.9838	24.18218	188.2614	30	30	9	16	6	6Ø16	
32	9.228	10.1508	79.0253	30	30	9	16	6	6Ø16	
33	9.1179	10.02969	78.08244	30	30	9	16	6	6Ø16	
34	20.4104	22.45144	174.7874	30	30	9	16	6	6Ø16	
35	19.7939	21.77329	169.5079	30	30	9	16	6	6Ø16	
36	24.3534	26.78874	208.5538	30	30	9	16	6	6Ø16	
37	8.1572	8.97292	69.85535	30	30	9	16	6	6Ø16	
38	9.2692	10.19612	79.37812	30	30	9	16	6	6Ø16	
39	7.7356	8.50916	66.24492	30	30	9	16	6	6Ø16	
40	19.0446	20.94906	163.0912	30	30	9	16	6	6Ø16	
41	21.2102	23.33122	181.6366	30	30	9	16	6	6Ø16	column1
42	15.8756	17.46316	135.953	30	30	9	16	6	6Ø16	
215	2.7224	2.99464	23.31366	30	30	9	16	6	6Ø16	
216	2.5406	2.79466	21.75679	30	30	9	16	6	6Ø16	
217	2.212	2.4332	18.94278	30	30	9	16	6	6Ø16	
218	2.058	2.2638	17.62398	30	30	9	16	6	6Ø16	
248	2.0595	2.26545	17.63682	30	30	9	16	6	6Ø16	
249	2.213	2.4343	18.95134	30	30	9	16	6	6Ø16	
250	2.5412	2.79532	21.76193	30	30	9	16	6	6Ø16	
251	2.7227	2.99497	23.31623	30	30	9	16	6	6Ø16	

Column of of frame

Frame1	M_u (m.t)	N_u (t)	b (cm)	t (cm)
sec1	61.3	-172.13	40	100
sec2	62.13	-308.96	40	140
sec3	40.67	-267.6	40	120
sec4	15.04	-176.84	40	80
sec5	23.97	-82.44	40	60
Frame2				
sec1	48.62	-161.03	40	100
sec2	25.2	-241.55	40	100
sec3	14.35	-166.49	40	80
sec4	17.76	-71.52	40	60
Frame3				
sec1	53.02	-169.5	40	100
sec2	7.036	-271.97	40	100
sec3	3.82	-253.66	40	100
sec4	13.92	-180.11	40	80
sec5	11.44	-69.85	40	60
Frame4				
sec1	49.13	-143.2	40	100
sec2	4.98	-255.37	40	100
sec3	3.67	-249	40	100
sec4	16.3	-205.8	40	100
sec5	23.5	-86.1	40	60
Frame5				
sec1	47.96	-138.7	40	100
sec2	4.73	-250.05	40	100
sec3	4.09	-241.2	40	100
sec4	19.9	-204.9	40	100
sec5	21.2	-84.78	40	60

Design of Footings

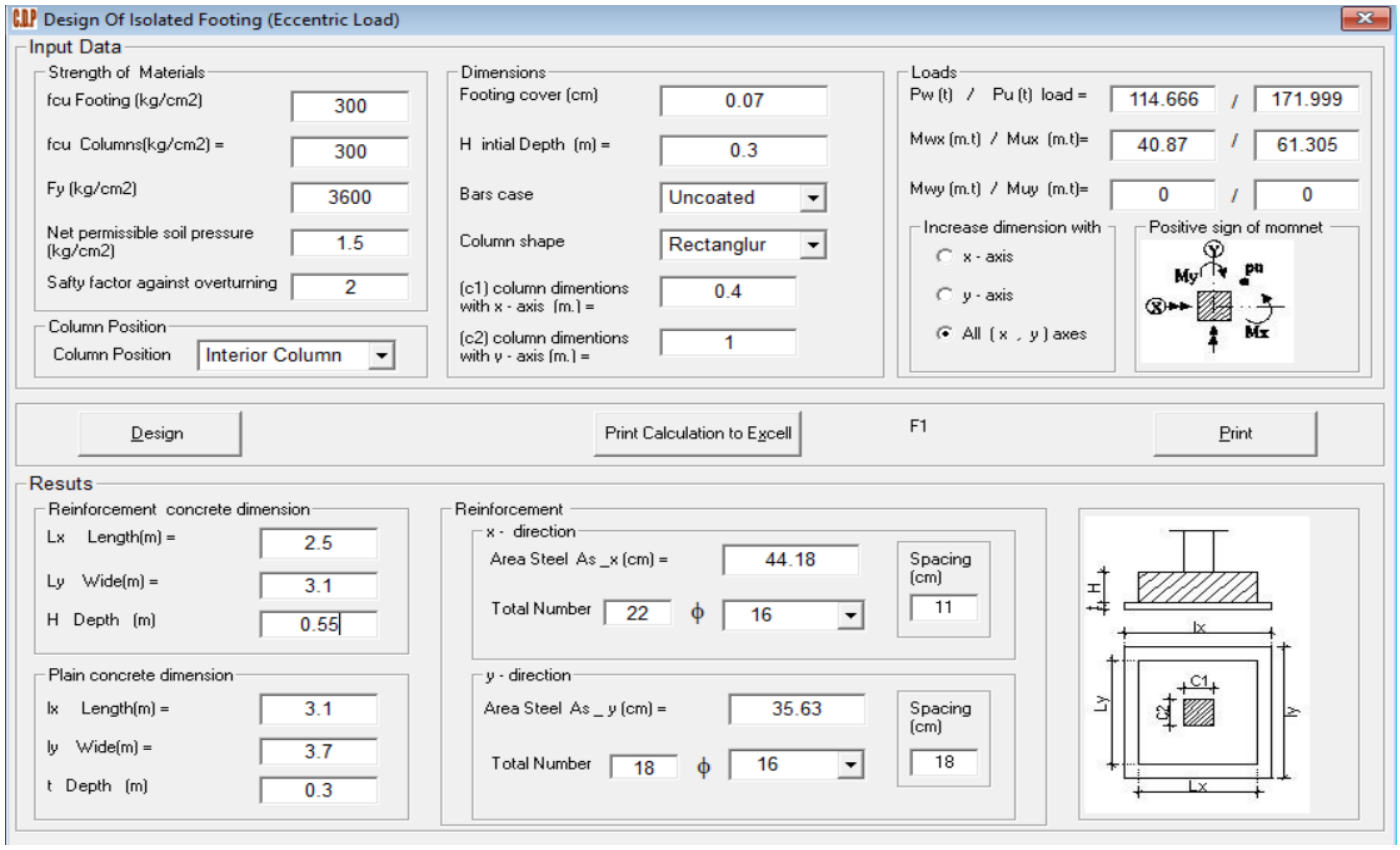
Concrete	F_{cu} =	300	kg/cm^2
Steel	F_y =	3600	kg/cm^2
Bearing capacity	q_{all} =	1.50	kg/cm^2

	Input
	OutPut
	Equations

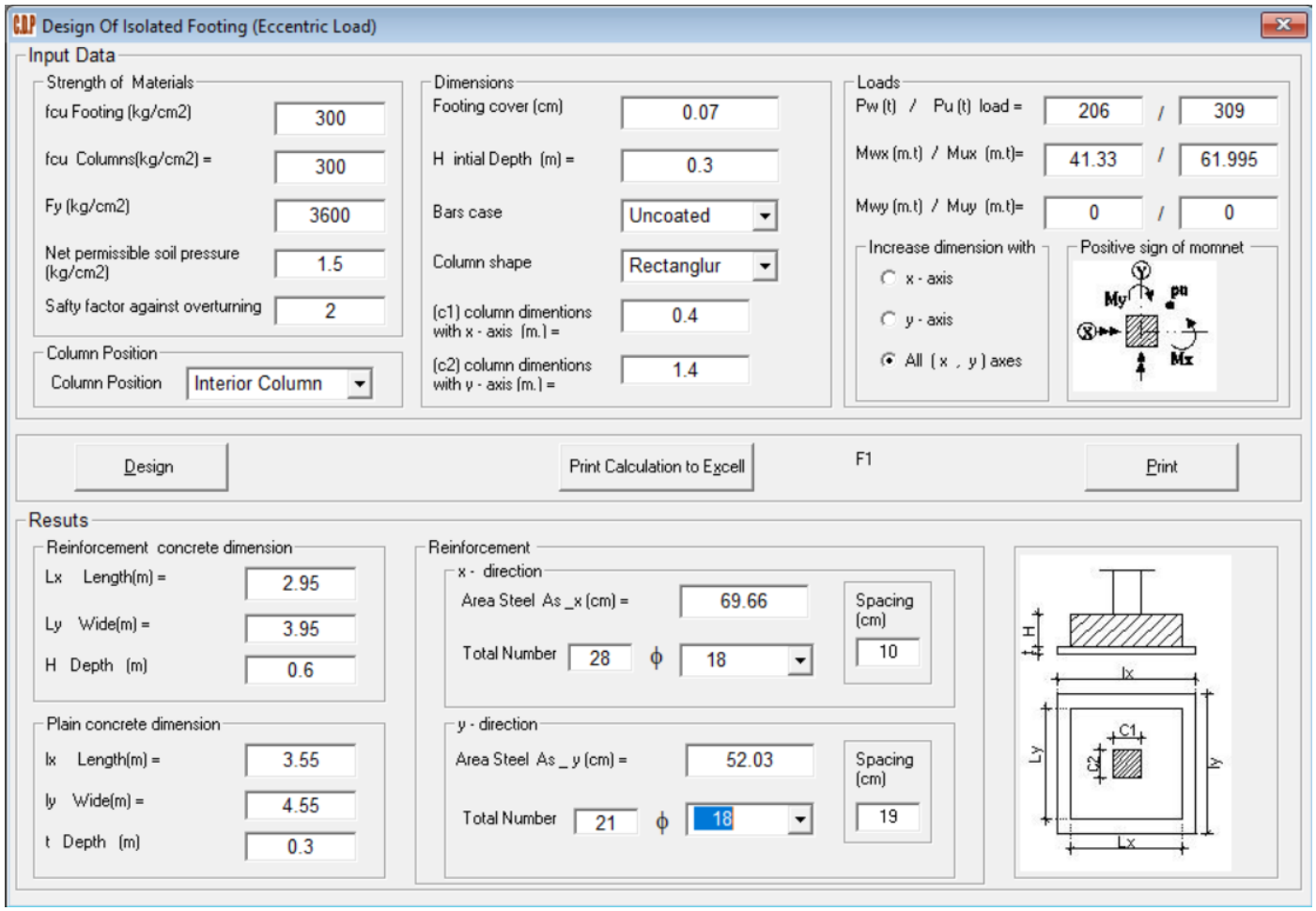
Footing	Coulmn Reaction	Coulmn Dim.		Dim. Of P.C			Dim. Of R.C			Shear Stress		Punching Shear		RFT							
																Long Direction			Short Direction		
	Working (Ton)	b (cm)	t (cm)	B (cm)	L (cm)	T (cm)	B (cm)	L (cm)	T (cm)	Kg/cm2	Notes	Kg/cm2	Notes	As/m	As min	No.	Ø	Total No.	No.	Ø	Total No.
F1	46.66666667	30	40	180	190	30	120	130	40	3.653846	safe	4.979396	safe	4.365338	5.25	5	12	8	5	12	8
F2	14.66666667	30	30	105	105	30	45	45	40	-2.793651	safe	-2.471306	safe	0.279033	5.25	5	12	4	5	12	4

Footings of frames

Column(40*100)cm



Column(40*140)cm



Column(40*120)cm

Design Of Isolated Footing (Eccentric Load)

Input Data

Strength of Materials

fcu Footing (kg/cm2)	300
fcu Columns(kg/cm2) =	300
Fy (kg/cm2)	3600
Net permissible soil pressure (kg/cm2)	1.5
Safty factor against overturning	2

Column Position

Column Position: Interior Column

Dimensions

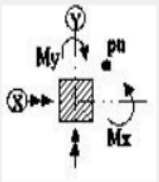
Footing cover (cm)	0.07
H intial Depth (m) =	0.3
Bars case	Uncoated
Column shape	Rectanglur
(c1) column dimentions with x - axis (m.) =	0.4
(c2) column dimentions with y - axis (m.) =	1.2

Loads

Pw (t) / Pu (t) load =	178.4	267.6
Mwx (m.t) / Mux (m.t)=	27.11	40.665
Mwy (m.t) / Muy (m.t)=	0	0

Increase dimension with: x - axis / y - axis / All (x , y) axes

Positive sign of momnet



Design | Print Calculation to Excell | F1 | Print

Resuts

Reinforcement concrete dimension

Lx Length(m) =	2.7
Ly Wide(m) =	3.5
H Depth (m)	0.55

Plain concrete dimension

lx Length(m) =	3.3
ly Wide(m) =	4.1
t Depth (m)	0.3

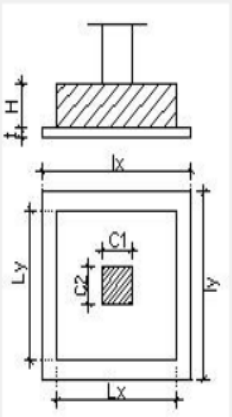
Reinforcement

x - direction

Area Steel As_x (cm) =	57.26			Spacing (cm)
Total Number	23	ϕ	18	12

y - direction

Area Steel As_y (cm) =	44.17			Spacing (cm)
Total Number	18	ϕ	18	20



Column(40*80)cm

Design Of Isolated Footing (Eccentric Load)

Input Data

Strength of Materials

fcu Footing (kg/cm2)	300
fcu Columns(kg/cm2) =	300
Fy (kg/cm2)	3600
Net permissible soil pressure (kg/cm2)	1.5
Safty factor against overturning	2

Column Position

Column Position: Interior Column

Dimensions

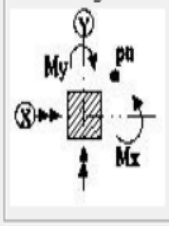
Footing cover (cm)	0.07
H intial Depth (m) =	0.3
Bars case	Uncoated
Column shape	Rectanglur
(c1) column dimentions with x - axis (m.) =	0.4
(c2) column dimentions with y - axis (m.) =	0.8

Loads

Pw (t) / Pu (t) load =	120	180
Mwx (m.t) / Mux (m.t)=	9.33	13.995
Mwy (m.t) / Muy (m.t)=	0	0

Increase dimension with: x - axis / y - axis / All (x , y) axes

Positive sign of momnet



Design | Print Calculation to Excell | F1 | Print

Resuts

Reinforcement concrete dimension

Lx Length(m) =	2.1
Ly Wide(m) =	2.5
H Depth (m)	0.45

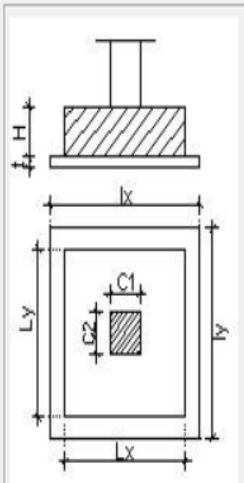
Plain concrete dimension

lx Length(m) =	2.7
ly Wide(m) =	3.1
t Depth (m)	0.3

Reinforcement

x - direction: Area Steel As_x (cm) = 32.16; Total Number 16 ϕ 16; Spacing (cm) 14

y - direction: Area Steel As_y (cm) = 27.01; Total Number 14 ϕ 16; Spacing (cm) 19



Column(40*60)cm

Design Of Isolated Footing (Eccentric Load)

Input Data

Strength of Materials

fcu Footing (kg/cm2)	300
fcu Columns(kg/cm2) =	300
Fy (kg/cm2)	3600
Net permissible soil pressure (kg/cm2)	1.5
Safty factor against overturning	2

Column Position

Column Position: Interior Column

Dimensions

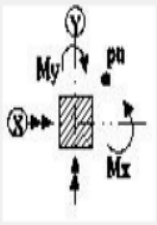
Footing cover (cm)	0.07
H intial Depth (m) =	0.3
Bars case	Uncoated
Column shape	Rectanglur
(c1) column dimentions with x - axis (m.) =	0.4
(c2) column dimentions with y - axis (m.) =	0.6

Loads

Pw (t) / Pu (t) load =	57.4	/ 86.1
Mwx (m.t) / Mux (m.t)=	15.67	/ 23.505
Mwy (m.t) / Muy (m.t)=	0	/ 0

Increase dimension with: x - axis / y - axis / All (x , y) axes

Positive sign of momnet



Design | Print Calculation to Excell | F1 | Print

Resuts

Reinforcement concrete dimension

Lx Length(m) =	1.7
Ly Wide(m) =	1.9
H Depth (m)	0.45

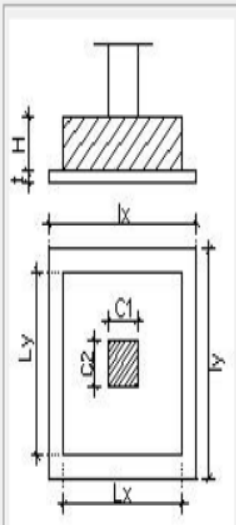
Plain concrete dimension

lx Length(m) =	2.3
ly Wide(m) =	2.5
t Depth (m)	0.3

Reinforcement

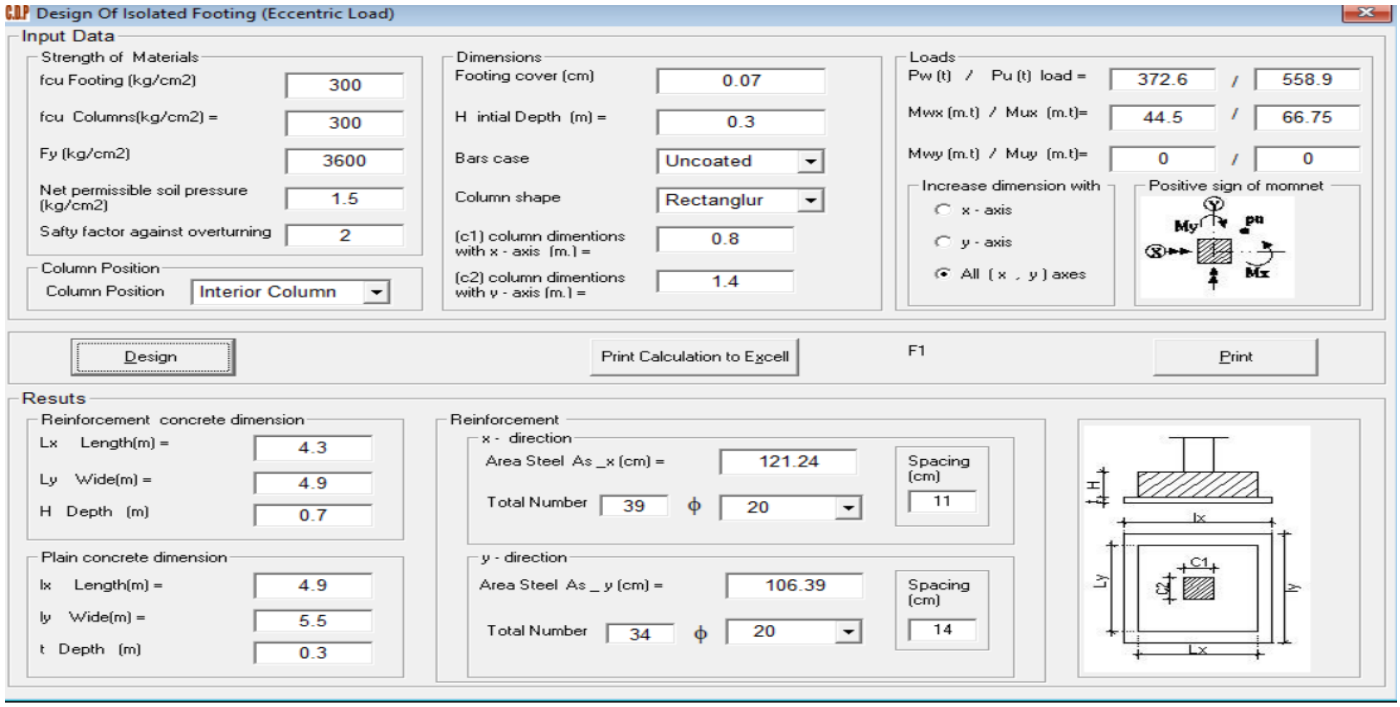
x - direction: Area Steel As_x (cm) = 17.23; Total Number 9 ϕ 16; Spacing (cm) 21

y - direction: Area Steel As_y (cm) = 15.41; Total Number 8 ϕ 16; Spacing (cm) 27

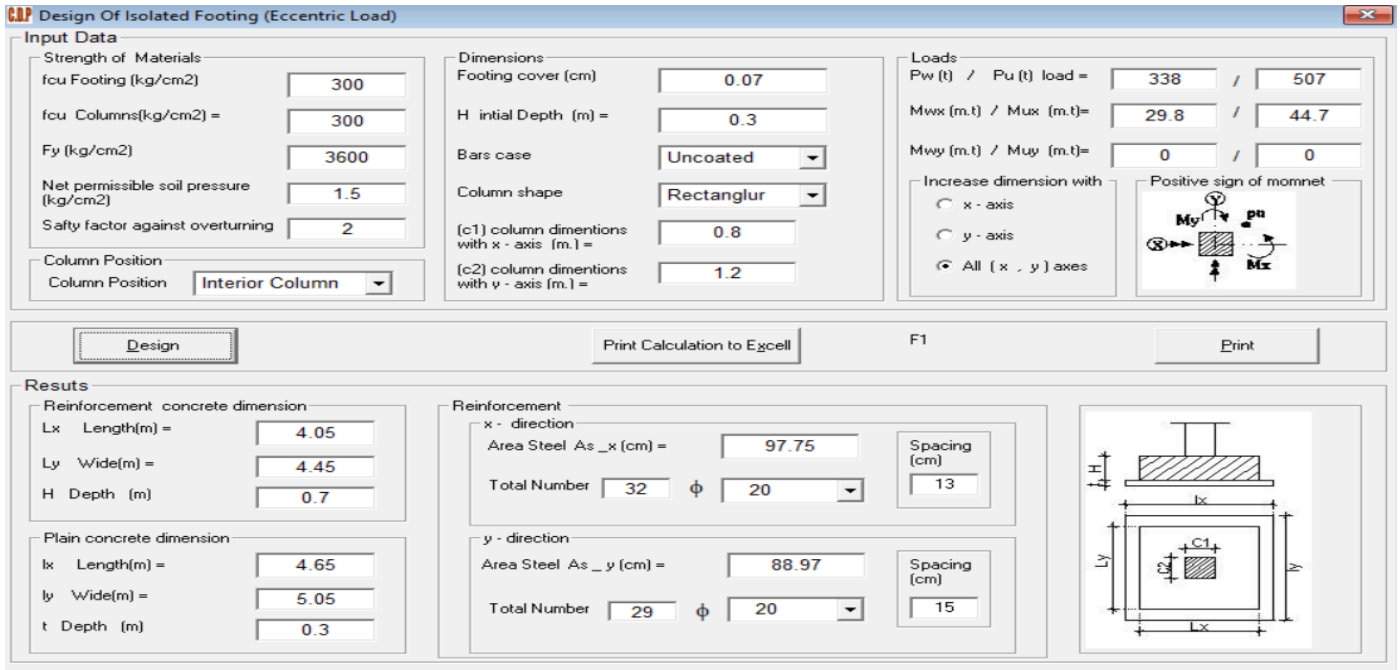


Footings of axis(2,6,11,15,20,25,30,35,40)

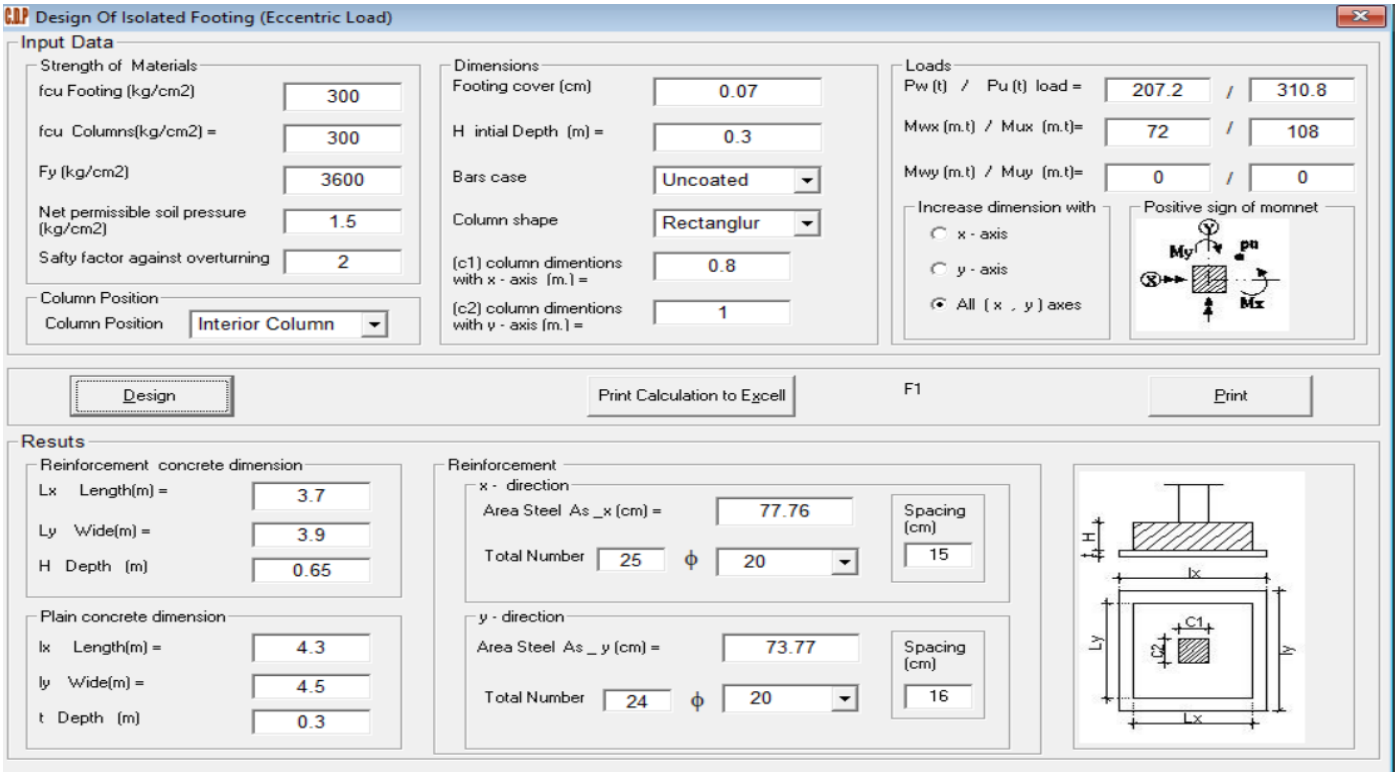
Column(80*140)cm



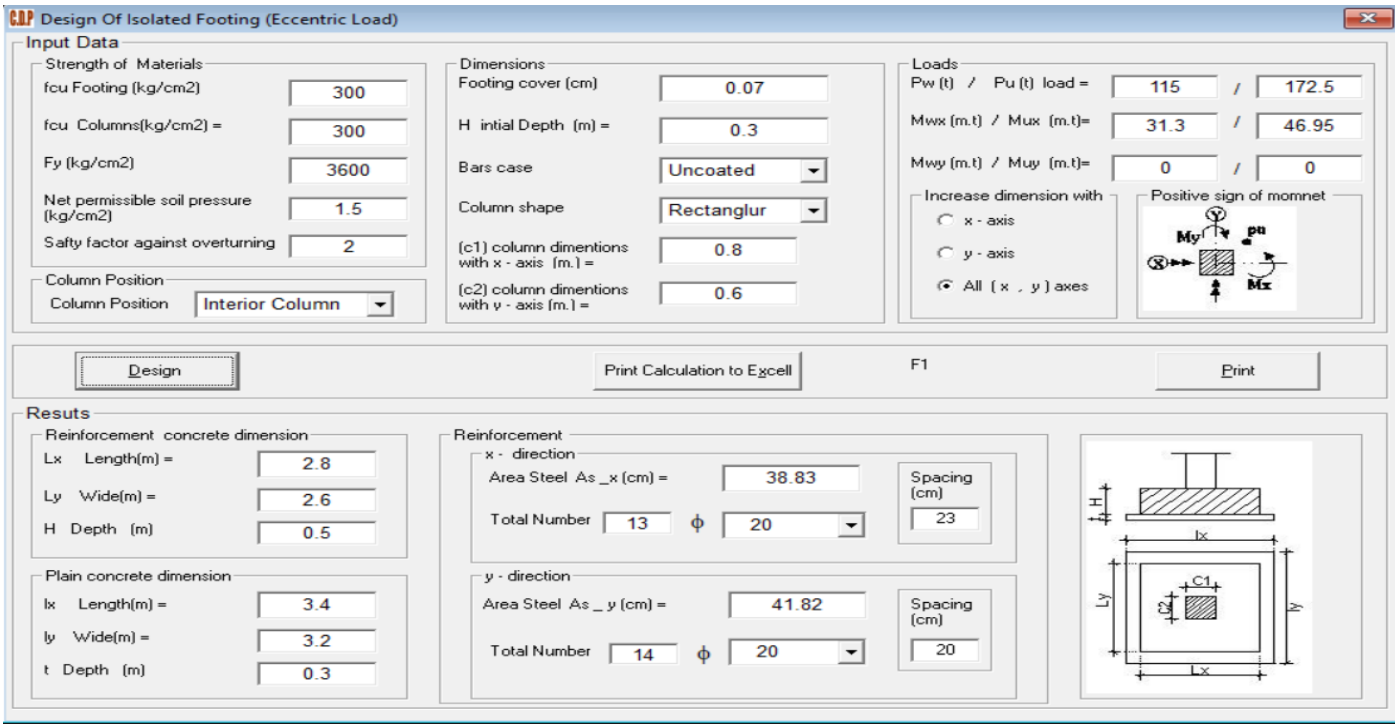
Column(80*120)cm



Column(80*100)cm



Column(80*60)cm



Design of stairs

Stair1

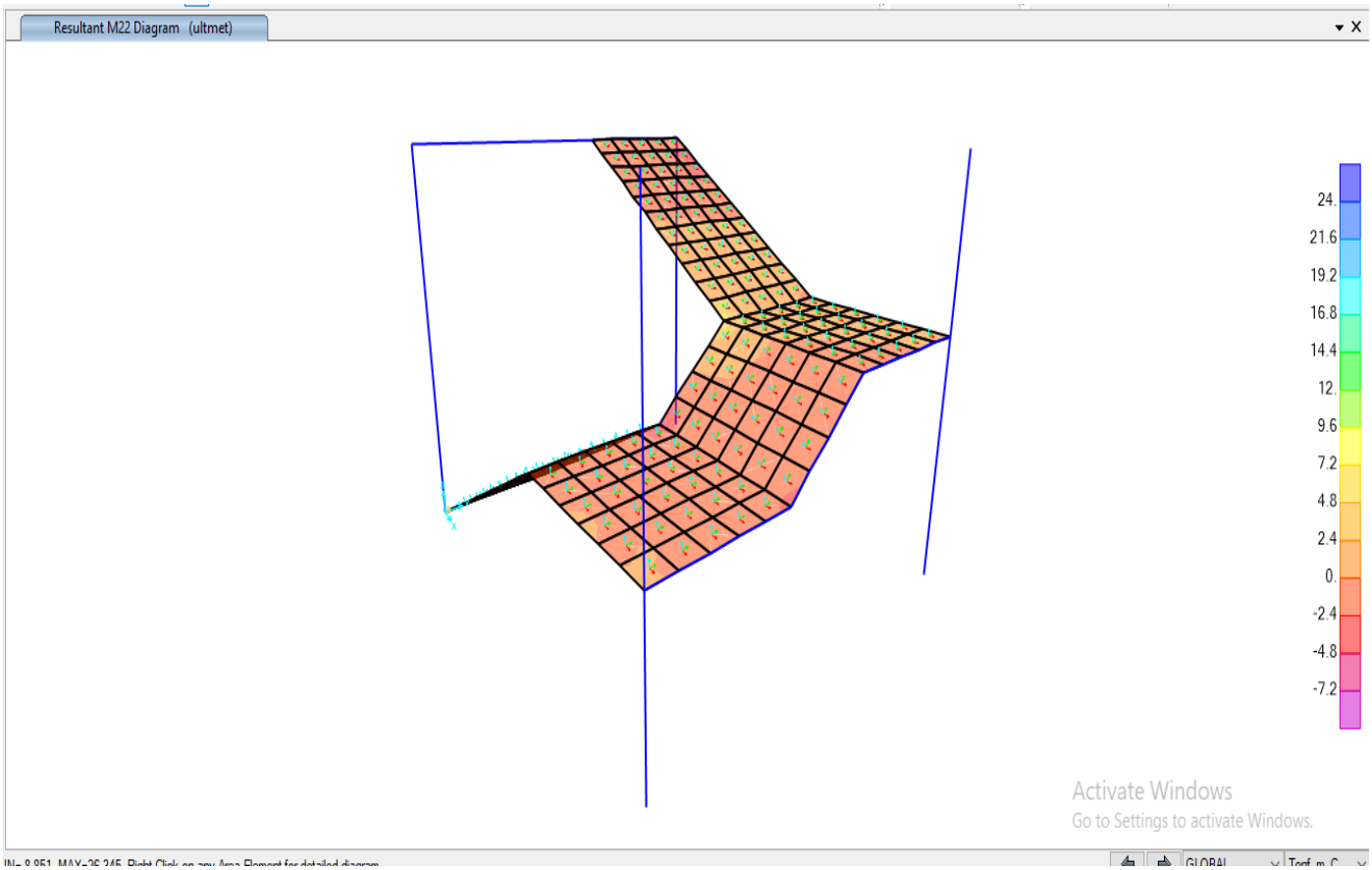
Data:

t=22cm wall=0.5 t/m²

L.L=0.5t/m² F.C=0.2t/m²

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	7	16	1407.43	350	220	200	0.826	8.13778



Stair2

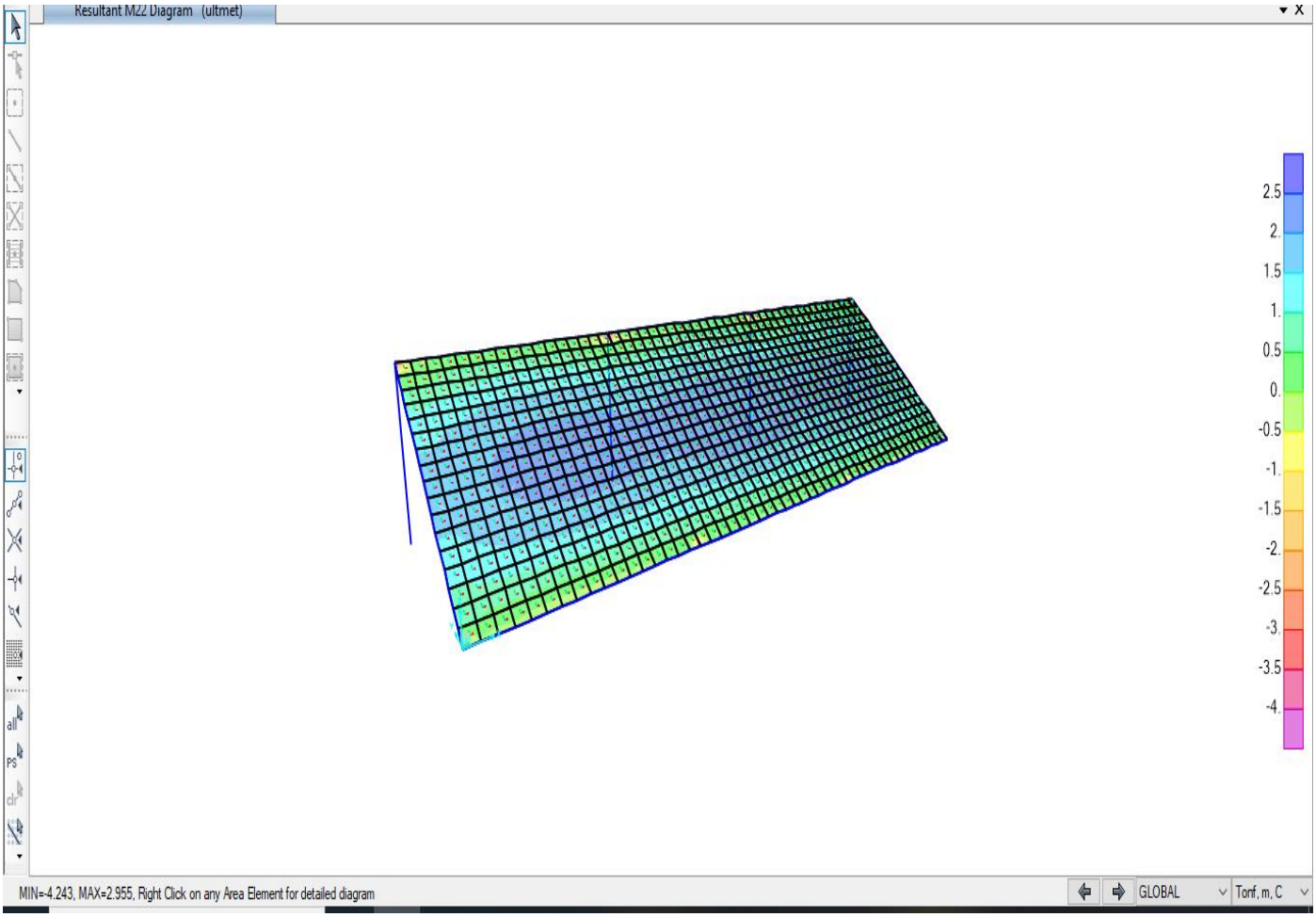
Data:

t=16cm wall=0.5 t/m²

L.L=0.5t/m² F.C=0.2t/m²

	input
	output

Mesh	N	ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	16	1005.31	350	160	140	0.826	4.06889



Stair3

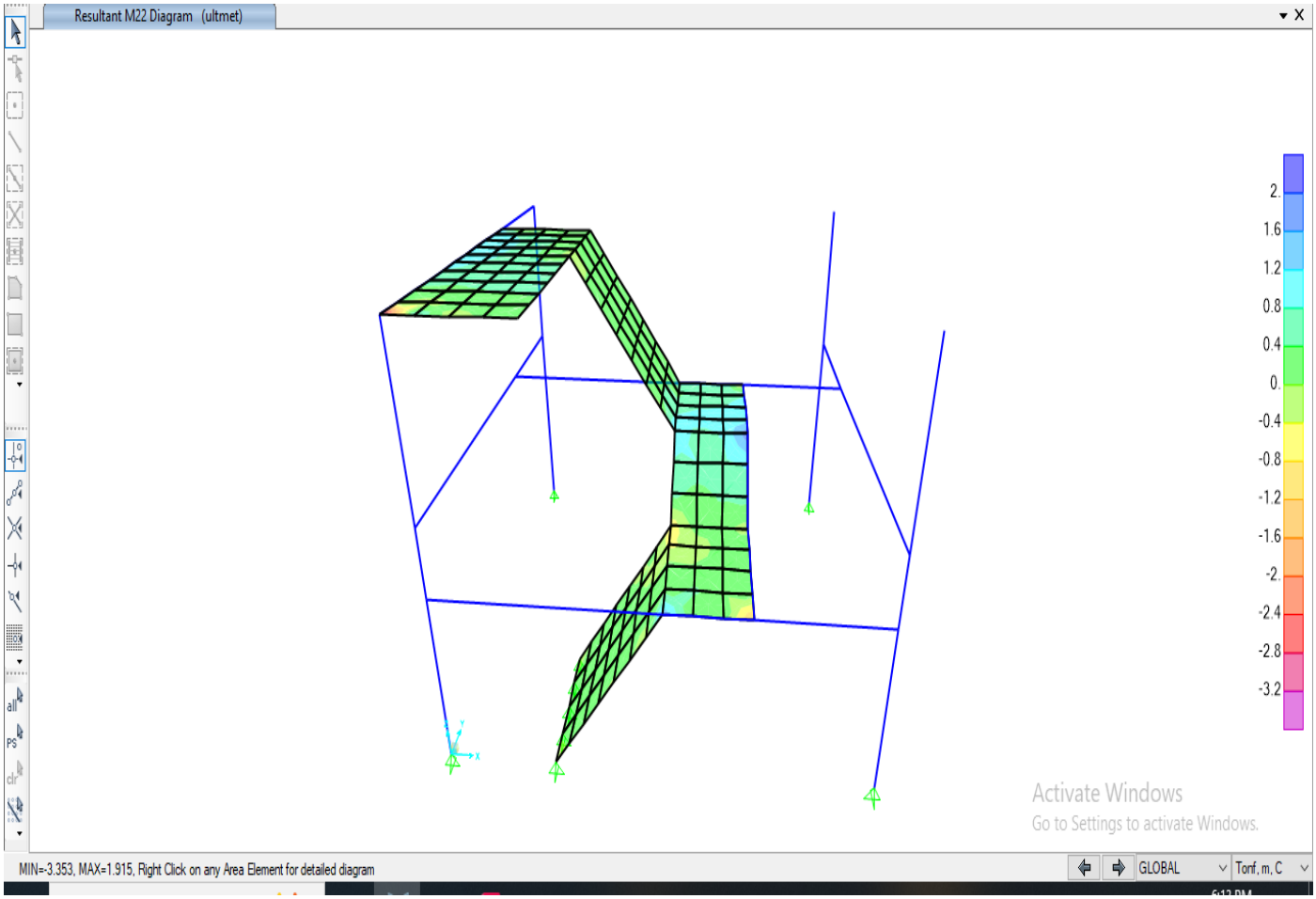
Data:

t=16cm wall=0.5 t/m²

L.L=0.5t/m² F.C=0.2t/m²

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	7	12	791.681	350	160	140	0.826	3.20425



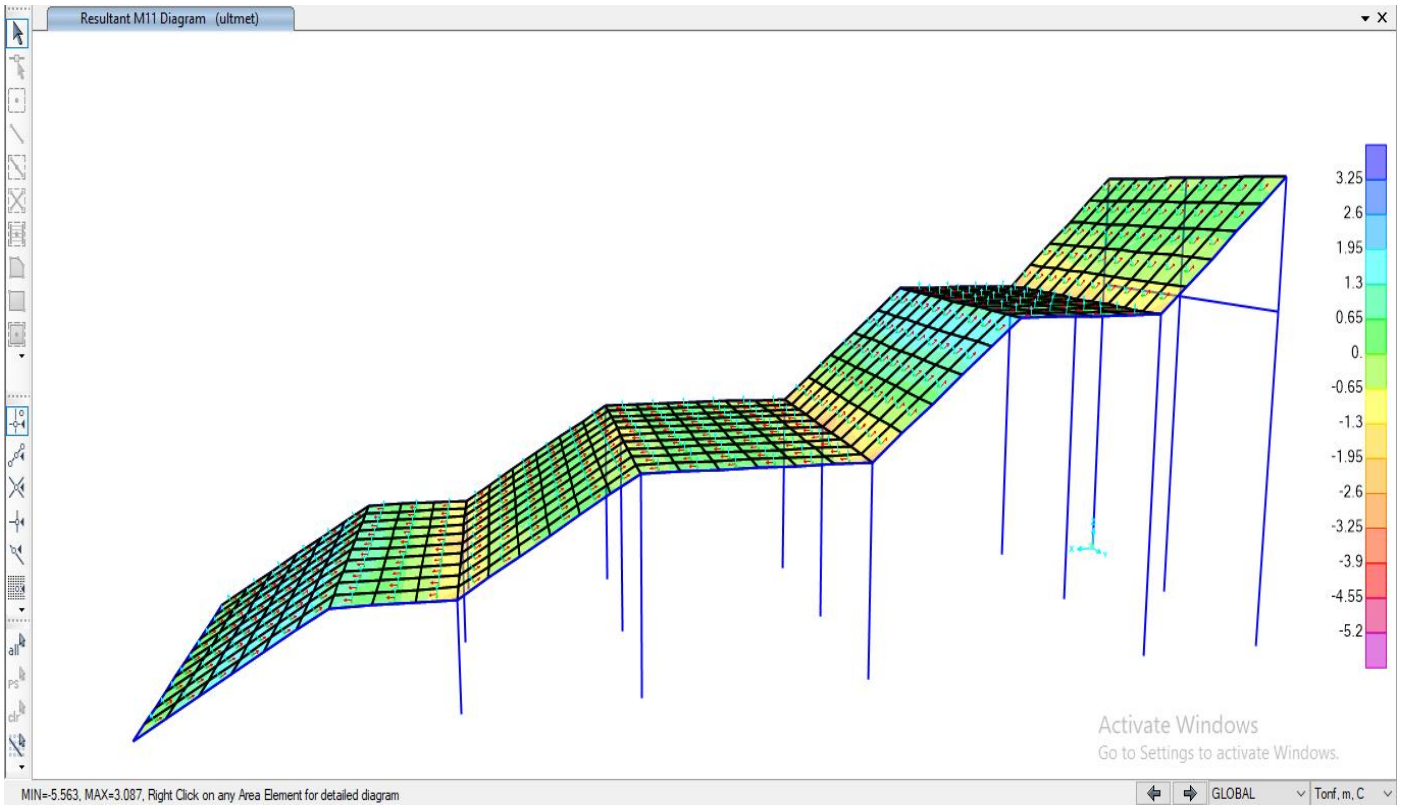
Stair4

Data:

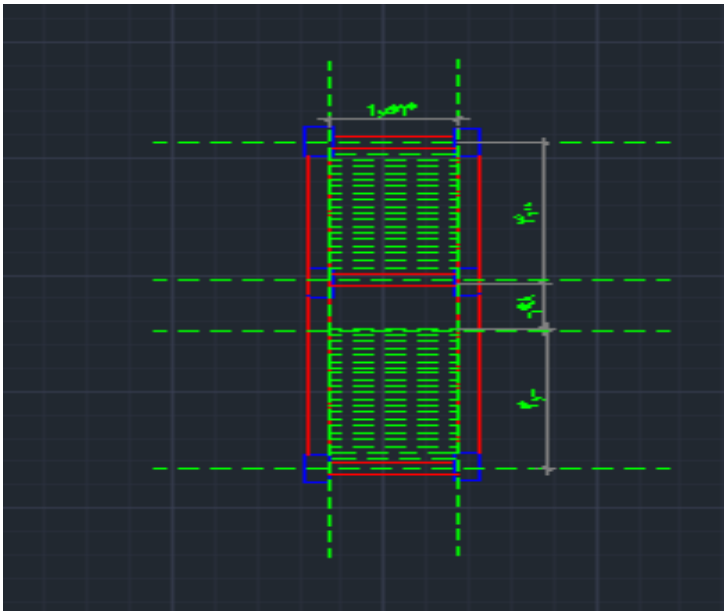
t=20cm wall=0.5 t/m²
L.L=0.5t/m² F.C=0.2t/m²

	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	5	16	1005.31	350	200	180	0.826	5.23143



Stair5



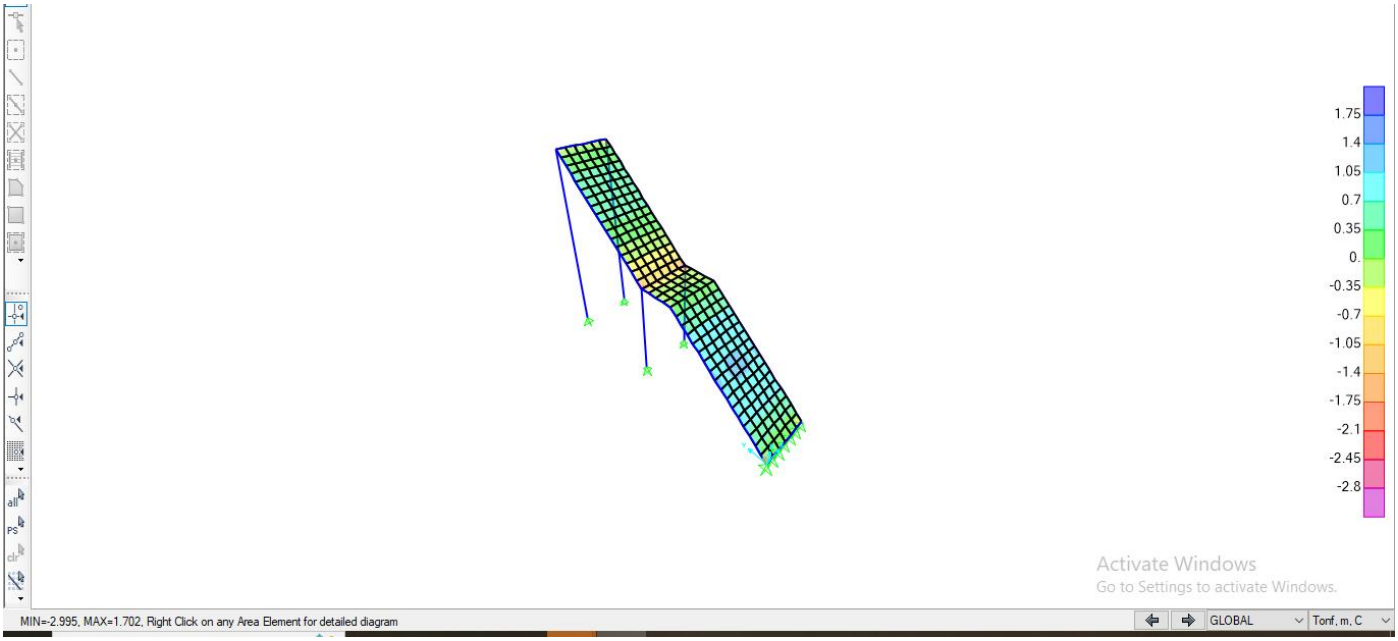
Data:

t=16cm wall=0.5 t/m²

L.L=0.5t/m² F.C=0.2t/m²

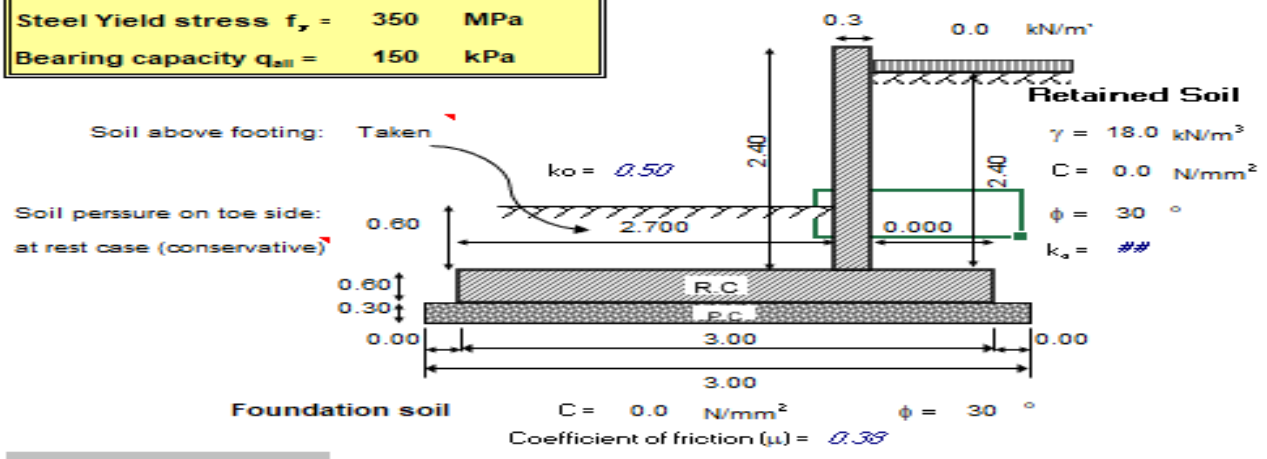
	input
	output

Mesh	N	Ø	As	Fy	T	d	J	Moment
		mm	mm2	N/mm2	mm	mm		Ton.m
	7	12	791.681	350	160	140	0.826	3.20425



Design of Retaining walls

Concrete	$f_{c'}$ =	30	MPa
Steel Yield stress	f_y =	350	MPa
Bearing capacity	q_{all} =	150	kPa



Sliding check:

Stabilizing force from:	kN	Horizontal force from:	kN
Weight of wall	18.00	Active earth pressure on wall	17.28
Weight of footing (RC+PC)	64.80	Active earth pressure on footing	15.39
Weight of soil on active side	0.00	Active surcharge pressure	0.00
Weight of soil on passive side	29.16	Passive earth pressure on wall	-1.62
Surcharge	0.00	Passive side pressure on footing	-8.51
Total weights: Σ =	111.96	Driving force: Σ =	22.55

Factor of safety against sliding **1.91** > 1.5 *Satisfactory*

Over-turning check:

Stabilizing moment from:	kN.m	Over-turning moment from:	kN.m
Weight of concrete	148.50	Active earth pressure	35.94
Weight and pressure of soil	44.43	Active surcharge pressure	0.00
Σ =	192.93	Σ =	35.94

Factor of safety for overturning = **5.37** > 1.5 **Satisfactory**

Bearing capacity check:

Moment on footing center =	10.95	kN.m			
Total weight on footing =	111.96	kN	Eccentricity =	0.10	m
Max. stress on soil =	✔ 44.6	kPa	Safe stress		
Min. stress on soil =	30.0	kPa	No tension on soil		
Max. stress on soil =	✔ **44.6**	kPa	Safe stress		After Redistribution
Min. stress on soil =	**30.0**	kPa			

Calculation of Rft. :

	M_u (kN.m)	cover (mm)	d (mm)	As (mm²)	As min				
For Wall	22.1	50	250	283	540	3	ϕ	16	/m
For Base	117.6	75	525	718	1080	6	ϕ	16	/m

Shear on base: V_u = 56.2 kN < V_c = 399 kN **Safe**

يعد مشروع التخرج في إدارة المشروعات دراسة شاملة تجمع بين المفاهيم النظرية والتطبيق العملي لإدارة المشروعات الإنشائية. يبدأ المشروع بمرحلة بجمع المعلومات الكافية عن المشروع من لوحات وتعاقد ومكان المشروع حيث يتم عمل حصر تفصيلي للوحات تشمل تحليل السوق وتقييم الاحتياجات وتقدير التكاليف المتوقعة ويتم ايضا تحديد نطاق المشروع بدقة، ووضع الأهداف الرئيسية والفرعية، وتحديد المعالم الهامة التي يجب تحقيقها.

تعتبر مرحلة إعداد الجدول الزمني من المراحل الحاسمة حيث يتم تقسيم المشروع إلى مهام محددة باستخدام هيكل تقسيم العمل(WBS) ، وتحديد المدة الزمنية لكل مهمة والعلاقات المتداخلة بين المهام المختلفة. يتبع ذلك مرحلة الإدارة والتنفيذ التي تتضمن إدارة الموارد البشرية والمادية.

يتميز المشروع باستخدام تقنيات BIM المتقدمة، حيث يتم توظيف BIM 4D لربط النموذج ثلاثي الأبعاد بالجدول الزمني، مما يتيح محاكاة تسلسل عمليات البناء وتحديد التعارضات المحتملة قبل التنفيذ. كما يتم استخدام BIM 5D لإدارة التكاليف وربط عناصر النموذج بالتكاليف الفعلية، مما يساعد في تقدير الميزانية بدقة أكبر وتحليل التدفق النقدي للمشروع.

تعتبر المراقبة والتحكم عنصراً أساسياً في المشروع، حيث يتم متابعة التقدم الفعلي ومقارنته بالخطة الموضوعة، وتحديد الانحرافات واتخاذ الإجراءات التصحيحية اللازمة. كما تتم إدارة

التغييرات بشكل منهجي من خلال تقييم طلبات التغيير ودراسة تأثيراتها على المشروع واعتماد التغييرات المناسبة وتوثيقها.

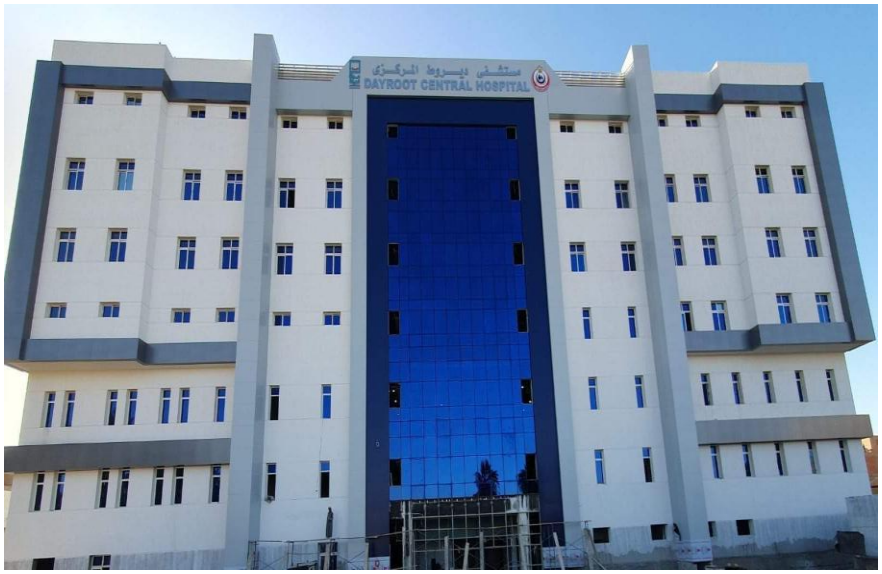
يختتم المشروع بإعداد مجموعة شاملة من المخرجات لعمل المتابعة الدورية. بالإضافة إلى ذلك، يتم تقديم نماذج BIM المتكاملة التي تشمل النموذج ثلاثي الأبعاد ومحاكاة البناء وتحليل التكاليف.

مشروع : انشاء مستشفى ديروط المركزي بمحافظه اسيوط مركز ديروط ، ومستشفى اورام كفر الشيخ .

أولا: مستشفى ديروط المركزي

- الوصف: يحتوي هذا المستشفى على مبنى واحد مقسم إلى منطقتين، ويتكون من طابق أرضي و ٦ طوابق علوية.
- المساحة الإجمالية ٣٠٦٥م٢
- التكلفة الإجمالية للمشروع: ٢٩٣٨٦٧٠١٩,٧٨ جنية مصري
- مدة المشروع: ٢٨ شهراً

صور من الواقع وبعد عمل **3dmodeling**



من ارض الواقع



3dmodeling

ثانيا: مستشفى كفرالشيخ للأورام

- الوصف: يتكون هذا المستشفى من مبنى واحد مقسم إلى منطقتين ويتكون من بدروم وطابق أرضي و٧ طوابق علوية.
- المساحة الإجمالية٣٤٠٠ م٢
- التكلفة الإجمالية ٢٣٠٩٨٤٨٢٩,١٩ جنيه مصري
- مدة المشروع الإجمالية ٣٨ شهراً

صور من الواقع وبعد عمل **3dmodeling**



من ارض الواقع





3dmodeling

البرامج المستخدمة في المشروع









اولا: الخطوات والبنود التى تتم بها عمل وتدقيق الجدول الزمنى :

- البنية الهرمية للاعمال **(WBS) Work Break Down Structure** .
- ويجب ان تشمل البنية الهرمية للمشروع كل مراحل واقسام المشروع ويشمل ذلك :

١- النشاطات التمهيدية **Preliminaries** .

٢- النشاطات المتعلقة بالمواد **Material Submittals & Approval** .

٣- النشاطات المتعلقة بالمخططات الهندسية **Shop Drawing Submittals & Approval** .

٤- النشاطات المتعلقة بالانفاق على مقاولى **Subcontractors Approval** .

٥- نشاطات المشروع الاساسية **Project Activity** والتى يجب ان تغطى جميع اجزاء المشروع .

٦- يفضل جعل البنية الهرمية موافقة قدر الامكان مع التقسيمات المعتمدة فى جدول الكميات **B.O.Q** .

- اكواد الأنشطة **Activity Codes** .

أ- يجب عدم اهمال تصميم اكواد الانشطة حتى تصميم بنية هرمية تفصيلية **WBS** لان هذه الاكواد تساعدنا كثيرا عند تصميم الفلاتر **Filters** فى المشاريع التى تتضمن عدد ضخم من الانشطة .

• الانشطة **Activities**

- يجب ان تكون المدة الزمنية للنشاط متوافقة مع الموارد التى تم ادخالها .

- يجب الا تزيد مدة النشاط عن ٢٥ يوما لان المدد الكبيرة تؤدى الى تقليل التفصيل فى البرنامج ولكى يسهل عمل **Control** عليها .

- ولابد من معرفة عمل التسلسل المنطقى للانشطة وهذا مهم جدا .

- وان تكون العلاقات بين الانشطة منطقية .

- عدم الاعتماد على التداخل السالب بين الانشطة فى العلاقة **F.S** واستبدالها بـ **S.S**.

- التحقق من المسار الحرج فى المشروع .

- لا تزيد انشطة المسار الحرج عن ٢٠٪ من اجمالى انشطة المشروع .

- التحقق من الوصف **Description** المعتمد لكل نشاط .

• الموارد والتكاليف

- عمل وتجهيز انتاجية العمالة **Productivity Rate** .

- تحميل البرنامج بجميع الموارد المطلوبة من عمالة ومعدات ومواد ...

مراجعة مخطط التقدم الافتراضى **S Curve**

والذى يتم انشاءه باستخدام برنامج الاكسل بعد اخذ القيم من البريمافيرا وذلك بتنفيذ عمليات تحديث افتراضية اسبوعية على البرنامج حتى الوصول الى تاريخ انتهاء المشروع .

مراجعة عوامل التثقيل **Weight of Activity** التى يتم بناء عليها عمل **Weight System** لمراقبة تقدم المشروع مستقبلا اثناء التنفيذ .

مراجعة مخطط التدفق النقدى **Cash Flow**

التحقق من مخطط التدفق النقدى **Cash Flow** ومطابقتة لقدرة المالك التمويلية ، حيث يمكن ان يحدث تلاعب باستقطاع اموال كثيرة فى اول المشروع لخدمة اغراض المقاول خاصة فى مشاريع (**Lump Sum**) .

* النقاط المرحلية **Milestone** :

- يوجد فى المشاريع الكبيرة عدد من التواريخ المرحلية **Milestones** و التي يجب التحقق من مطابقتها فى البرنامج بما هو موجود في العقد.

• العوم الكلي(**Total Float**) :

- يجب الإنتباه جيداً لقيم العوم الكلي (**Total Float**) فهي تكشف أمور كثيره و يحجم كثير من المقاولون عن طباعة العمود (**Total Float Column**) لأن العوم الكلي (**Float**) العالي جداً وغير الطبيعي يكشف أن هناك نشاطات غير مرتبطة بنشاطات لاحقة (**Successors**) فتذهب تواريخها المتأخرة إلى نهاية المشروع وهذا خطاء والحل هو ربطها بنشاطات أخرى لاحقة أو بقيد (**Constraints**) إذا كان مطلوب تسليم هذه الانشطة دون غيرها في وقت تعاقدي محدد قبل نهاية المشروع.

- التأكد من عدم وجود عوم كلي سالب **Negative Total Float** :

- من الأمور المهمة جداً هو العوم السالب (**Negative Total Float**) لأنه يعطي دلالة على وجود قيود (**Constraints**) غير صحيحة و يحدث ذلك في الحالات التالية :

- وضع تاريخ قيد بداية (**Start Constraints**) قبل تاريخ البدء المبكر للنشاط **Early Start Date** .

- وضع تاريخ قيد بداية (**Start Constraints**) في يوم أجازة.

- تجاوز تاريخ انتهاء البرنامج للتاريخ الإفتراضي الذي تم إدارجه في الحقل **Project must finish by**.

- و الخلاصة أنه عند وجود عوم كلي سالب (**Negative Float**) فهذا دلالة على وجود شئ غير صحيح.

• القيود **Constraints** :

- يجب الإنتباه وبشدة للقيود (**Constraints**) فكثير من المقاولين يكثر منها لأنها وسيلة سهلة لجعل البرنامج يمضي كما يريد المقاول و هذا الأمر مرفوض بشدة لأن هذا الأمر سيؤدي إلى تقييد البرنامج و لن يسير في مساره الطبيعي و تنشأ مشاكل كثير عند تحديث البرنامج (**Updating**) فكثير من هذه القيود سيؤدي إلى ظهور عوم سالب (**Negative Float**) و بالتالي يجب التقليل من استخدام القيود قدر الإمكان.

- عند استخدام القيود يجب أن يكون ذلك متوافقاً مع حالة المشروع وأن يكون قيداً حقيقياً لا يتم وضعه لمجرد أن المهندس يريد ان ينتهي النشاط أو يبدأ في وقت محدد حيث يتم هذا الأمر باستخدام العلاقات وكلما تم إستبدال القيود بعلاقات (**Relationships**) كان ذلك أفضل.عند وضع تواريخ معينة للمقاول للإلتزام يلجأ المقاول عادة لفرضها كقيود في البرنامج و علينا في هذه الحالة التحقق من قيم العوم الكلي للنشاطات (**Total Float**)و عند اكتشاف عوم سالب يجب تنبيه المقاول إلى تعديل المدد أو العلاقات على أسس واقعية وهذا بدوره يؤدي إلى الكشف المبكر على حدوث تأخير في المشروع.

- مثال :عند تحديث البرنامج الزمني (**Updating**) لمشروع ما قد يحدث تأخر في بعض الانشطة .

- إذا كانت هذه الانشطة المتأخرة غير مرتبطة بـ **Milestone** ذو تاريخ انتهاء محدد (مقيد) فإن هذا التأخير قد لا يؤدي إلى تأخير المشروع ككل و بالتالي لن يظهر عوم سالب .

- أما إذا كانت هذه الانشطة المتأخرة مرتبطة بـ **Milestone** ذو تاريخ انتهاء محدد (مقيد) فإن هذا التأخير سيؤدي إلى ظهور عوم سالب مع أن تاريخ انتهاء المشروع ككل لم يتأثر .

• فواصل الإيقاف أو فترات التوقف **Lags** :

- لابد ان يكون لفواصل الإيقاف معنى تنفيذى كفترة الإنتظار اللازمة بعد صب الخرسانة.

- لا يسمح للمقاول باستخدام فواصل الإيقاف إلا إذا كانت مطلوبة فعلا , هذا إذا كانت نية المقاول سليمة لآنها تعطى صورة زائفة عن المشروع .

Updating التحديث

مراقبه ومتابعه وتطوير وتحديث البرنامج الزمني**updated Schedule** بمقارنته مع برنامج الاساس**baseline Schedule**

- يجب تحديث البرنامج الزمني في فواصل زمنية دورية (اسبوعيا مثلا)

- و يجب التاكد من صحة البيانات الفعلية خلال المتابعة الدورية للمشروع المقدمة من مصادر موثوق بها وليس الاعتماد على ما يقدمه المقاول فقط .

و يجب أن تشمل هذه العملية تحديث الموارد و التكلفة بالإضافة إلى النشاطات .

- تجهيز وتقديم الجدول الزمنيه والتقييمات الزمنيه لفترات زمنيه محدده مثل ٣**week Look Ahead** والتقارير الشهريه وغيرها.

مثل تقارير نسب الانجاز.....

- المطالبه بتمديد وقت المشروع يجب الالمام الجيد بالفديك وغيره

- عمل التغطيه اللازمه للتاخييرات **Recovery Programme**

وأخيرا

* يعتبر مهندس التخطيط مدير مشروع مصغر ويعتبر ايضا جهاز الانذار والتحذير في المشروع ولا يمكن الاستغاء عنه في المشاريع الكبيره وخصوصا عند حصول مشاكل وتاخيرات اذ ان الحكم هو تقارير مهندس التخطيط .

جروب العمل

١-احمد خالد محمد مشرف

٢-محمد بشير محمد

٣-احمد فتحي محمد

٤-اسلام محمد علي

٥-محمود حسين محمد

٦-محمد شعبان عبد المنعم

٧-عبده محمد حسن



يعد مشروع التخرج في إدارة المشروعات دراسة شاملة تجمع بين المفاهيم النظرية والتطبيق العملي لإدارة المشـروعات الإنشـائية. يبدأ المشـروع بمرحلة بجمع المعلومات الكافيه عن المشـروع من لوحات وتعاقد ومكان المشـروع حيث يتم عمل حصـر تفصـيلي للوحات تشـمل تحليل السـوق وتقييم الاحتياجات وتقدير التكاليف المتوقعة ويتم ايضا تحديد نطاق المشروع بدقة، ووضع الأهداف الرئيسية والفرعية، وتحديد المعالم الهامة التي يجب تحقيقها.

تعتبر مرحلة إعداد الجدول الزمني من المراحل الحاسمة حيث يتم تقسيم المشروع إلى مهام محددة باستخدام هيكل تقسـيم العمل(WBS) ، وتحديد المدة الزمنية لكل مهمة والعلاقات المتداخلة بين المهام المختلفة. يتبع ذلك مرحلة الإدارة والتنفيذ التي تتضمن إدارة الموارد البشرية والمادية.

يتميز المشـروع باسـتخدام تقنيات BIM المتقدمة، حيث يتم توظيف BIM 4D لربط النموذج ثلاثي الأبعاد بالجدول الزمني، مما يتيح محاكاة تسـلسـل عمليات البناء وتحديد التعارضـات المحتملة قبل التنفيذ. كما يتم استخدام BIM 5D لإدارة التكاليف وربط عناصر النموذج بالتكاليف الفعلية، مما يساعد في تقدير الميزانية بدقة أكبر وتحليل التدفق النقدي للمشروع.

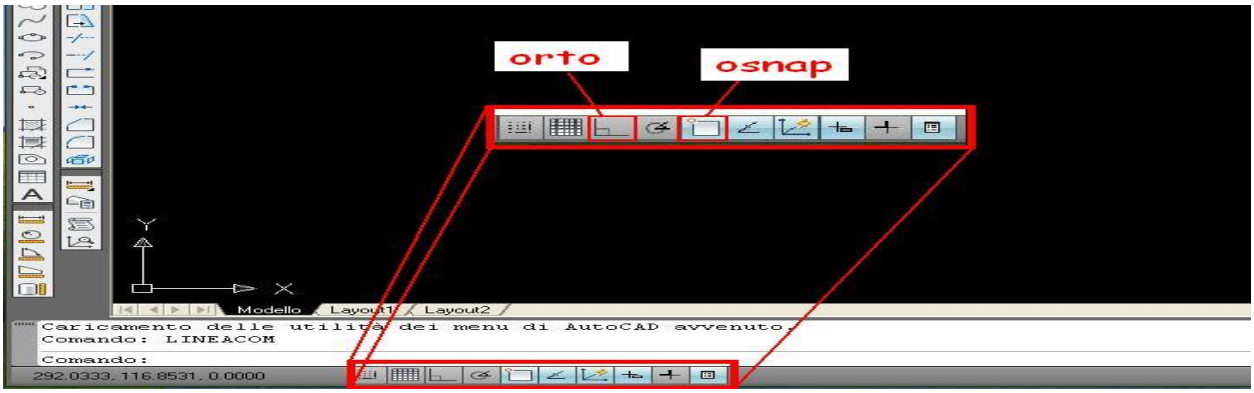
تعتبر المراقبة والتحكم عنصـراً أسـاسـياً في المشـروع، حيث يتم متابعة التقدم الفعلي ومقارنته بالخطة الموضـوعة، وتحديد الانحرافات واتخاذ الإجراءات التصـحيحية اللازمة. كما تتم إدارة التغييرات بشـكل منهجي من خلال تقييم طلبات التغيير ودراسة تأثيراتها على المشروع واعتماد التغييرات المناسبة وتوثيقها.

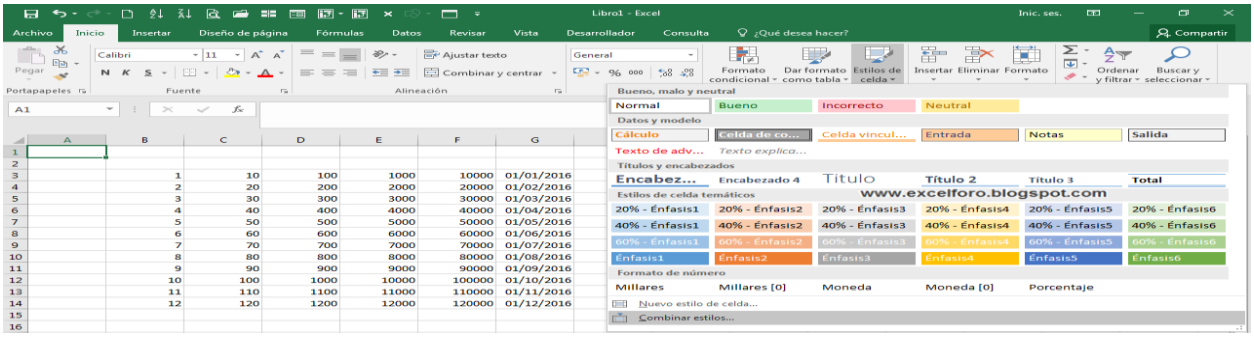
يختتم المشـروع بإعداد مجموعة شـاملة من المخرجات لعمل المتابعة الدورية. بالإضـافة إلى ذلك، يتم تقديم نماذج BIM المتكاملة التي تشمل النموذج ثلاثي الأبعاد ومحاكاة البناء وتحليل التكاليف.

مشروع : انشاء كمـــــبوند تـــــــــــــوريك &&&& كمـــــــــبوندجـــــــــايد

اولا بدأنا اعمال الحصر ـ ياستخدام برناج الكاد والاضافات الموجوده به وتم وضعها وتنظيمها في شيتات اكسيل

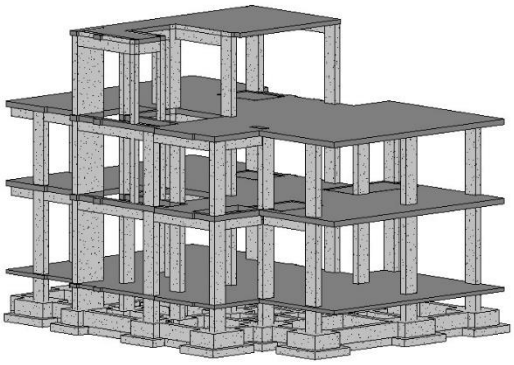

AUTOCAD


orto
osnap
Modello
Layout1
Layout2
Caricamento delle utilità dei menu di AutoCAD avvenuto.
Comando: LINEACOM
Comando:
292.0333, 116.8531, 0.0000

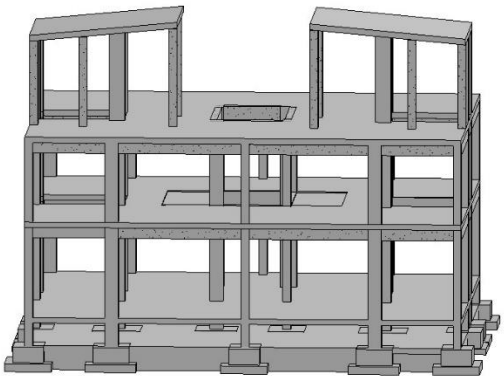

Libro1 - Excel
www.excelforo.blogspot.com

ثانينا تم عمل نمذجه للمنشات باستخدام الريفيت معماريا وانشائيا

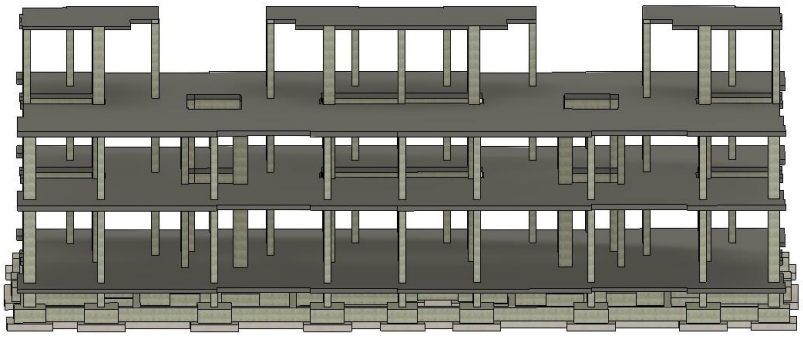




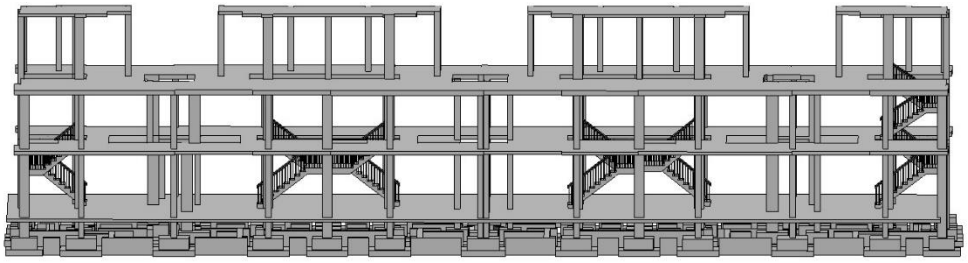




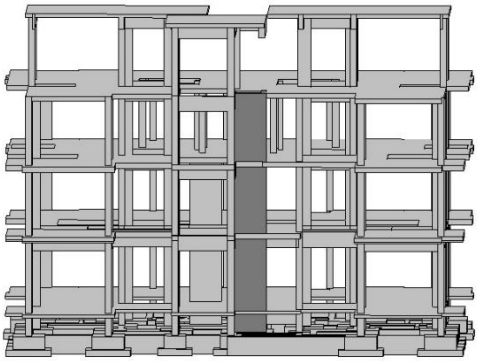









FRONT





ثـــالثـــا تم عمـــل الموقع العـــام وتجيع المـوديلات ومن ثم الردنـــدر

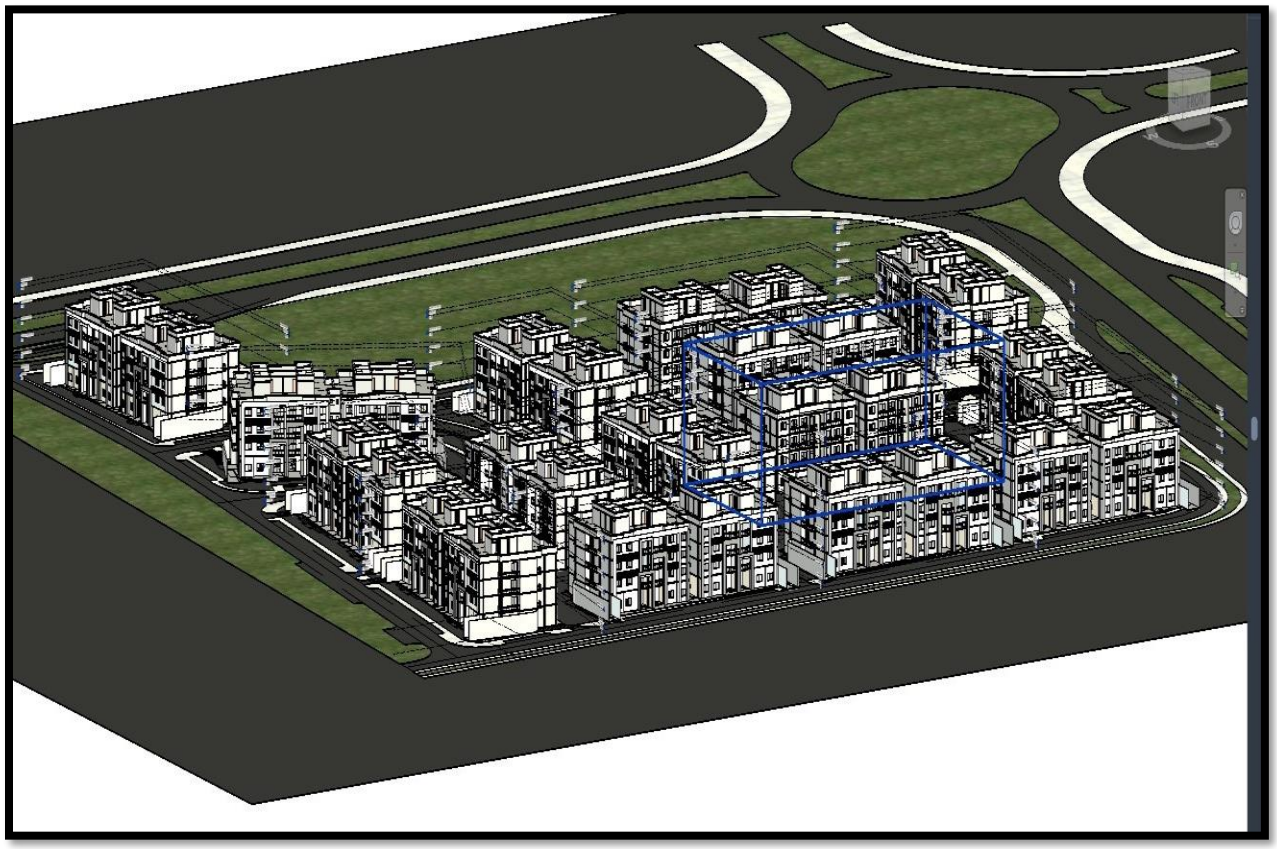

V1
V1


V1


V3
V2
V1


V3
V2
V1


V4
V5
V3
V2
V1







ومن ثم تم عمل البرامج الزمنيه

1-تم تحديد الانشطه في كل عمل

2-عمل كود وتسميه لكل منها

3-تم تحديد نوع العلاقات بين الانشطه

4- تم عمل تسعير للبنود المختلفه

5 -تحديد ساعات العمل

6-التوجه للبريمافيرا لعمل كل WBS ,,EBS,,OBS

7- تم عمل الانشطه وتحميلها بالريسورس وعمل العلاقات

4d & 5dثم انتقلنا الي مرحله النافيس وورك لعمل

العمل عباره عن فيديوهات مرفقه مع الملف

**ومن ثم انتقلنا لعمل الكتب الخاصـــه بالتخرج وعددها 4 بمتوســـط 300 صـــــــ

PLANNING BOOK .2

FOR A RESIDENTIAL PROJECT GAYED COMPOUND

NUB

NAHDA UNIVERSITY
IN BENI SUEF
جامعة النهضة ببني سويف

NUB
Civil Engineering

UNDER THE SUPERVISION OF

DR:YASEER ABD ELSHAFY **DR:HANAA GAMAL**

BY

BELAL NABIL AWES

MOHAMED ASHRAF AMIR EMAD ZAKI

BOLA TARIK FAYZ AMR NADY HASSAN

ESSAM MAHMOUD ALI ABDELRAHMAN HOSSAM

BIM MANGE BOOK

FOR A RESIDENTIAL PROJECT ZAYED&CAIRO

NUB
NAHDA UNIVERSITY
IN BENI SUEF
جامعة النهضة ببني سويف

NUB
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UNDER THE SUPERVISION OF

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BELAL NABIL AWES

MOHAMED ASHRAF AMIR EMAD ZAKI

BOLA TARIK FAYZ AMR NADY HASSAN

ESSAM MAHMOUD ALI ABDELRAHMAN HOSSAM

PLANNING BOOK .1

FOR A RESIDENTIAL PROJECT TOREC COMPOUND

NUB
NAHDA UNIVERSITY
BENI SUEF
جامعة النهضة - بني سويف

NUB
Civil Engineering

UNDER THE SUPERVISION OF

DR:YASEER ABD ELSHAFY DR:HANAA GAMAL

BY

BELAL NABIL AWES

MOHAMED ASHRAF AMIR EMAD ZAKI

BOLA TARIK FAYZ AMR NADY HASSAN

ESSAM MAHMOUD ALI ABDELRAHMAN HOSSAM

BILL OF QUANTITY.

FOR A RESIDENTIAL PROJECT AT ZAYED CITY

NUB
NAHDA UNIVERSITY
IN BENI SUEF
جامعة النهضة - ببني سويف

NUB
Civil Engineering

UNDER THE SUPERVISION OF

DR:YASEER ABD ELSHAFY **DR:HANAA GAMAL**

BY

BELAL NABIL AWES

MOHAMED ASHRAF AMIR EMAD ZAKI

BOLA TARIK FAYZ AMR NADY HASSAN

ESSAM MAHMOUD ALI ABDELRAHMAN HOSSAM

فريق العمل



Effect of using Nano Caco3 on the fresh Mechanical Microstructure and Durality of Ultra-High-Performance Concrete

Supervised by
Dr. Reham Maged
Dr. Naglaa.GalaEldinFahmy

Team work
Ahmed Ashry - Saif Mohamed - Amr lofty
Mohamed Mahmoud - Abdelrhman fakhery

CONTENTS

Chapter 1 :	**Presents an introduction to identify the problem and discussing the objectives and scope of the present study.**
Chapter 2 :	Introduces a historical background in the point of research and also a review of the important theories, Previous analytical researches and the results of the experimental works are
Chapter 3 :	Explains the experimental test program which is prepared to study the mainproperties of of incorporating Nano Caco3 in Ultra-High-performance
Chapter 4 :	Includes analysis and discussions of the experimental test results. A comparative study for test specimens using different mixes were performed
Chapter 5 :	Includes the summary and conclusions obtained from the research and suggestions for the further studies

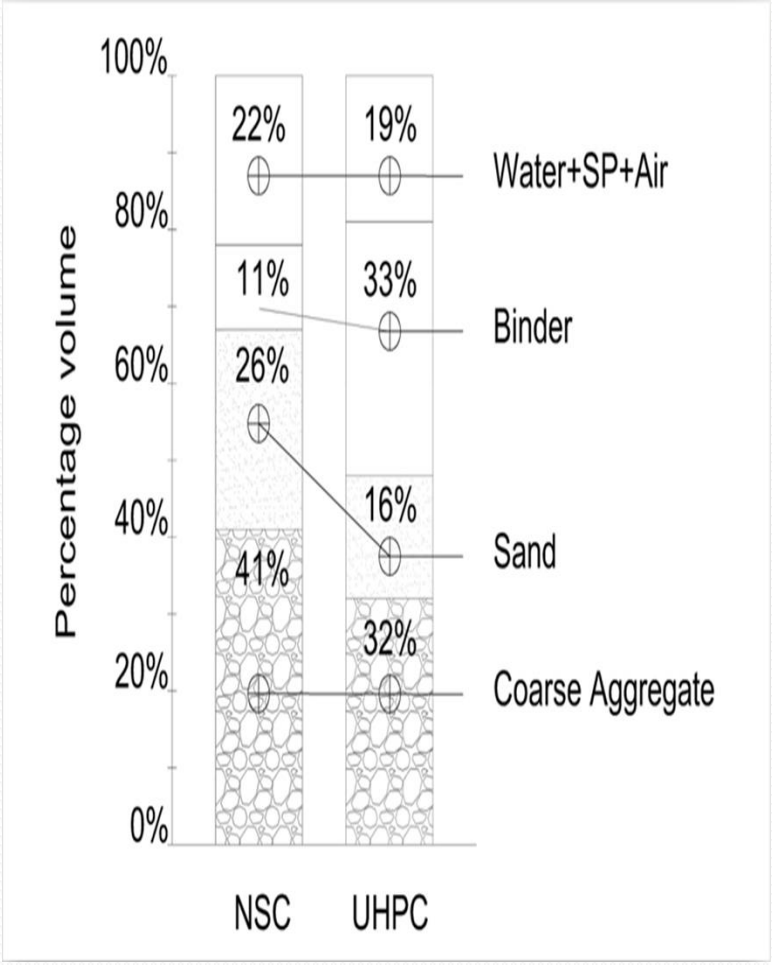
INTRODUCTION

- Ultra High Performance Concrete (UHPC) is an advanced construction material with outstanding mechanical properties and durability. It is characterized by its compressive strength only, which usually exceeds 100 : 150 MPa (megapascals), and quickly transforms into bending and tensile strength. Unlike traditional cement



What is the ultra high performance concrete ?

- Ultra-high-performance concrete (UHPC) is “a generic term referring to a composite made of ordinary Portland cement (OPC) that has an ultra-high CS, better durability, and high toughness.
- Nonetheless, the mass of OPC in UHPC is typically 700–1200 kg/m3, which is 2–3 times the amount in conventional concrete.
- the production of OPC requires significant amounts of natural resources and energy and creates significant amounts of Carbon dioxide.
- Producing one ton of clinker is predicted to require 6.65 Mega Joule of energy and emit approximately 0.83 tons of Carbon dioxide.
- The researchers attempted to lower the binder volume and substitute extra cement-based materials for OPC.



[UHPC]- ADVANTAGES

- High strength
- Durability
- Reduced thickness
- Resistant to corrosion
- Increased safety
- Versatility
- Reduced Maintenance Costs.

[UHPC] – Disadvantages

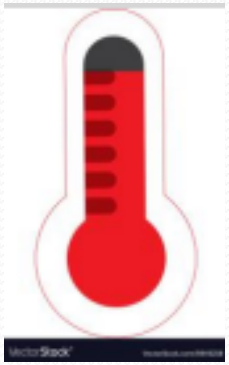
1. High cost of production



2. Requires skilled labor



3. Risk of heat generation



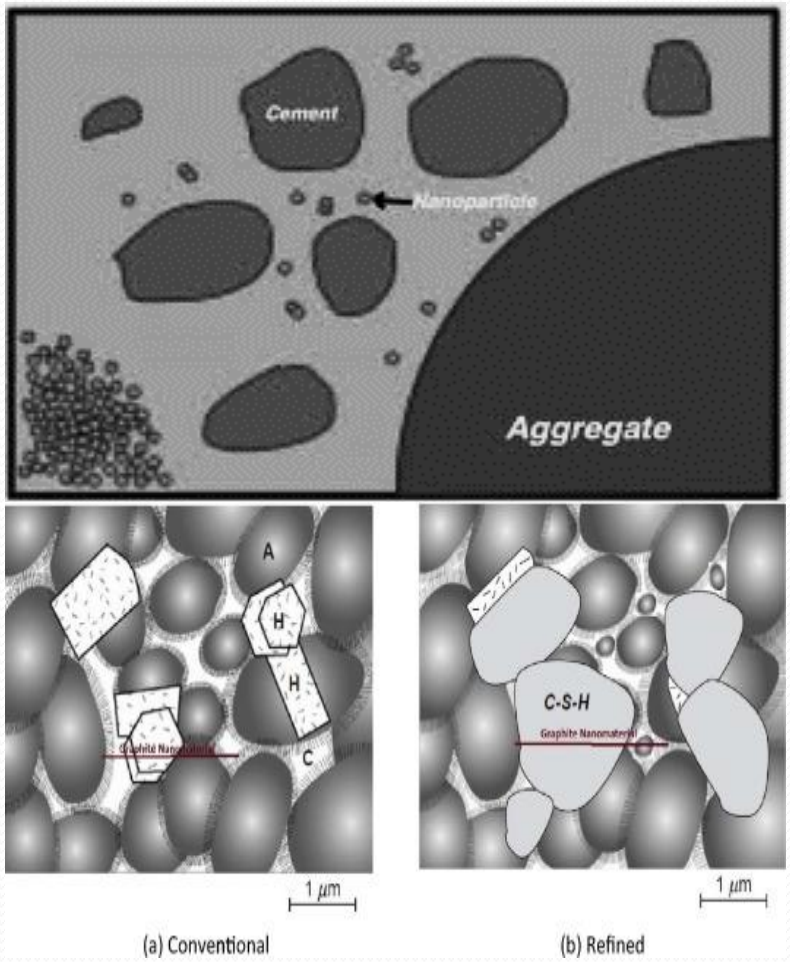
4. Difficult to repair

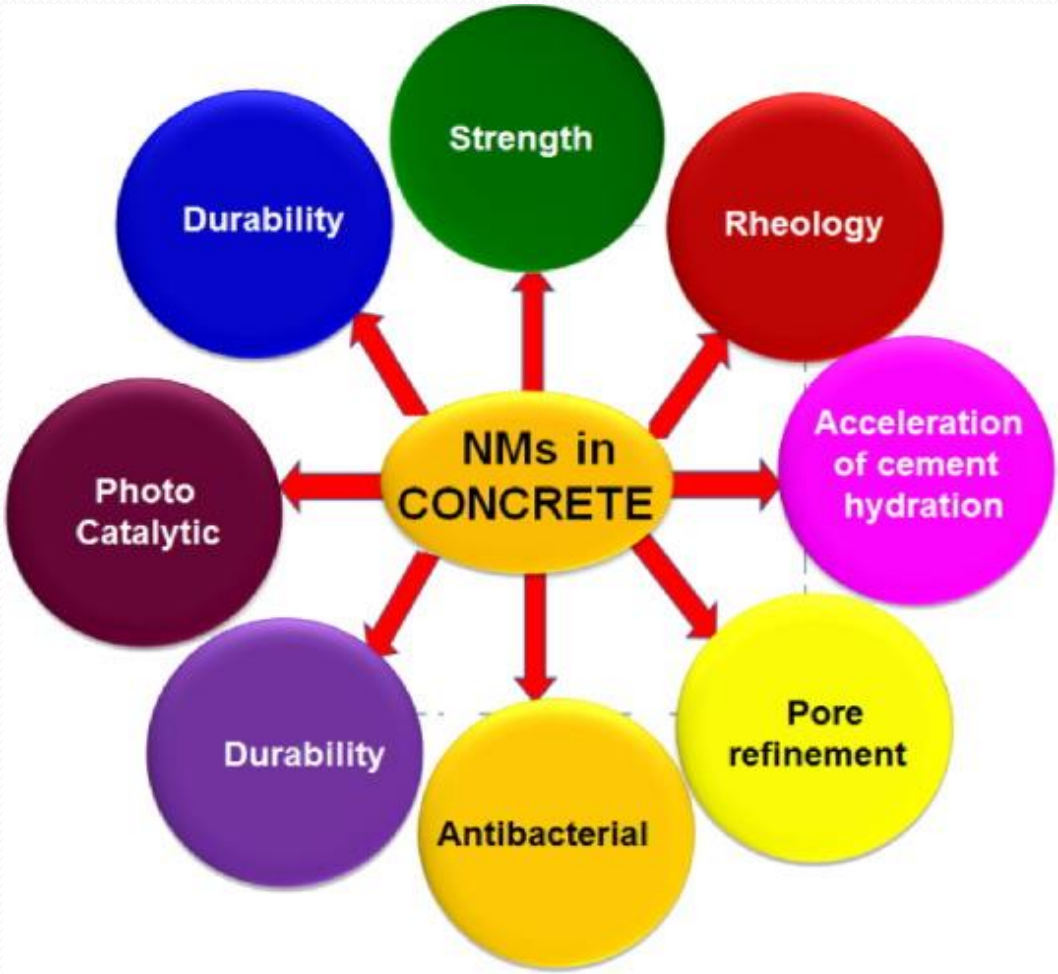


Nano technology

- Nano technology has made a revolution in the field of construction and has changed our vision, expectations and abilities to control the materials behavior .The presence of nano materials in a concrete mix decreases the cementcontent compared to conventional concrete. This can be happened without sacrificing strength characteristics. Such reduction of cement content required to achieve a target concrete strength.
- Studies have shown that concrete containing nano particles has demonstrated increased strength, durability and reduction of pores in the concrete due to the pore filling properties of the nano materials. This also results in increased resistance to corrosion of the steel reinforcements. Hence, the nano materials are useful to improve the life of the building.

Nano technology





- Nanoparticles are also utilized to lower porosity by acting as nucleation agents to improve the interfacial zone (ITZ) between the aggregate and matrix in addition to their filler function [107-109].
- Heikal et al. discovered that substituting cement with 1% nano clay reduces cement's initial and final setting periods while increasing one-day strength by roughly 80% [107].
- Nazari et al., advocated that using NS up to 3% accelerates calcium silicate hydrates formation, which improves the strength [110].
- Khaleel et al. [111] agreed that the increased strength of concrete is due to the reduced porosity of concrete caused by NS addition. Several researchers observed that the compressive strength increased due to using NS but at different dosages [112,113].
- Furthermore, it has been discovered that adding more than 2% NS to the mix proportion of concrete does not improve its compressive strength. This is due to agglomeration during the mixing process, and as a result, the pores in the concrete cannot be filled [114,115].

Nano $CaCO_3$ - Disadvantages

- 1. High Cost: The addition of nano CaCO3 to concrete can increase the initial cost.
- 2. Difficulty in Dispersion: Dispersion of nano CaCO3 in concrete can be challenging.
- 3. Effect on Color: The addition of nano CaCO3 to concrete can affect its color.
- 4. Effect on Mechanical Properties: The addition of nano CaCO3 to concrete can affect its mechanical properties, such as compressive strength and tensile strength.
- 5. Difficulty in Preparation: Preparation of nano CaCO3 requires special techniques and precise requirements

Main objective of this research program

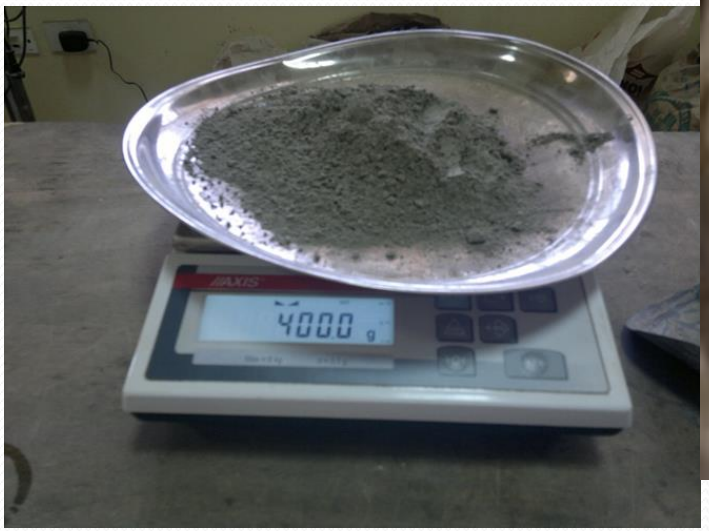
- Effect of using Nano Caco3 on the fresh Mechanical Microstructure and Durality of Ultra-High-Performance Concrete
- Determine the optimum content of the used Nano Caco3 in studied UHPC.
- To Study of increasing concrete resistance .

STEPS











Material used

1.CEMENT

For this specific testing commercially available Type I portland cement, which conforms the ASTM C 150 (Standard Specification for portland cement) was used. It was supplied by Beni Suef Cement Company BSCC (Beni Suef city, Egypt). The basic physical properties and compound composition of cement are presented in Table 3.1 and 3.2 respectively.

Table 3-1 Basic Physical Properties of Type I portland cement Used

Specific Gravity	Fineness	Setting time	
		Initial (min.)	Final (min.)
3.15	320 m^2/kg (1561 ft^2/lb)	90	260

Table 3-2Compound Composition of Type I portland Cement Used.

Compounds	percentage by mass
Tricalcium Silicate (C_3S)	49.0
Dicalcium Silicate (C_2S)	25.0
Tricalcium Aluminate (C_3F)	12.0
Tetracalcium Aluminoferrite (C_4AF)	8.0
Calcium Sulfate (CSH_2)	2.2
Calcium Oxide (CaO)	0.8
Magnesium Oxide (MgO)	2.0
Others	1.0

2. Sand

Naturally occurring quartz sand was used as the fine aggregate in the concrete mix throughout this experimental program. The physical properties of the sand employed are detailed in Table

Property	Value
Specific gravity (t/m^3)	2.75
Volumetric weight (t/m^3)	1.70
Voids ratio (%)	40.3%
Absorption (%)	1%
Clay and Fine Materials%	1%

The grading of the fine aggregate is provided in Table

Sieve size (mm)	Grading % Passing	Specification limits (ASTM C33) % passing
4.75	100	95-100
2.36	97.4	80-100
1.18	83.9	50-85
0.61	54.08	25-60
0.31	22.18	5-30
0.16	1.7	0-10

3. *Silica Fume*

SF is a noncombustible amorphous silica (SiO_2) waste byproduct of the silicon and silicon alloys industry. Egyptian Ferro Alloys Corporation created the utilized silica fume (EFACO). Table (3.8) shows the chemical component analysis. The silica fume utilized had a density of 2210 kg/m^3 and a fineness of 23.52 m^2/gm. The silica fume utilized satisfied the primary criteria of Standard Specification for Silica Fume Used in Cementitious Mixtures (ASTM C 1240)

Table 3-8The Used Silica Fume's Chemical Components Analysis

Chemical Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	L.O.I.
Average (%)	97	0.1	1	0.2	0.15	0.1	0.2	2.2

4. Super-plasticizer

- Sika Viscocrete 3425, a polycarboxylate-based superplasticizer (SP), was used in this study. It is supplied by Sika Egypt, a construction chemicals company. This superplasticizer is classified as a Type 3 (third group) SP for concrete and mortar, meeting the standards of ASTM C494, Types G and F (ASTM C494, 2003). The main physical properties of the used superplasticizer are clearly presented in Table

Property	Value
Appearance / colour	Clear liquid
Density Kg/lit (ASTM C494)	1.08
pH value	4.0
Solid Content (by weight)	40%



5. water

As per the Egyptian code of practice, clear, drinkable, new, and impurity-free tap water was utilised for mixing and curing the examined samples.



6．Steel fiber

Diameter: 0.75
Length: 35 mm



7 . Nano $CaCO_3$

- Calcium carbonate (CaCO3) is commonly used in concrete as a filler and smoother. This material acts as packing granules to fill the voids between aggregate and fine aggregate in the concrete mixture. CaCO3 can be available in fine powder form or in small granules.





Mixtures Proportions in (Kg/m^3)

Mix	C	cement	Water	sand	Steel fiber	Sp	Q z	S f	Cac o3
Mix 1	0 %	726.47	191.2	798.5	221.76	23.52	145.29	221.7	0
Mix 2	1 %	726.47	191.2	798.5	221.76	23.52	145.29	221.7	7.35
Mix 3	2 %	726.47	191.2	798.5	221.76	23.52	145.29	221.7	14.7
Mix 4	3 %	726.47	191.2	798.5	221.76	23.52	145.29	221.7	22.5

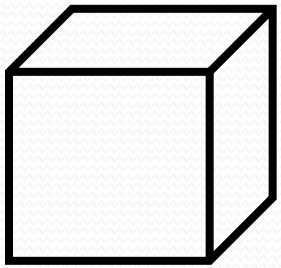


MIXING

1. Materials were mixed separately at high speed for 1 to 3 minutes, either with water and superplasticizer or with water alone.
2. The next step involved 1 minute of dry mixing of cement and silica fume.
3. Afterward, mixing continued for 4 minutes with the addition of half of the calculated mixing water. For self-curing mixtures, Nano Caco3 was incorporated into this half portion of the water.
4. The samples were then cast and cured in a controlled room environment at 20°C and at least 95% relative humidity for 24 hours.

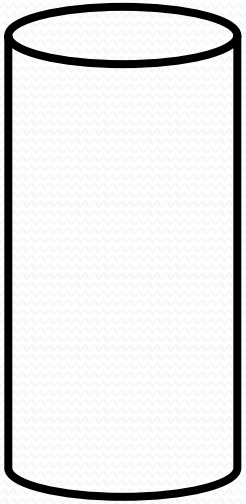
Tested Samples

Compressive Strength



Cubes
10x10x10 cm

- Tensile Strength



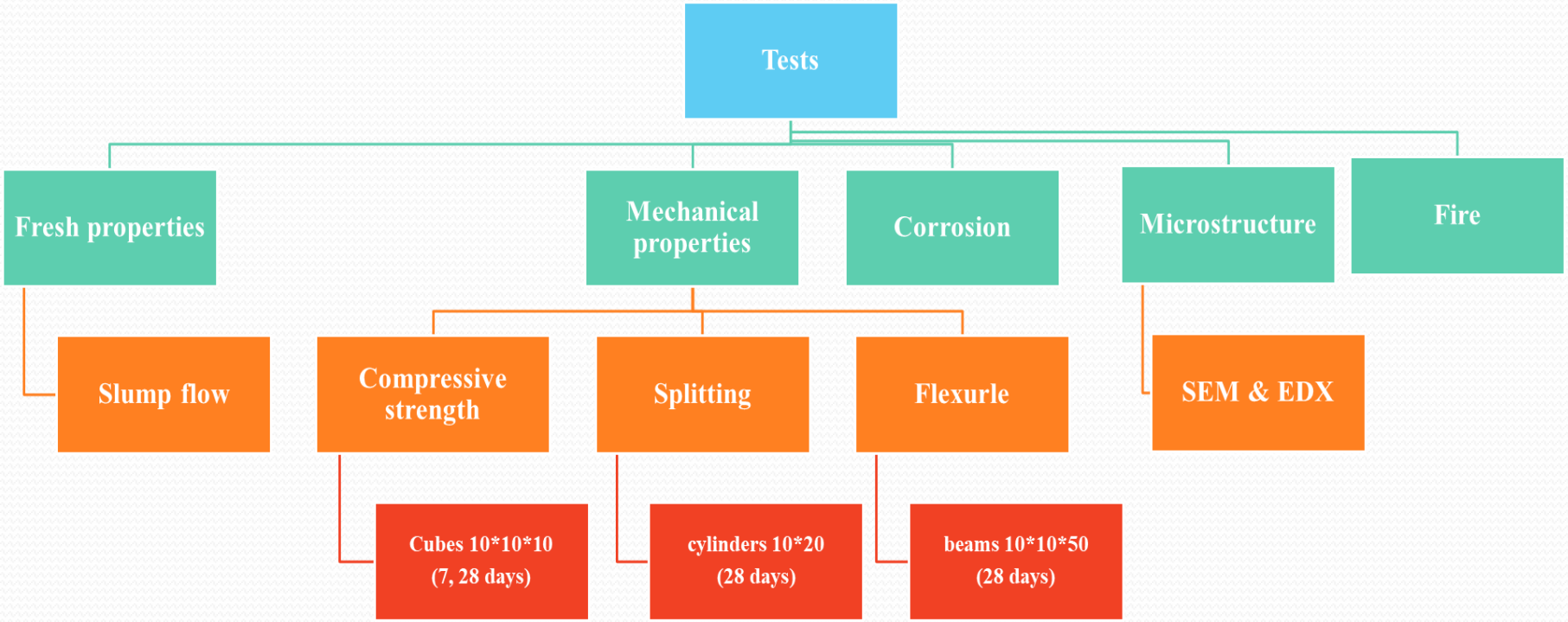
Cylinders
10x20 cm

Flexural Strength



Prisms
10x10x50 cm

TESTING PROCEDURES


Tests
Fresh properties
Mechanical properties
Corrosion
Microstructure
Fire
Slump flow
Compressive strength
Splitting
Flexurle
SEM & EDX
Cubes 10*10*10 (7, 28 days)
cylinders 10*20 (28 days)
beams 10*10*50 (28 days)

SLUMP TEST

- The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. The cone is placed on a hard nonabsorbent surface. This cone is filled with fresh concrete in three stages. Each time, each layer is tamped 25 times.



THE SLUMP WAS TESTED TO IDENTIFY THE .FRESH CHARACTERISTICS TABLE







COMPRESSION TEST

- testing compressive force to a material specimen, typically in cuboid or cylindrical form, using specialized fixtures or platens on a universal testing machine. The test measures the material's response to crushing loads and helps determine crucial properties like elastic limit, yield point, and compressive strength. A compressive strength test was carried out on UHPC (100 x 100 x 100 mm) cube specimens by a compressive testing machine (capacity = 3000 KN) at the ages of 7, 28 days due to ASTM C39.



SPLITTING TENSION TEST

- is an indirect way of assessing the tensile bond strength of concrete-concrete composites. compressive force, aligned with the interface, causing splitting horizontal tensile stresses. The splitting tension test was performed on concrete cylinders of 10 cm diameter and 20 cm length for 28 days as stated by ASTM C 494/C495M $\sigma T = 2P/\pi DL$.

SPLITTING TENSION TEST



FLEXURAL TEST

- A conventional flexure (bending) test was performed on concrete beams with square section of 10 cm dimensions and 50 cm total length in accordance with ASTM The beams were tested under central load with 50 cm clear span Prism Flexure Strength= 3 PL/2bd2.

FLEXURAL TEST





Curing with salt solution

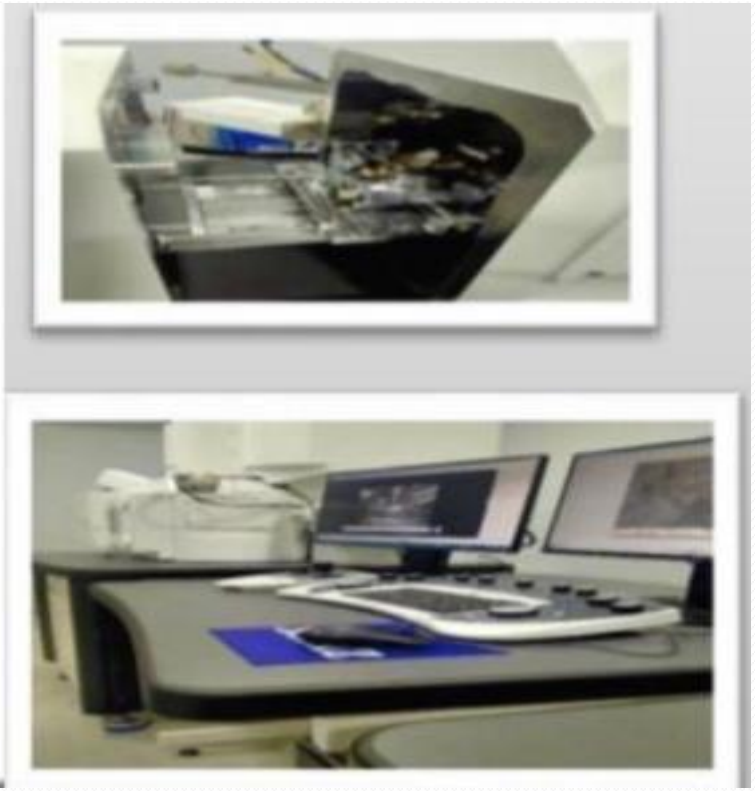


SEM TEST

- SCANNING ELECTRON MICROSCOPE MICROSTRUCTURE CHARACTERISTICS INVESTIGATION HAVE CONDUCTED FOR THE SPECIMENS OF AGE 28 DAYS. WE WENT TO TAKE THE SEM TEST AT MINYA UNIVERSIT Y CARL ZEISS SIGMA 500VP SEM AND EDX WERE USED FOR THE OBSERVATION. SMALL FRAGMENTS (10X10X10) MM IN SIZE FROM THE CENTER OF THE CONCRETE CUBES WERE USED FOR SEM AND EDX.

SEM TEST



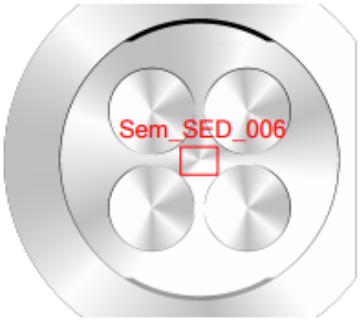


EDX TEST

- The EDX test is used to analyze the chemical composition of materials.

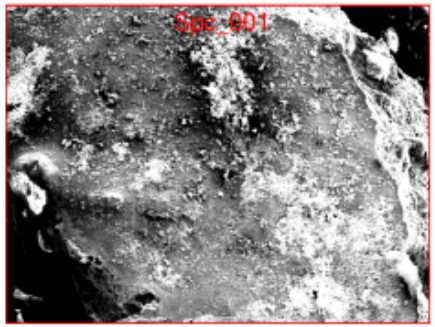
NUHPC0

Smp_1210



20 mm

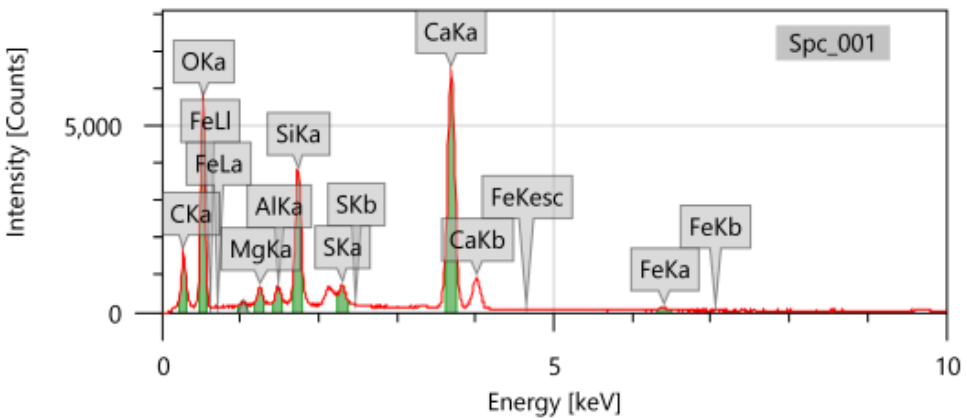
Sem_SED_006



500 µm

Signal SED
Landing Voltage 20.0 kV
WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

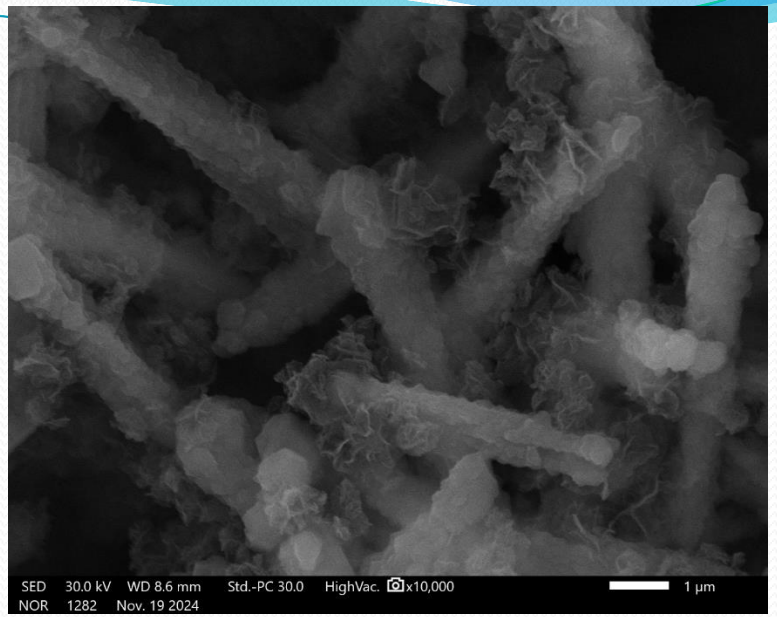
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measurement conditions	
Acceleration voltage	20.00 kV
Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	31.18 seconds
Dead time	4.00
Count rate	9703.00 CPS

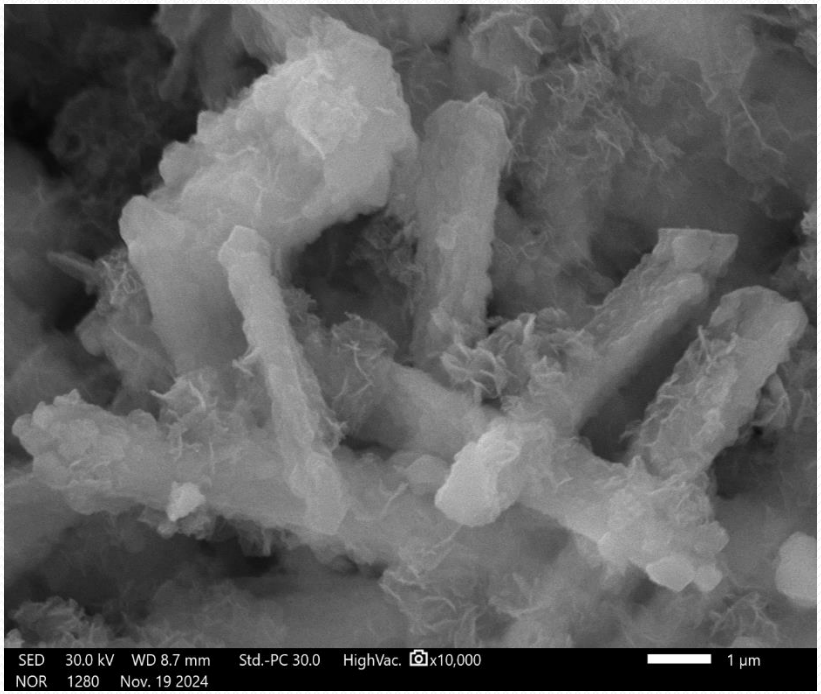


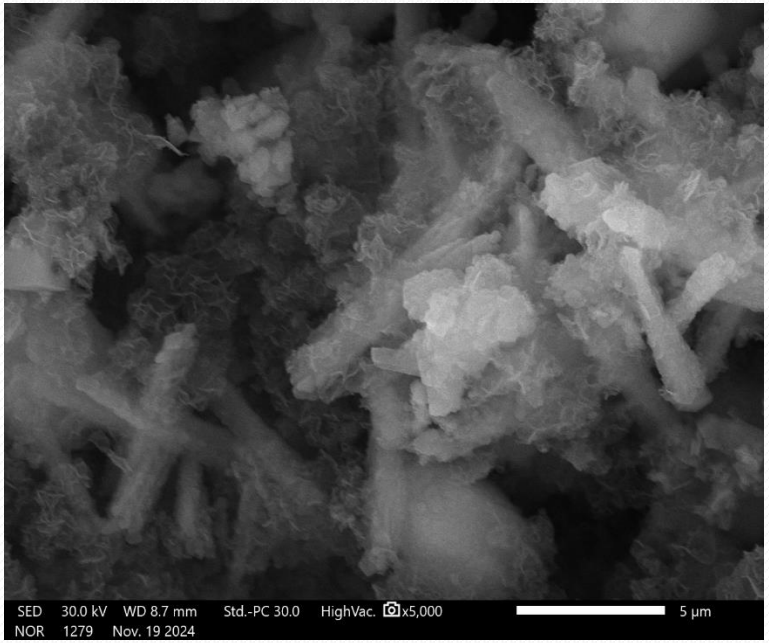
Display name	Standard data	Quantification method	Result Type
Spc_001	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	13.88±0.09	21.49±0.13
O	K	52.18±0.27	60.66±0.31
Na	K	0.35±0.03	0.29±0.02
Mg	K	1.12±0.03	0.86±0.02
Al	K	0.99±0.03	0.68±0.02
Si	K	7.05±0.06	4.67±0.04
S	K	0.98±0.02	0.57±0.01
Ca	K	22.77±0.11	10.56±0.05
Fe	K	0.68±0.03	0.23±0.01
Total		100.00	100.00
Spc_001			Fitting ratio 0.0228

NUHPC0

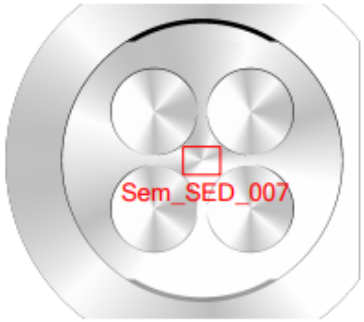

SED 30.0 kV WD 8.6 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1282 Nov. 19 2024


SED 30.0 kV WD 8.7 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1280 Nov. 19 2024


SED 30.0 kV WD 8.7 mm Std.-PC 30.0 HighVac. x5,000 5 µm
NOR 1279 Nov. 19 2024

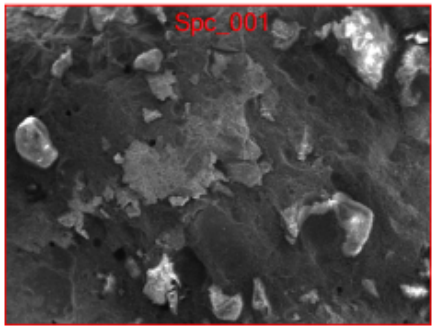
NUHPC1

Smp_1185



20 mm

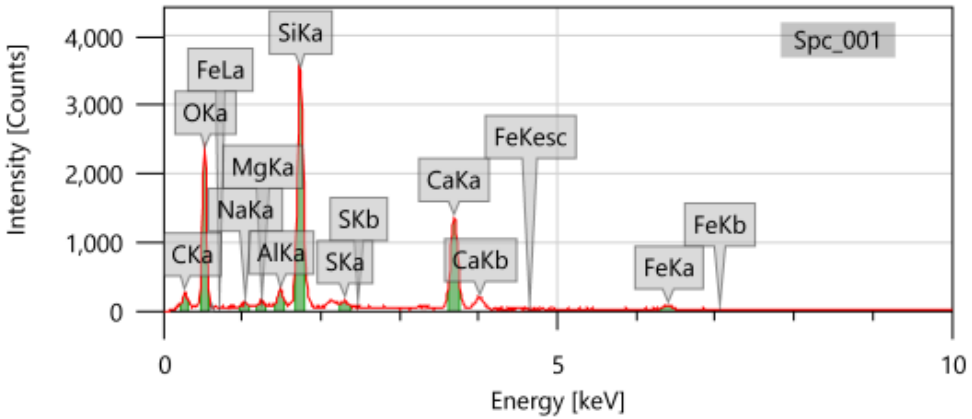
Sem_SED_007



500 µm

Signal SED
Landing Voltage 20.0 kV
WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

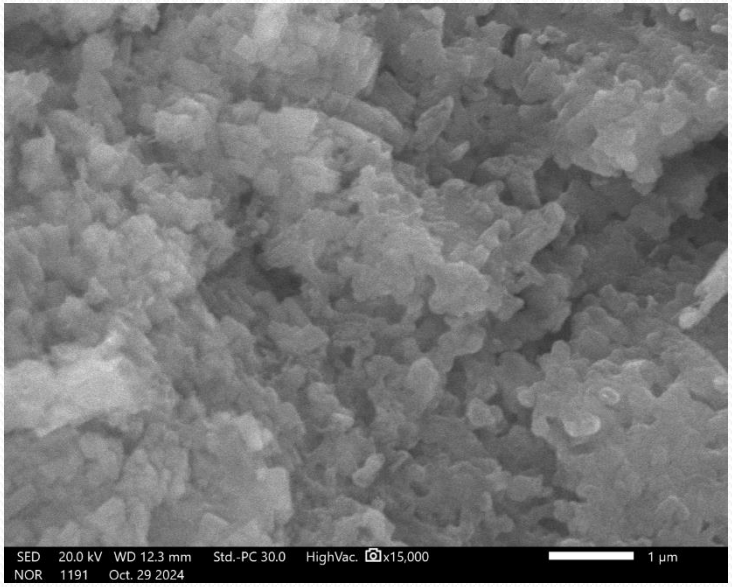
Items	Value
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Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	30.61 seconds
Dead time	2.00
Count rate	3482.00 CPS

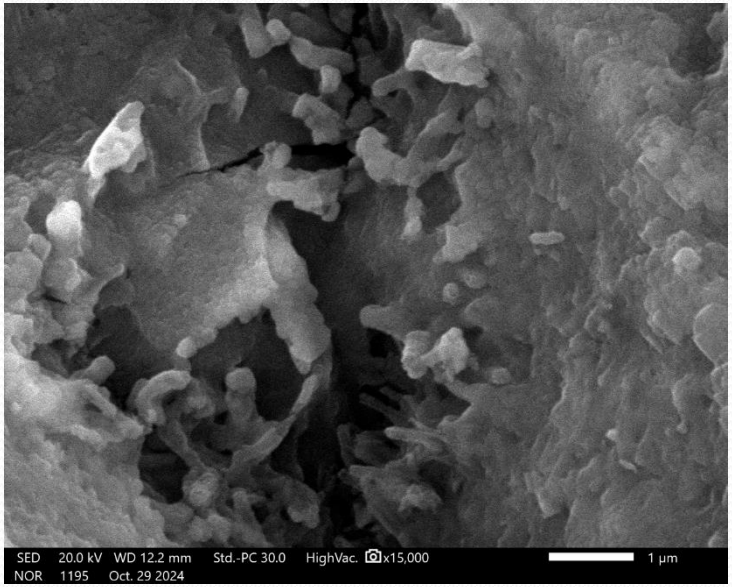


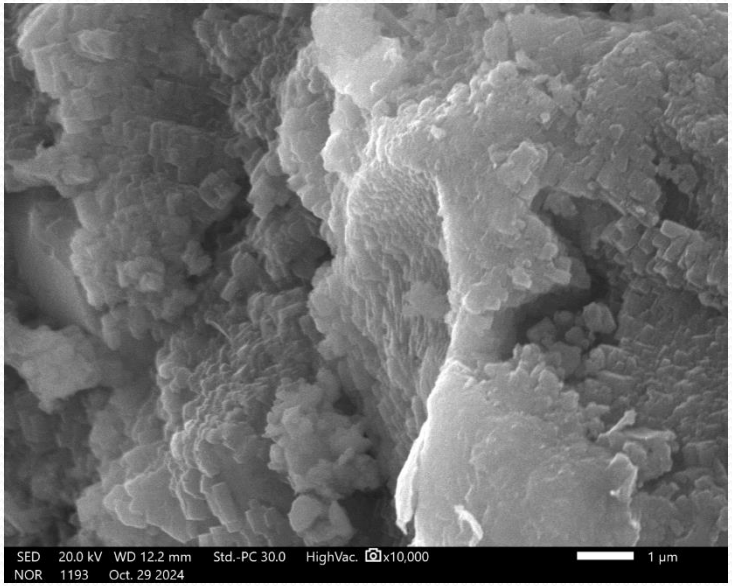
Display name	Standard data	Quantification method	Result Type
Spc_001	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	8.61±0.15	13.82±0.25
O	K	51.85±0.42	62.48±0.50
Na	K	0.64±0.05	0.54±0.04
Mg	K	0.50±0.04	0.40±0.03
Al	K	1.35±0.05	0.96±0.04
Si	K	19.95±0.17	13.70±0.12
S	K	0.55±0.04	0.33±0.02
Ca	K	15.17±0.17	7.30±0.08
Fe	K	1.37±0.07	0.47±0.03
Total		100.00	100.00
Spc_001			Fitting ratio 0.0295

NUHPC1

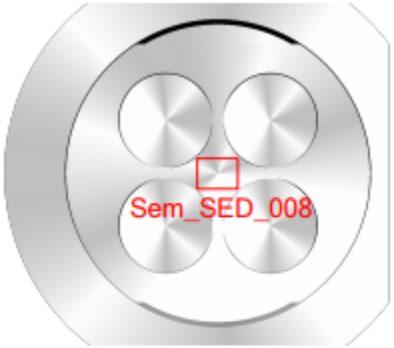

SED 20.0 kV WD 12.3 mm Std.-PC 30.0 HighVac. x15,000 1 µm
NOR 1191 Oct. 29 2024


SED 20.0 kV WD 12.2 mm Std.-PC 30.0 HighVac. x15,000 1 µm
NOR 1195 Oct. 29 2024


SED 20.0 kV WD 12.2 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1193 Oct. 29 2024

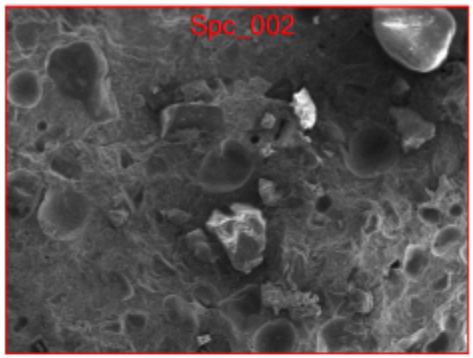
NUHPC2

Smp_1185



20 mm

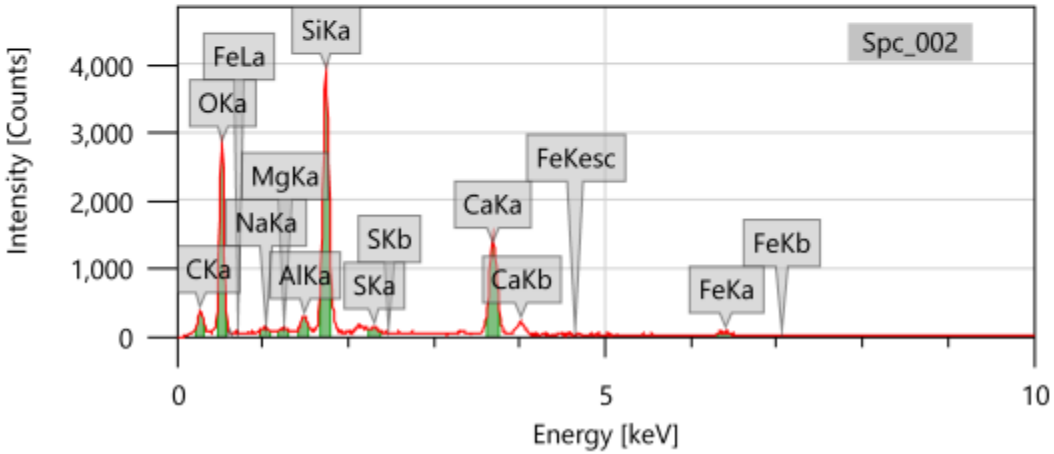
Sem_SED_008



500 µm

Signal SED
Landing Voltage 20.0 kV
WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

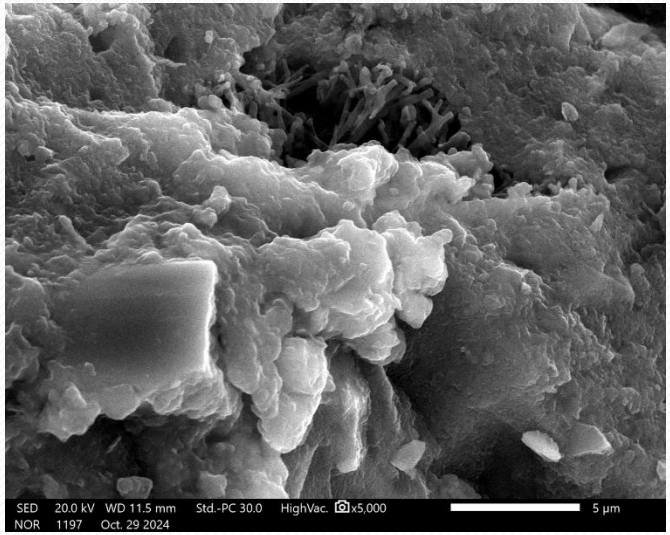
Items	Value
measurement conditions	
Acceleration voltage	20.00 kV
Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	30.65 seconds
Dead time	2.00
Count rate	3769.00 CPS

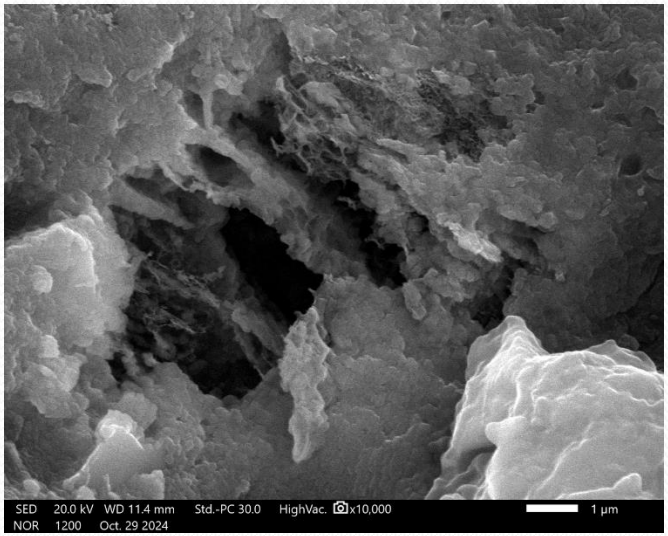


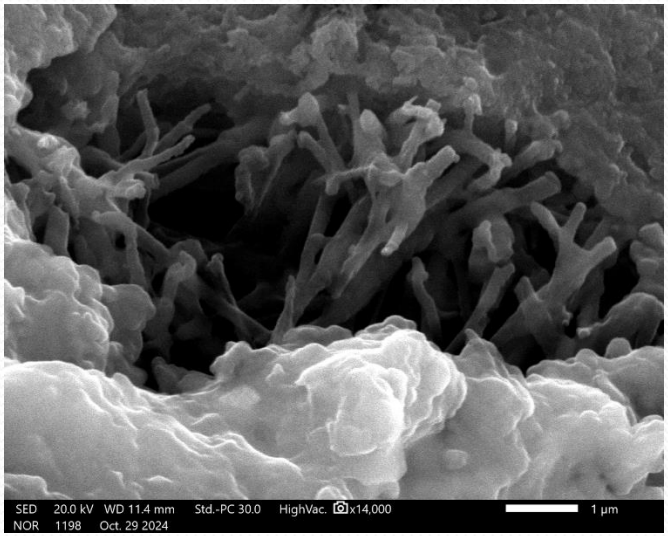
Display name	Standard data	Quantification method	Result Type
Spc_002	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	12.87±0.16	19.73±0.25
O	K	52.54±0.38	60.45±0.44
Na	K	0.47±0.04	0.37±0.03
Mg	K	0.26±0.03	0.20±0.02
Al	K	1.09±0.04	0.74±0.03
Si	K	18.08±0.15	11.85±0.10
S	K	0.47±0.03	0.27±0.02
Ca	K	13.09±0.14	6.01±0.06
Fe	K	1.14±0.06	0.37±0.02
Total		100.00	100.00
Spc_002			Fitting ratio 0.0243

NUHPC2

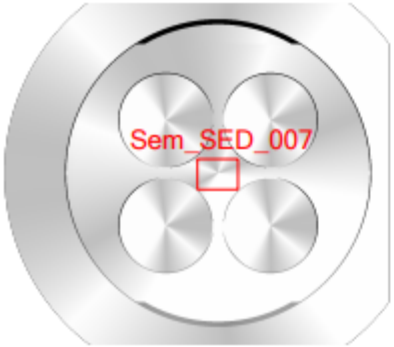

SED 20.0 kV WD 11.5 mm Std.-PC 30.0 HighVac. x5,000 5 µm
NOR 1197 Oct. 29 2024


SED 20.0 kV WD 11.4 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1200 Oct. 29 2024


SED 20.0 kV WD 11.4 mm Std.-PC 30.0 HighVac. x14,000 1 µm
NOR 1198 Oct. 29 2024

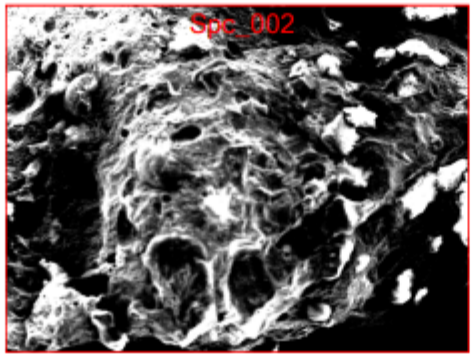
NUHPC3

Smp_1210



20 mm

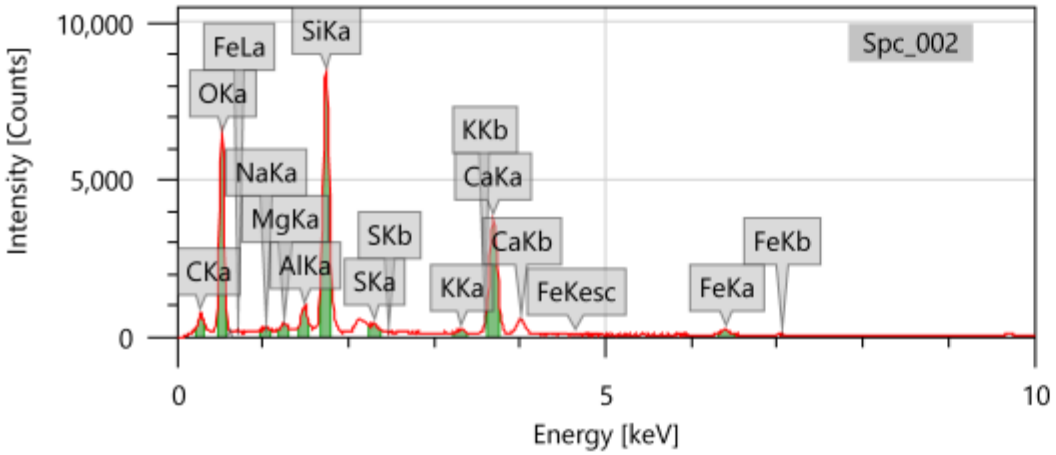
Sem_SED_007



500 µm

Signal SED
Landing Voltage 20.0 kV
WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

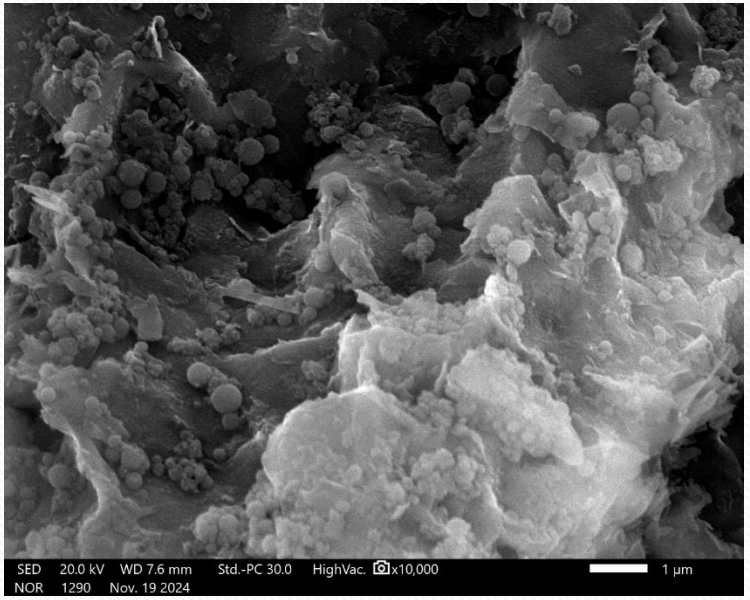
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Probe current	0.00 nA
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Measurement detector	First
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Real time	31.19 seconds
Dead time	4.00
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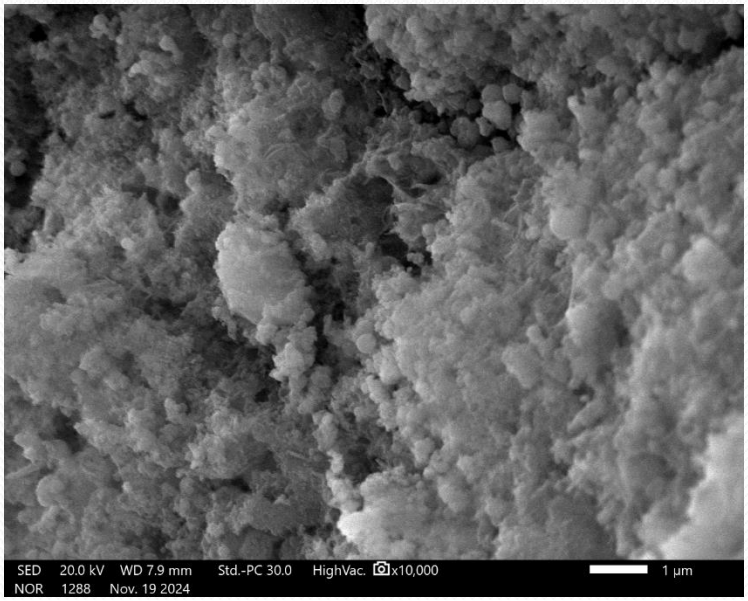


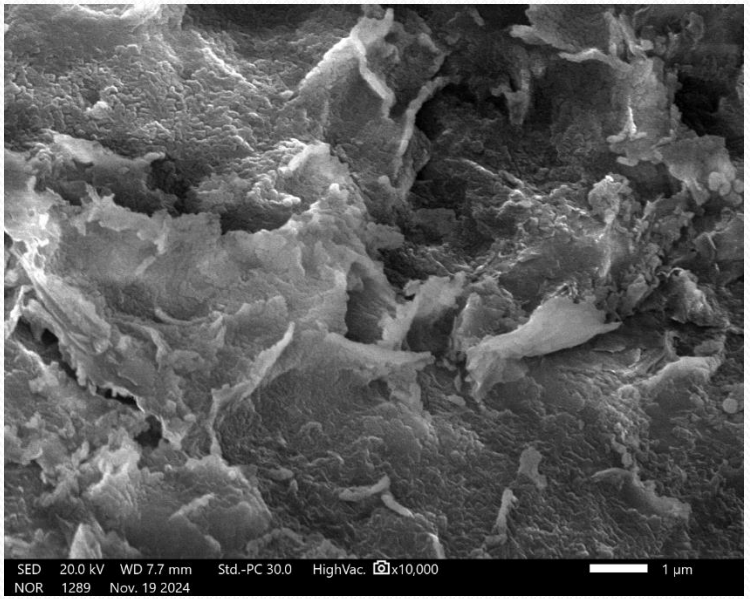
Display name	Standard data	Quantification method	Result Type
Spc_002	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	8.88±0.09	14.17±0.15
O	K	52.86±0.25	63.30±0.31
Na	K	0.53±0.03	0.44±0.02
Mg	K	0.60±0.02	0.48±0.02
Al	K	1.70±0.03	1.21±0.02
Si	K	17.74±0.10	12.10±0.07
S	K	0.46±0.02	0.28±0.01
K	K	0.45±0.02	0.22±0.01
Ca	K	15.16±0.10	7.25±0.05
Fe	K	1.62±0.05	0.55±0.02
Total		100.00	100.00
Spc_002			Fitting ratio 0.0197

NUHPC3


SED 20.0 kV WD 7.6 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1290 Nov. 19 2024


SED 20.0 kV WD 7.9 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1288 Nov. 19 2024

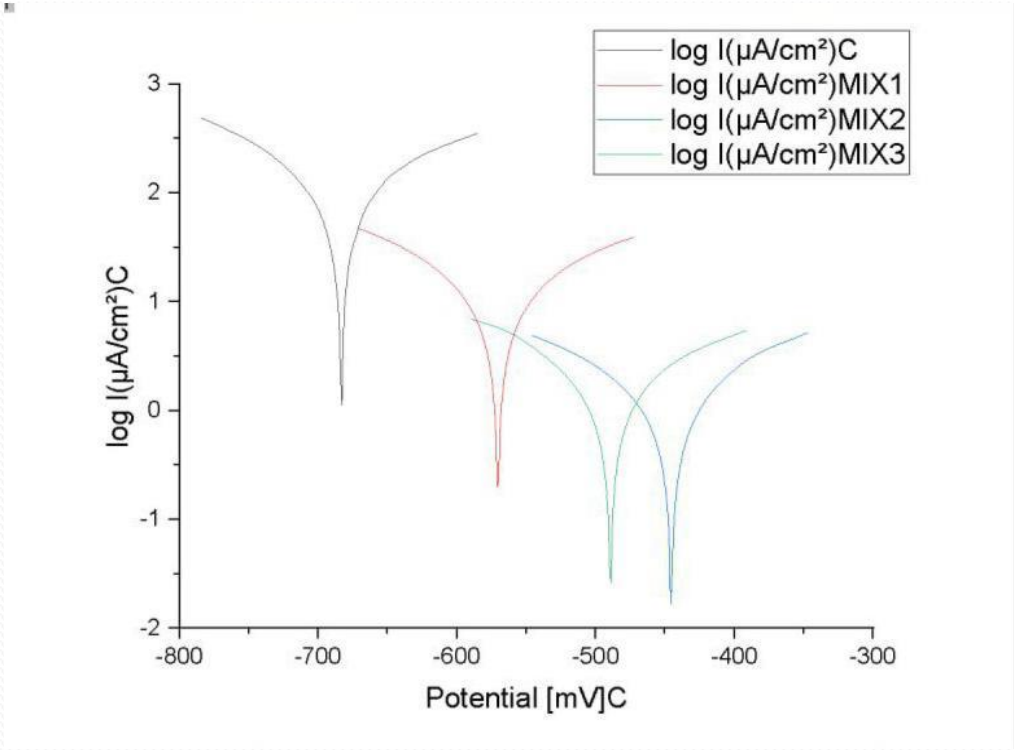

SED 20.0 kV WD 7.7 mm Std.-PC 30.0 HighVac. x10,000 1 µm
NOR 1289 Nov. 19 2024

Corrosion

- . The corrosion resistance of HSS implanted in UHPC specimens cured in 3.5 percent NaCl solution is compared to the reference mix without nanoparticles for hardened UHPC specimens including nanoparticles.



Corrosion


log I(µA/cm²)C
log I(µA/cm²)MIX1
log I(µA/cm²)MIX2
log I(µA/cm²)MIX3
log I(µA/cm²)C
3
2
1
0
-1
-2
-800
-700
-600
-500
-400
-300
Potential [mV]C



FIRE STRENGTH

- Fire resistance test for high-strength concrete aims to evaluate its performance under high temperatures. At 900°C, concrete strength decreases by 20-30%, while at 600°C, strength decreases by 10-20%.





FIRE STRENGTH

fire	• 600	• 900
NUHPC0	450.25	169.37
NUHPC1	835.43	185.18
NUHPC2	913.10	193.22
NUHPC3	967	216078

28day
1254
1340
1386

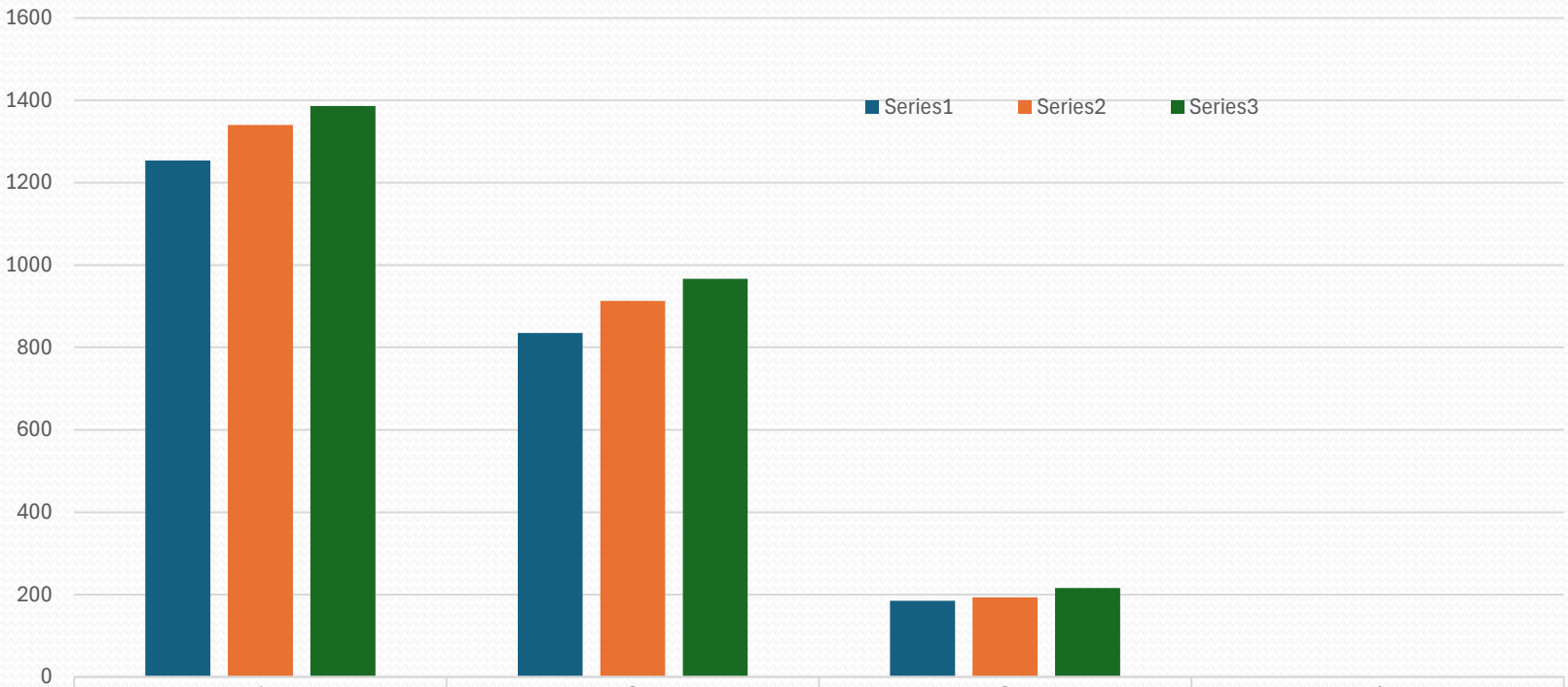






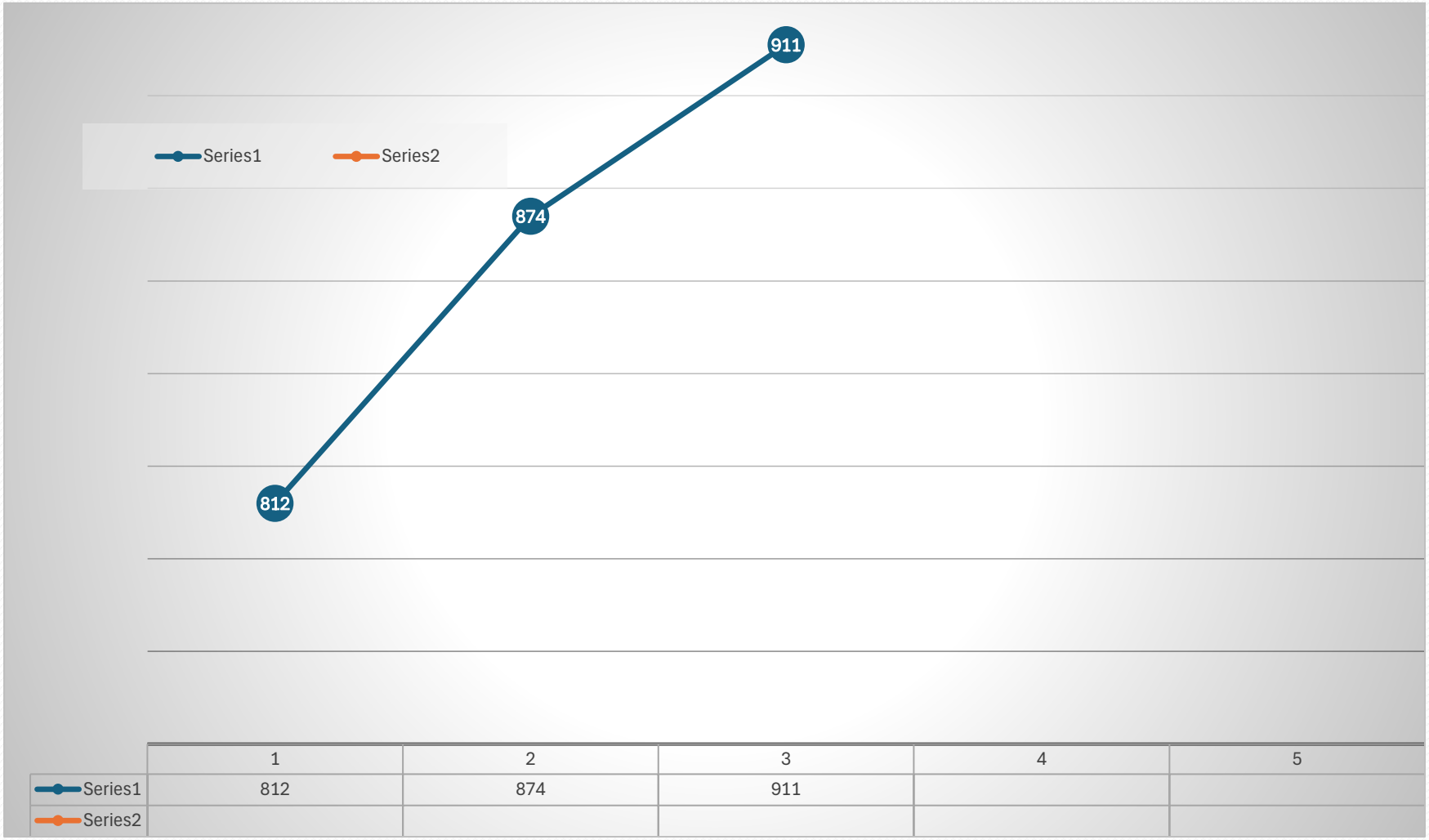


FIRE STRENGTH



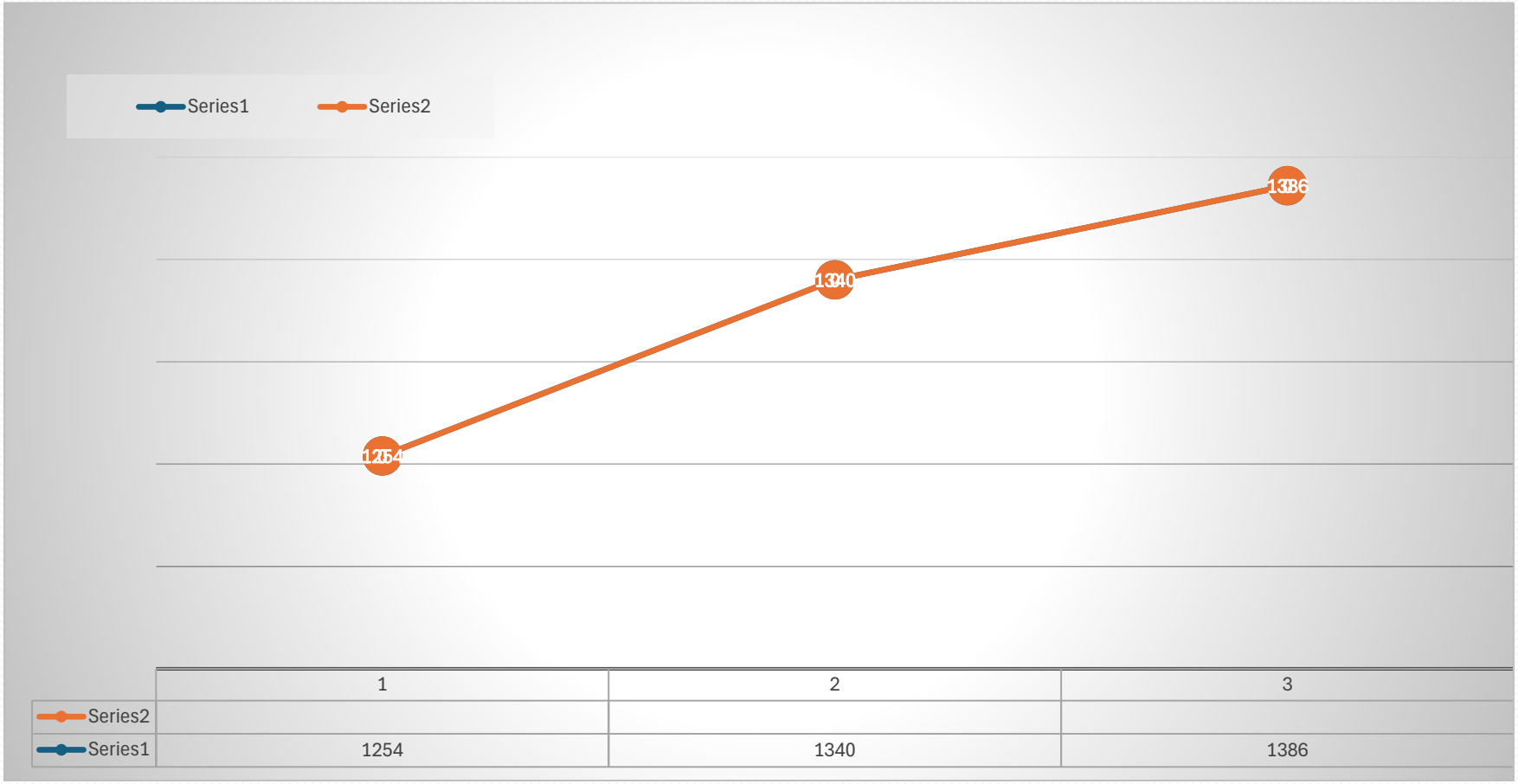
	1	2	3	4
Series1	1254	835.43	185.18	
Series2	1340	913.1	193.22	
Series3	1386	967	216	

COMPRESSION TEST- 7day



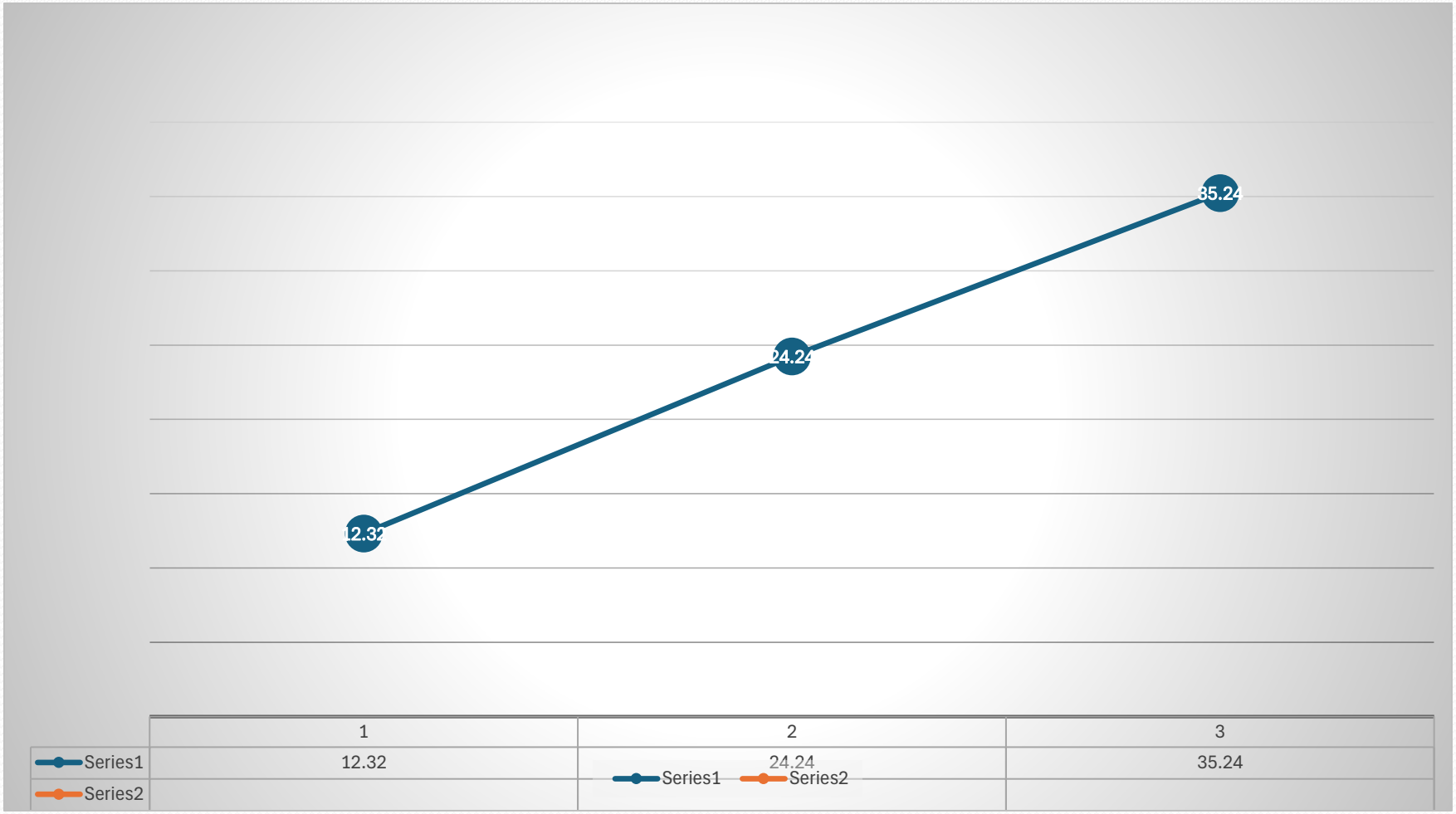
	1	2	3	4	5
Series1	812	874	911		
Series2					

COMPRESSION TEST-28day



	1	2	3
Series2			
Series1	1254	1340	1386

Flexural Strength



Conclusions

- 1. Adding nano-$CaCO_3$ improved the flowability of UHPC mixtures and exhibited better workability than that induced by control admixture.
- 2. The addition of nano-$CaCO_3$ had a strong acceleration effect on the early-age setting and hardening process. Hence, nano-$CaCO_3$ addition can be considered as a setting and hardening accelerator.
- 3. Mixtures incorporating nano-$CaCO_3$ showed comparable and/ or better early-age compressive, tensile and flexural strength results than that of the control.
- 4. SEM analysis reveals that nano-$CaCO_3$ was helpful for increasing the compressive strength of the UHPC at early ages due to the acceleration of cement hydration by the seeding effect and the tighter pore structure of cement as a result of nano filling. On the other hand, the pozzolanic effect of the Nano-$CaCo_3$ at later ages can further enhance the mechanical strength of concrete, making up for the limited effect of the nano-$CaCO_3$.

THANKS YOU

Nahda University
Faculty of Engineering
Department of Civil Engineering

Effect of using Nano Caco3 on the freshi Mechaniceel Microstructine and Durailty of Ultra-High-Performance Concrete

A Thesis

Submitted to the Department of Civil Engineering, Faculty of Engineering, Nahda University, for submission as a graduation project

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2025

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g. / Ahmed Ashry
Saif Mohamed
Amr lofty
Mohamed Mahmoud
Abdelrhman fakhery

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List of Abbreviations

Abbreviations	Description
UHPC	Ultra High Performance Concrete
SEM	Scanning electron microscopy
EDX	Energy Dispersive X-ray

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Introduction

Overview

Ultra-High-performance cement-based concretes (UHPC), such as high- performance concrete and ultra-high-performance concrete, have been considered as promising materials in the last decade because of their advanced characteristics in the compressive and tensile strength, stiffness and long-term durability compared to the normal or high-strength concretes. Such concretes typically have low water-to-binder (w/b) ratio and high binder content, including cement and mineral admixtures, which results in a high compressive strength, high elastic modulus and excellent durability. However, a large amount of binder in the matrix could, consequently, cause a disadvantage not only in economic efficiency but also in engineering properties under working conditions. And Nano Calcium Carbonate (Nano CaCO3) is a versatile nanomaterial with unique properties. It has an ultrafine particle size, typically in the range of 1-100 nanometers, providing a large surface area and high reactivity. Nano CaCO3 enhances mechanical strength, thermal stability, and durability when used as a filler in plastics, rubber, and coatings. Its excellent dispersion ability ensures uniformity in composite materials. Additionally, it is cost-effective and environmentally friendly, making it suitable for various industrial applications.

Commonly, UHPC exhibits a larger shrinkage compared to normal concrete and autogenous shrinkage significantly contributes to the total shrinkage in UHPC compared to drying shrinkage. In the first few days after mixing, UHPC already shows a considerably high autogenous shrinkage, which increases the potential of cracking at early ages. The risk of cracking inducedby the restrained autogenous shrinkage would limit the application of UHPC in construction. Furthermore, UHPC offers an extremely dense matrix, however, with a few cracks appearing in the UHPC, the transport properties of concrete (e.g., permeability or diffusion) would significantly increase, which reduces the durability of UHPC. Basically, the large autogenous shrinkage of UHPC is originated from the extremely low water/binder ratio and remarkably high silica fume (SF) content normally used in UHPC. Therefore, the internal relative humidity (RH)in the cementitious matrix is significantly dropped during hardening of concrete. Furthermore, self-desiccation also occurs under some sealed curing conditions(i.e.,without an external source of water

1.1 Thesis Objectives and Contributions

This study aims to produce Ultra-high-performance cement concrete (UHPC), by using super plasticizers and silica fume with Nano Caco3 . prepared using chemical methods are incorporated to investigate how affect UHPC Several mixes weremade using Nano Caco3 with percent (0%, 0.3%, 0.7% and 1%,) and microstructure characteristics, mechanical properties of various HPC mixtures are evaluated and discussed

1.2 The main scopes of the study

1- Determine the optimum content of the used Nano Caco3 in studied UHPC.

2- To Study of increasing concrete resistance .

1.3 Thesis Organization

The thesis is organized as follows: -

Chapter 1 : Presents an introduction to identify the problem and discussing the objectives and scope of the present study.

Chapter 2 : Introduces a historical background in the point of research and also a review of the important theories, Previous analytical researches and the results of the experimental works are

Chapter 3 : Explains the experimental test program which is prepared to study the mainproperties of of incorporating Nano Caco3 in Ultra-High-performance

Chapter 4 : Includes analysis and discussions of the experimental test results.

A comparative study for test specimens using different mixes were performed

Chapter 5 : Includes the summary and conclusions obtained from the research and suggestions for the further studies

Chapter 2

2. Ultra High Performance Concrete

2.1 Introduction

When Otto Graf managed to produce a concrete with a strength of 70 N/mm2 in the early 1950s, the construction industry showed very little interest in this new product. And this lack of interest didn't change even as in 1966 Kurt Walz proved that, using special production methods, it was possible to achieve a strength of 140 MPa. Only after it was realized that adding a limited amount of silica fume plus suitable superplasticizers was a simple way of producing a concrete with high strength and at the same time good workability did the first ideas regarding potential applications begin to materialise. Not until the late 1980s was it possible to produce concrete in strength classes up to C100/115. [5]

The discovery of the effect of silica fume, a fine, reactive material, and the development of efficient superplasticizers proved very important in this development. At the start, high-strength concrete was ascribed only a limited role, primarily because of the much higher production costs compared with conventional concretes. It turned out, however, that it is more realistic to make comparisons on the basis of an entire project. One example was Stichtse Bridge, built near the Dutch city of Amsterdam in 1997. The use of C80/90 concrete enabled the cross-sectional area of this bridge, which spans 160 m, to be reduced by 30%. The smaller cross-sectional area of the box girder resulted in a 26% saving in prestressing steel. Owing to the 60% thinner webs and bottom flange, the length of the individual segments could be increased from 3.50 to 5.00 m, which in turn led to the construction time being shortened by three months [6].

Limestone (i.e. calcium carbonate (CaCO3)), however, has shown an ability to accelerate the hydration process of Portland cement. CaCO3 usually has no chlorides and can readily be found, for instance, in chalk and marble, or produced artificially by combin ing calcium and carbon dioxide (Myers, 2007). Studies have shown that CaCO3 accelerates the hydration process by acting as a

nucleation site on which cement hydration products form. This micro-physical effect results in a higher development rate of mechanical properties (Sato and Beaudoin, 2007). A higher accelerating effect occurs when more CaCO3 is added; however, exceeding the optimal amount of CaCO3 (which mainly depends on its particle size) can lead to a reduction in mechanical strength (Kakali et al., 2000) [3].

Ever since the invention of nanomaterials, the concrete industry has made significant investments into exploring the effects of nano-sized materials in concrete and their potential applications (Balaguru, 2005). Many nano-additives create superior results to that of their micro counterparts. For example, a previous study showed that the addition of nano-silicon dioxide (SiO2) (40 nm) improved the early-age compressive strength by approximately twice that induced by silica fume addition (0. 1 m) (Jo et al., 2007). Although there is a large amount of research investigating the effects of very fine CaCO3 particles, limited research has explored the effects of nano-CaCO3 (15–40 nm) addition, and benefits and potential applications, particularly in UHPC. [4].

In addition, there were the advantages of the good workability of the concrete, the low creep and shrinkage losses, the high wearing resistance and the excellent durability of the concrete. It became clear that the solution using C80/90 concrete was, on the whole, no more expensive than the alternative with conventional concrete, and at the same time resulted in a structure with a very high quality. Increasing the strength of the concrete to values beyond about 120 N/mm2 was regarded as unrealistic because the strength of the aggregate, as the weakest component in the mix and accounting for about 75% of the volume of the concrete, would prevent this. Another innovation thought of as promising at that time was the development of SIFCON (Slurry Infiltrated Fibre CONcrete). The production of this material involves first introducing steel fibres into the formwork and packing these tightly. The spaces between the fibres are then filled with a cement matrix. This method results in a fibre content of 12–13%, which roughly corresponds to a 10-fold increase over the maximum fibre content of conventional fibre-reinforced concrete. The material is characterized by its very high strain at failure [7].

One disadvantage, however, is that the packing results in an inhomogeneous distribution of the fibres (predominantly 2D). When it comes to the effectiveness and hence the associated costs, this limits the potential applications. A variation on SIFCON is SIMCON (Slurry Infiltrated Mat CONcrete). This material is produced by introducing a mat of discontinuous steel fibres into the formwork and subsequently covering this with an easy-flowing cement mortar [8].

The concrete that was known as high-strength concrete in the late 1970s is now referred to as UHPC because it has been found to be much more than just stronger: it displays enhanced performances in such areas as durability and abrasion resistance. Although widely used, the expression ‘‘UHPC’’ is very often criticized as being too vague, even as having no meaning at all. Since there is no single best definition for the material known as UHPC, it is preferable to define it as a low water/binder concrete which receives an adequate water curing. [9].

Fig. 1 represents schematically the fundamental microstructural difference between cement pastes having a 0.65 and 0.25 water/cement ratio. In a 0.25 W =C ratio cement paste, there are more cement grains and consequently less water per unit volume so that cement grains are much closer to each other than in a 0.65 W =C cement paste. This major difference results in a completely different type of hydrated cement paste. A 0.65 W =C ratio cement paste is very porous and rich in crystallized outer hydration products formed through a solution–precipitation process, while a 0.25 W =C ratio cement paste is very compact and essentially composed of inner hydration products resembling a gel developed through a diffusion process. [10].

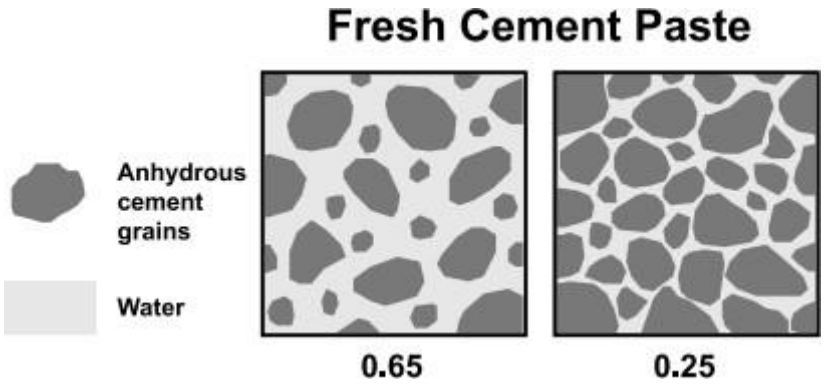


Figure 1 Schematical representation of the microstructure of two cement pastes having W =C ratios of 0.65 and 0.25[10].

2.2 Principles for the production of UHPC

Concrete technology has made remarkable advances in recent decades, the current edition of DIN EN 206/DIN 1045-2 includes the strength classes C55/C67 to C100/115, the 'high-strength concretes'. Over the past 15 years, many working in this field have developed ultra-high performance concretes (UHPC) up to a level where they are ready for application – and with compressive strengths from about 150 to 200 MPa, Compared with conventional normal- and high strength concretes with their capillary porosity, UHPC exhibits a much denser microstructure , Owing to UHPCs good durability, its materials-saving composition and the low maintenance requirement, structures made from UHPC [11]

2.3 Raw materials

The raw materials of UHPC include cementitious component, quartz powder, quartz sand,superplasticizer, and fibers. Quartz sand usually has a particle size from 150 to 600 lm and is dimensionally the largest granular material. Powder quartz (PQ) has a particle size distribution ranging from 0.1 to 100 lm and is generally considered as an inert filler. Fibers used in UHPC are often micro steel fibers with length of 13 mm and diameter of 0.2 mm. Optimization of raw materials results in required performance of UHPC. The following sections discuss the raw materials of UHPC in details[12].

2.3.1 Cementitious components

Cement content in UHPC is generally about 800–1000 kg/m3 . The high cement content affects not only the production costs, but also the heat of hydration, and dimensional stability. The following sections will discuss the common cementitious components and their effects on the performance of UHPC

Portland cement Cement has a low alkali content, low to medium fineness, and a low C3A-content can reduce water content, ettringite formation, and heat of hydration . CEM I 52.5, ASTM Types I or II, and GB P.I cements are recommended to be used for UHPC. There are also promising tentative with other types of cement. Considering the fact that the cementitious components in UHPC could not hydrate completely and act as fillers, Strunge and Deuse utilized microfine cements with particle size between that of Portland cement and silica fume. Singh prepared highly reactive bdicalcium silicate at low temperature by hydrothermal method, and felt it was suitable for UHPC. However, the belite cement hydrated slowly and gave very low early strength [7]

Grade 52.5 ordinary Portland cement (C) was manufactured by the Chongqing Tenghui Company. Semi-condensed SF was supplied by Elkem Company, China. GGBS was from the Chongqing Iron and Steel Company and ground in the laboratory. LP was made from limestone rock from the Chongqing Gele Mountain. As an essentially inert mineral material, LP was regarded as a component of the cementitious materials in this investigation. The chemical compositions and physical properties of each cementitious material are listed in Table 1. The fine aggregate was medium sand with a fineness modulus of 2.3, an apparent density of 2.72 g/cm3 , and a bulk density of 1.60 g/cm3 . The coarse aggregate was crushed limestone with a maximum diameter of 20 mm, an apparent density

of 2.70 g/cm3 , and a bulk density of 1.65 g/cm3 . The size distributions of the coarse and fine aggregates are listed in Table 1[8]

Table 1Chemical compositions and physical properties of binders.

Ch

Binders	Chemical compositions (%)								Specific surface area (m^2/kg)	Density (g/cm^3)
	CaO	SiO_2	Al_2O_3	MgO	Fe_2O_3	TiO_2	SO_3	LOI		
C	59.37	20.86	9.28	2.07	3.74	0.47	2.49	1.47	330	3.10
SF	–	95.19	–	0.80	0.13	–	–	2.81	20,000	2.23
GGBS	50.44	30.36	16.90	1.84	0.34	0.57		2.42	870	2.75
LP	52.12	3.45	1.47	0.77	0.24	–	–	40.22	600	2.75

Regarding the chemical composition of the OPCs considered for the production of HPC and UHPC, it is observed that there are no major differences between the OPCs used for the production of CC, as shown in Table 2. The typical OPC base is essentially the same: between 60 to 72% of CaO, between 14 and 22% of SiO2, resulting in approximately 80% of the cement composed of CaO + SiO2. One can note that virtually all the cement presented in Table 2 had appreciable values (up to ~4%) of loss on ignition (associated with the CO2 thermal decomposition) and/or MgO. This can be explained by the presence of carbonaceous fillers, e.g., calcite (CaCO3) and/or dolomite (CaMg(CO3)2), or periclase (MgO) [9]

CaO (%)	SiO_2 (%)	Fe_2O_3 (%)	Al_2O_3 (%)	SO_3 (%)	MgO (%)	Loss on Ignition (%)
62.91	20.34	4.58	4.47	2.58	1.24	3.27
61.33	21.01	3.12	6.40	2.30	3.02	-
63.62	19.70	2.93	-	-	1.28	-
66.45	17.84	3.58	4.26	4.10	2.14	-
63.07	19.38	3.28	4.58	3.50	2.79	1.54
64.62	20.18	3.24	4.98	3.15	1.98	2.59
62.60	20.60	3.20	5.10	3.60	3.00	-
67.97	16.19	3.79	3.59	4.05	1.71	0.51
71.22	14.80	3.48	4.54	4.11	-	4.02
68.91	15.74	4.80	3.18	3.80	2.00	1.00
62.90	18.90	2.80	3.70	3.10	4.20	3.20
62.15	20.95	3.80	4.85	2.00	3.10	-

Table 2 Chemical composition of Ordinary Portland Cement (OPC) used for HPC and UHPC[9]

Silica fume (SF) is an industrial byproduct from ferro-silicium alloys production and has a typical diameter of 0.2 lm. It is an essential constituent for UHPC. In 1993, Richard et al. proposed that silica fume content should be around 25% of Portland cement. Chan concluded that the optimal silica fume content was between 20% and 30% in terms of the bond characteristics. Other researchers found that the optimum silica fume content was 30–35% of the cement in UHPC with strength of 200 MPa .Actually, the optimum silica fume content was highly dependent on w/c, and a lower w/c required lower silica fume content .Under autoclave curing condition, if silica fume is absent, rapid generation of hydration products would result in formation of porous structure and low compressive strength. However, SF has limited output. Meantime, its variable carbon content can decrease the fluidity of UHPC. High unburnt coal in silica fume may result in dark surface color of concrete, which is an aesthetical problem. It has been shown that pulverized granulated blast furnace slag (GGBFS) and pulverized nano csco3 , metakaolin, limestone powder, and rice husk ash, etc., can be used to replace

silica fume in UHPC [10]

2.3.2 Aggregates

Generally, aggregates are relatively inexpensive concretemaking material. Refined quartz sand with diameter less than 0.6 mm was initially used in initial UHPC to achieve better performance, but its cost is high. In order to reduce the cost of UHPC, recycled glass cullet, natural sands, and artificial aggregates were used as replacements for refined quartz sand . The use of recycled glass cullet (RGC) decreased flexural strength, compressive strength, and fracture energy by approximately 15%, while natural sand resulted in similar mechanical properties and ductility as the refined quartz sand did . Zhao et al. used iron ore tailings to replace natural sand at various replacement levels, as shown in Fig. 4. When the tailing content was less than 40%, the UHPC specimens showed comparable mechanical properties to the control specimens after 90 days standard room curing. After 2 days steam curing, the compressive strengths decreased by less than 11% while the flexural strengths increased by 8%. Therefore, iron ore tailings have the potential to be used as fine aggregate of UHPC because they are relatively inert and the particle size is significantly bigger than that of cement. Collepardi et al. used crushed basalt with diameter less than 8 mm to replace part or all of the refined quartz sand to produce UHPC, and obtain comparable compressive strength. Other researchers used crushing basalt and limestone less than 20 mm as coarse aggregate, and got very promising results. This indicates that the key is to eliminate the defects caused by coarse aggregate rather than to remove it. Monosi et al. used ground Portland clinker with similar particle size distribution of natural fine quartz (100–400 lm) and limestone gravel (0.1–8 mm) respectively as aggregates. They found that the compressive strength of UHPC increased by about 20 MPa when clinker aggregates were used instead of natural aggregates. [13]

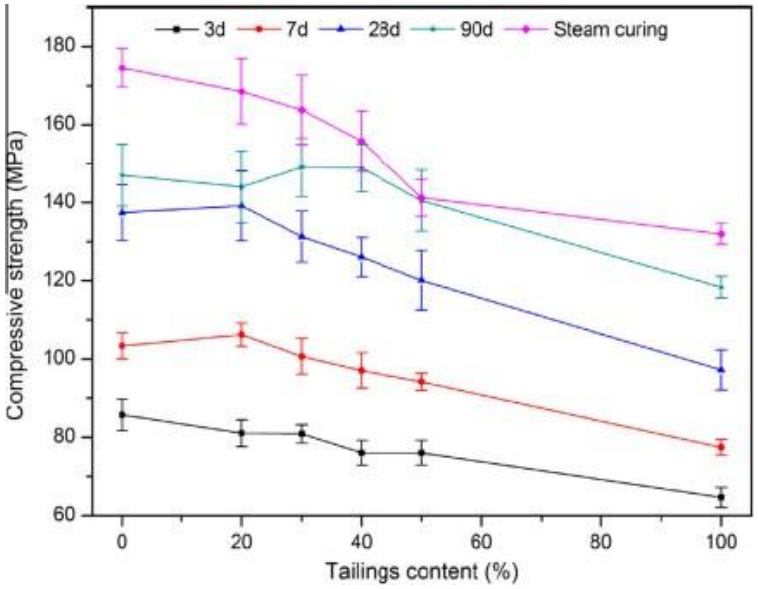


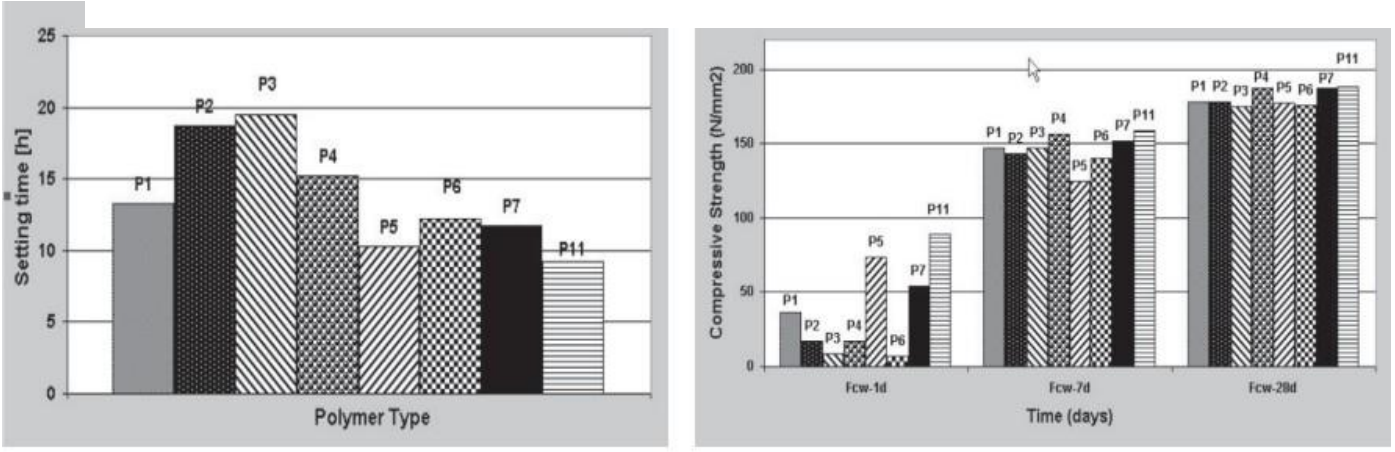
*Figure **2** Compressive strength of UHPC with different tailing contents[13]*

2.3.3 Superplasticizers (SP)

The superplasticizers are either synthesized or obtained as industrial by-products. The sulfonated melamine formaldehyde is obtained from melamine which is first converted to trimethyl melamine and then treated with formaldehyde. It is then reacted with sodium bisulfite and polymerized. The sulfonated naphthalene formaldehyde is obtained by sulfonating of naphthalene with sulfuric acid or SO3 and then reacted with formaldehyde. The acid is tben treated with sodium hydroxide. Another method of production of super-plasticizer is to use naturally occurring plant materials. For example, cashew nut shell liquid is fractionated, sulfonated and condensed with formaldehyde in the presence of additives to produce a superplasticizer[14].

The addition procedure of SP also influenced the workability of fresh UHPC Stepwise addition remarkably enhanced the dispersing effect of SP, and increased the flowability of UHPC, compared with the one time direct addition. Compatibility between SP and cementitious materials is often an issue. Schröfl et al. investigated the interaction between various superplasticizers (methacrylic acid ester-based and allylether-based PCEs) and cement as well as silica fume in UHPC. They found that methacrylate-based PC strongly interacted with cement, whereas allylether-based PCs were more effective with silica fume. The combination of the two PCs showed a significantly better dispersion than that using single type. UHPC with limestone microfiller demonstrated a good fluidity compared with those with metakaolin, pulverized nano csco3 and siliceous microfiller at the same content of SP. When cement replacement by SF was increased to from 30% to 40%, the amount of SP increased dramatically from 1.43% to 2.38% [15].

*Figure **3** Effect of different superplasticizers on fresh and harden properties of UHPC. [15].*



(a) Setting behavior (b) Compressive strength

Most work on hydration aspects on cements pertains to ASTM Type I cement. The type of cement should play an important role in determining its physicochemical properties in the presence of superplasticizers. Contrary to expectations, Ramachandran et a1.1601 found that concrete made with ASTM TypeV cement (water:cement = 0.5 and containing 0.6% SNF or SMF superplasticizer) developed lower strengths than the control. In concrete with Type I cement, the strengths did not show a decrease (Table 4). The strength data on the cement paste also showed the same effects. The conduction calorimetric curves in Fig.

difherences in strength development in these cements were explained by the lower porosities, and also very low rates of early hydration developed in Type V cements.[16]

W/C	Compressive Strength (MPa)				
	1day	3 days	7 days	28 days	90 days
Reference Concrete					
0.40	15.2	24.5	30.4	40.6	52.1
0.45	10.4	18.2	24.5	34.8	42.5
0.50	7.2	13.4	18.9	29.0	36.0
Superplasticized Concrete					
0.40	15.9	22.3	27.3	36.0	44.6
0.45	11.8	18.3	22.7	30.5	39.3
0.50	7.7	11.8	15.4	22.4	27.8

Table 4. Compressive Strength Development in Super plasticized Concrete Containing Type V Cement. .[16]

1.3.4 Fibers

Steel fiber (SF) is the most popular type of fiber used as concrete reinforcement. Initially, SFs are used to prevent/control plastic and drying shrinkage in concrete. Further research and development revealed that addition of SFs in concrete significantly increases its flexural toughness, the energy absorption capacity, ductile behaviour prior to the ultimate failure, reduced cracking, and improved durability [17]

As mentioned above, the excellent ductability and impact resistance of UHPC are attributed to the use of proper fibers. Table 5 shows the typical properties of the commonly used fibers in concrete. Steel and carbon fibers are commonly used in UHPC matrices because of their superior tensile strengths. Yang found steel fibers significantly enhanced the mechanical properties, but polypropylene and glass fibers did not improved the strengths due to their low strengths. [18]

*Table **5** Typical properties of fibers. [18]*

Typical properties of fibers.

Type	Diameter (μm)	Relative density (g cm^{-3})	Tensile strength (MPa)	Young modulus (GPa)	Elongation (%)
Asbestos	⩽0.5	2.75	500–980	84–140	0.3–0.6
Acrylic	5–17	1.18	800–950	16–23	9–11
Polyester	10–80	1.38	735–1200	6–18	11–15
Polyethylene	800–1000	0.96	200–300	5–6	3–4
Polypropylene	20–70	0.91	300–770	3.5–11	15–25
Nylon	23	1.16	900–960	4.2–5.2	18–20
PVA	1.30	1.30	600–2500	5–50	6–17
Aramid	10–12	1.44	2500–3100	60–120	2.1–4.5
Rock wool	2.7	2.7	490–770	70–119	0.6
Glass	10–16	2.74	1400–2500	70–80	2.5–3.5
Wood	25–400	1.40	50–1000	15–40	–
Carbon	7–18	1.75	1800–4000	200–480	1.2–1.6
Steel	250–1000	7.80	280–2800	200–250	0.5–4.0

According to the origin of fibres, they are classified in three categories of metallic fibers (such as

steel, carbon steel, and stainless steel), mineral fibers (such as asbestos and glass fibers), and organic fibers. Organic fibers can be further divided into natural and man-made fibers. Natural fibers can be classified into vegetable origin or sisal (such as wood fibers and leaf fibers), and animal origin (such as hair fibers and silk). Man-made fibers can also be divided into two groups as natural polymer (such as cellulose and protein fibers), and synthetic fibers (such as nylon and polypropylene). Figure 4 shows the classification of fibers based on this method (James Patrick Maina Mwangi, 1985). Table 6 shows the properties of different types of fibers can be used in the concrete industry (Johnson and Colin, 1982) [19]

Figure 4Fibers Classification (James Patrick Maina Mwangi, 1985) [19]

Fibers	*Diameter (μm)*	*Specific Gravity*	*Modulus of Elasticity (GPa)*	*Tensile Strength (GPa)*	*Elongation to Failure (%)*
Chrysotile Asbestos	*0.02-20*	*2.55*	*164*	*3.1*	*2-3*
Crocidolite Asbestos	*0.1-20*	*2.55*	*196*	*3.5*	*2-3*
E-Glass	*9-15*	*2.56*	*77*	*2-3.5*	*2-3.5*
AR-Glass	*9-15*	*2.71*	*80*	*2-2.8*	*2-3*
Fibrillated Polypropylene	*20-200*	*0.91*	*5*	*0.5*	*20*
Steel	*5-500*	*7.84*	*200*	*1-3*	*3-4*
Stainless Steel	*5-500*	*7.84*	*160*	*2.1*	*3*
Carbon Type I	*3*	*1.90*	*380*	*1.8*	*0.5*
Carbon Type II	*9*	*1.90*	*230*	*2.6*	*1.0*

Table 6 General Properties of Fibres (Johnson and Colin, 1980) [19]

2.4 Mechanical properties

The mechanical properties of concrete, which fundamentally impact its practical use in construction sites, are highly dependent on numerous factors such as the type of cementitious materials, curing conditions, size of aggregates, rate of loading, specimen shape and size, etc. In particular, ultra-high-performance fiber reinforced concrete (UHPFRC), which was developed in the mid1990s, is very sensitive to these factors due to its extremely high compressive strength (in excess of 150 MPa) and flowable characteristics with high volume fractions of steel fibers (more than 2% by volume) To achieve such a high strength material, a low water-to-binder ratio (W/B) (normally W/B ¼ 0.2) is applied with ultra-fine admixtures and heat treatment at 90 C. As a result, the mechanical properties of UHPFRC are more significantly affected by the type of cementitious materials, curing condition, and aggregate size, as compared to those of ordinary concrete. In addition, because the mechanical properties of UHPFRC subjected to tensile and flexural loadings are strongly influenced by the fiber distribution characteristics, which are influenced by the casting process , the properties are also more sensitive to the specimen shape and size than those of ordinary concrete. [20]

2.4.1 Compressive Strength

Compressive strength In order to determine the compression strength of UHPC, either cylinder or cubic specimens can be used. However, as the compression strength of UHPC obtained using cubic specimens is not a uniaxial strength, converting its value to the cylinder specimen values is necessary. This converting factor is 0.96, as can be seen in Fig 5

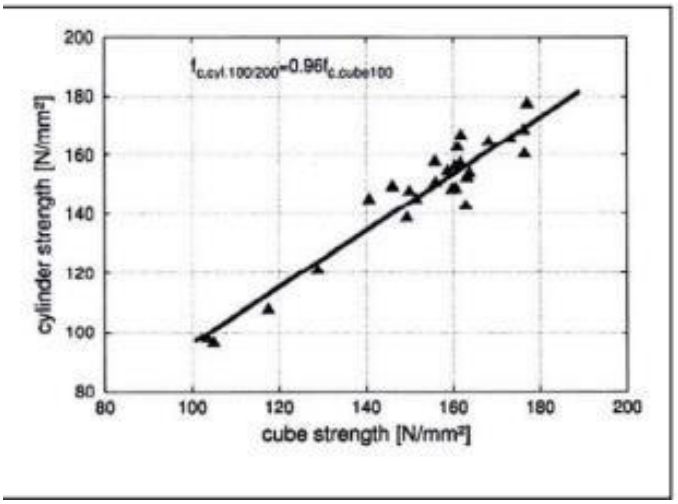


Figure 5 Relation of cylinder and cubic compressive strengths [21]

In this study UHPC was firstly designed to possess a compressive strength (fcku) after 28 days of ± 200 MPa. A variety number of UHPC casted using cylinder and cubic specimens were made, in order to investigate the actual compressive strength of UHPC used Next, it is identified that UHPC used in this study has mean compressive strength of 177.43 MPa (for UHPC contains fiber of 0 vol.-

than the design UHPC compressive strength value of 200 MPa (fckud). Specimens of UHPC contains no fiber experienced sudden explosive and brittle failures. While, UHPC specimens contains fibers had rupture failures, which marked the rupture of fibers.[21]

The triaxial compressive strength was determined simultaneously on the cylinder and cubes, Table 7 shows the compressive strength, the secant modulus of elasticity, the Poisson ratio, the modulus of rupture, and the direct tensile strength of the UHPC mixture. The values presented in the table are averages from three samples. [22]

Uniaxial compressive strength	123/148 MPa
Secant modulus of elasticity	41.1 GPa
Poisson ratio	0.17
Modulus of rupture	9.9 MPa
Direct tensile strength	6.6 MPa

Table 7 Average mechanical properties of the UHPC. [22]

The use of pozzolanic material has a significant impact on the development of UHPC's early compressive strength, mainly depending on its type, addition amount, mineral composition, particle shape and fineness, and pozzolanic activity. Table 8 shows that the control group had the lowest seven-day compressive strength (81.6 MPa). In the experimental group, the seven-day compressive strength of the UHPC mixtures was between 95.6 and 111.5 MPa. This result showed that the incorporation of pozzolanic materials can enhance the early age compressive strength of UHPC, and the percentage of improvement was between 17.2% and 36.6%. Table 9 shows the percentage of 28-day compressive strength achieved by the UHPC mixture at seven days. For the UHPC-5 mix containing large amounts of silica fume, its seven-day compressive strength was 89% of its 28-day compressive strength. For the HPC-1 mix containing large amounts of cement, its seven-day compressive strength was 91% of 28-day compressive strength.[23]

Mix No.	7-day Experimental Results			
	f_c' (MPa)	E_c (GPa)	f_r (MPa)	f_s (MPa)
HPC-1	81.6 (7.8)	32.3	6.6 (0.5)	4.4 (0.2)
UHPC-1	95.7 (11.2)	34.9	12.6 (1.4)	7.3 (0.9)
UHPC-2	107.0 (2.8)	37.2	15.1 (0.2)	9.6 (0.8)
UHPC-3	97.8 (7.9)	33.9	14.7 (0.3)	10.5 (0.3)
UHPC-4	95.6 (1.5)	35.4	12.2 (0.6)	8.9 (0.4)
UHPC-5	111.5 (3.3)	36.9	12.7 (1.4)	10.8 (0.1)

Note: f_c', compressive strength; E_c, elastic modulus; f_r, flexural strength; f_s, splitting strength; data in parentheses are standard deviation.

Table 8Results of hardened concrete properties at room temperature. [23]

Mix No.	f'_{c-7d}(MPa)	f'_{c-28d}(MPa)	f'_{c-7d}/f'_{c-28d}
HPC-1	81.6 (7.8)	90.0 (3.4)	0.91
UHPC-1	95.7 (11.2)	128.1 (5.4)	0.75
UHPC-2	107.0 (2.8)	127.0 (5.4)	0.84
UHPC-3	97.8 (7.9)	121.6 (14.9)	0.80
UHPC-4	95.6 (1.5)	123.6 (4.4)	0.77
UHPC-5	111.5 (3.3)	125.8 (6.8)	0.89

Note: f'_{c-7d}, 7-day compressive strength; f'_{c-28d}, 28-day compressive strength; data in parentheses are standard deviation.

Table 9 percentage of 28-day compressive strength

Johnston (1974), and Dixon and Mayfield (1971) found that an addition of up to 1.5% of SFs by volume increases the compressive strength from 0 to 15%. A gradual slope in the descending part of the stress-strain curves indicates the improved spalling resistance, ductility and toughness of SFRC as shown in Figure 6 (Padmarajaiah and Ramaswamy, 2002). [19]

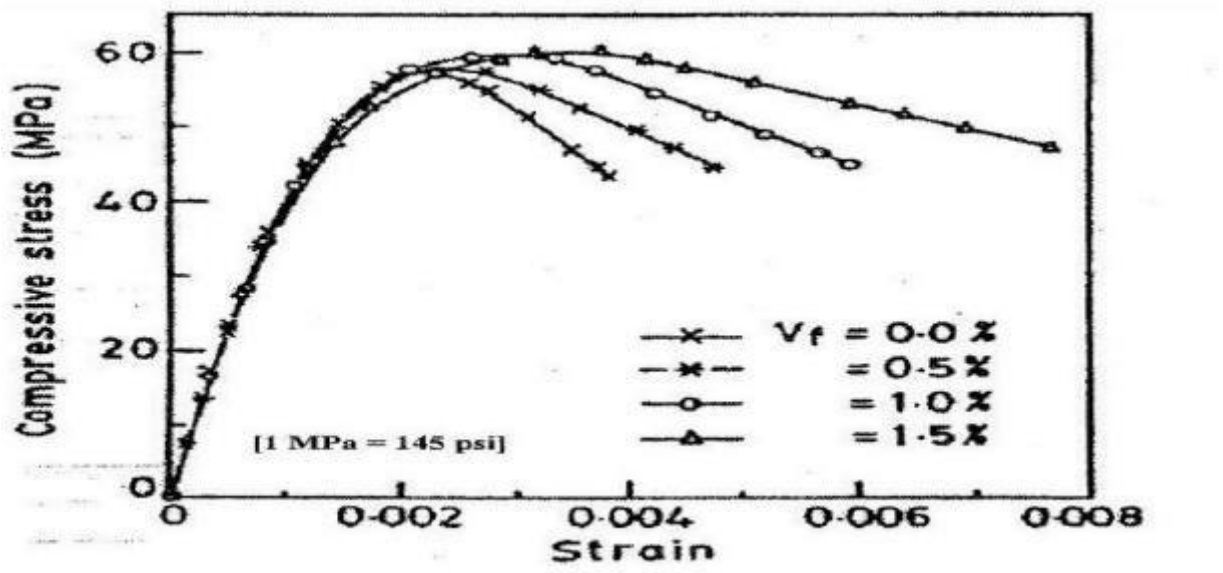


Figure 6Effects of SFs Content on Compressive Stress-Strain Curve of FRC (Padmarajaiah and Ramaswamy, 2002) [19]

Table 10 shows the compressive strength results for the various UHPC mixtures. The 7 days compressive strength and modulus of elasticity were 131 MPa (19 ksi) and 35.6 GPa (5163 ksi) respectively, for the UHPC mixture without fibers. However, after 28 days, the compressive strength and modulus of elasticity increased to 151 MPa (22 ksi) and 42.6 GPa (6179 ksi), respectively. This progression of UHPC compressive strength and modulus of elasticity continued at later age. For instance, an increase in compressive strength and modulus of elasticity by 6% and 8%, respectively, was observed at 56 days compared to that at 28 days. This was attributed to hydration reaction of pozzolanic cementitious materials at later ages [56]. An increase in compressive strength of 3%, 9% and 13% was observed for mixtures incorporating 1%, 3% and 6% of 8 mm (0.31 in) steel fibers, respectively, compared to that of the mixture without steel fibers. This increase in compressive strength due to steel fiber addition is in agreement with other studies [24]

Mixture	Steel fiber		Flow[a] (mm)	Compressive strength				Modulus of elasticity			
	Length (mm)	Dosage (%)		7 d (MPa)	14 d (MPa)	28 d (MPa)	56 d (MPa)	7 d (GPa)	14 d (GPa)	28 d (GPa)	56 d (GPa)
1	–	–	810	131	142	151	160	35.6	39.9	42.6	45.9
2	8	1	800	135	147	156	165	35.2	39.3	42.1	45.3
3		3	760	142	154	164	174	35.9	39.6	42.5	45.1
4		6	740	148	160	171	181	35.6	39.1	42.8	45.8
5	12	1	790	135	149	158	165	35.8	39.4	42.3	45.5
6		3	750	141	155	166	176	35.1	39.8	42.8	46.1
7		6	730	147	159	173	184	34.9	39.2	42.3	45.4
8	16	1	780	137	148	159	167	35.6	40.1	43.4	45.7
9		3	730	143	152	165	175	35.1	39.5	42.1	46.2
10		6	705	149	163	170	185	35.8	39.2	42.9	45.3

[a] Flow diameter; d = days; 1 mm = 0.04 in; 1 MPa = 0.145 ksi; 1 GPa = 145 ksi.

Table 10Flowability, compressive strength and modulus of elasticity results[24]

2.4.2 Splitting Strength

One of the perfectly enhanced characteristics of UHPC was splitting tensile strength. The results of tests performed on splitting tensile strength, are shown in Table 11 , and it can be noted that UHPC has a splitting tensile strength twice that of High Strength Concrete (HSC) and (3 to 5) times as for NSC, and the table shows that generally, splitting tensile strength is about (6-8) % of it's compressive strength, and it is clear that Ø100 mm (4 in.) cylinders give the results about 4% higher than Ø150mm (6 in.) cylinders for UHPC, while for Normal Strength Concrete (NSC) the value is about 10%.[11]

Mix Type	f'_c – MPa (ksi)	f_{ct} – MPa (ksi)		f_{ct}/f'_c (%)		$f_{ct}/f'^{0.5}_c$	f_{ct} (150/100) (6in/4in)
		Ø 150mm (Ø 6 in.)	Ø100mm (Ø 4 in.)	Ø150 (Ø 6)	Ø100 (Ø 4)		
NSC	38.4 (5.6)	2.68 (0.39)	2.97 (0.43)	7.0	7.7	0.48 (0.18)	0.902
HSC	69.7 (10.1)	-	5.95 (0.86)	-	8.5	0.71 (0.27)	-
UHPC-1	151.1 (21.9)	10.52 (1.53)	11.03 (1.60)	6.9	7.3	0.90 (0.34)	0.954
UHPC-2	133.2 (19.3)	8.61 (1.25)	8.91 (1.29)	6.5	6.7	0.77 (0.29)	0.966
UHPC-3	131.5 (19.1)	-	13.76 (2.00)	-	10.5	1.20 (0.46)	-

Table 11 Splitting Tensile Strength of Selected Mixes (150 days) [11]

Illustrate the splitting tensile strength test results of various UHPC mixes with and without steel fibers. From Fig. 7, it can be seen that the splitting tensile strengths of UHPC with 1%, 2% and 3% Vf are higher than UHPC without steel fibers at different ages of testing, where at age of 28 day UHPC achieved 9.05 MPa, whereas mixes UHFRC 1-C, UHFRC 2-C and UHFRC 3-C achieved 10.55, 11.75 and 12.55 respectively, with an increase by 16.57 %, 29.83 % and 38.6% compared control mix. On the other hand, by using hooked-end UHFRC 1-HE, UHFRC 2-HE and UHFRC 3-HE spiltting strength increased by 8, 21.5 and 27.6% in comparison with strength of control mix . [24]

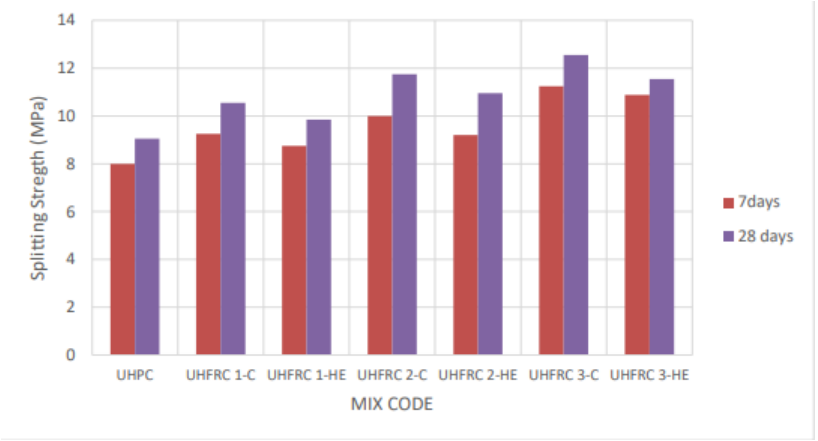


Figure 7splitting tensile strength test results of various UHPC mixes with and without steel fibers

The tensile strength of ultra high performance fiber reinforced concrete (UHPFRC) linearly increased with increased fiber volume ratio from 0% to 5% . Incorporation of 2% steel fibers by volume decreased autogenous shrinkage by 42% at 14 days of thermal treatment .

The increased amount of fibers increased the interaction of fibers with each other during mixing, caused balling and decreased the workability of the mixture, and hence the mechanical performances as well as In order to minimize the amounts of fiber and achieve desired performance, combination of two or three different fibers in UHPC matrix were applied . Park et al. found UHPC incorporated with 1.0% macro steel fibers and more than 0.5% micro steel fibers could cause tensile strain hardening behavior, as shown in Fig. 9. UHPFRC with twisted macro-fibers had the best tensile performance, with post cracking strength, strain capacity, and multiple micro-cracking behavior of 18.6 MPa, 0.64%, and 3.8 mm, respectively, whereas that with long smooth one exhibited the worst performance. Kim et al.studied the effects of combinations of micro and macro fibers on the flexural performance of UHPFRC, and obtained the following order of flexural performance: hooked B (HB) > twisted (T) > long smooth (LS) > hooked A (HA) fiber. The deflection capacity dMOR and energy absorption

capacity TMOR of UHPFRC with combinations of 1.0% micro and 1.0% macro fibers was 45.4–75.9% and 48.7–67.9% greater than those with 2.0% micro fibers. Distribution and orientation of the fibers also had considerable effect on mechanical properties of UHPFRC .The initial cracking and ultimate flexural strengths of UHPC placed parallel to the longitudinal direction were 5.5% and 61% larger than that placed transversely

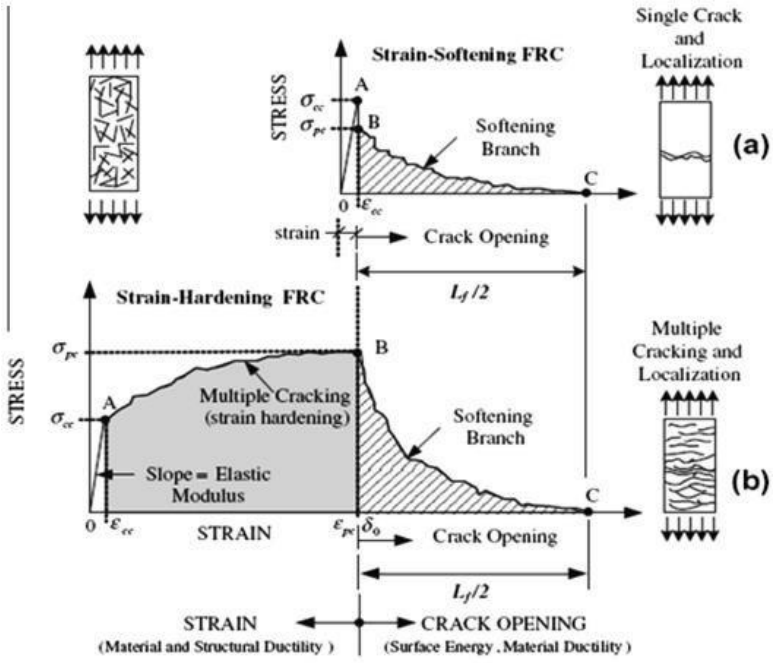


Figure 9 Typical tensile strain softening and hardening behavior of FRC

Addition of 1.5% by volume of SFs can improve the direct tensile strength of concrete up to 40% (Williamson, 1974). Those SFs aligned in the direction of the tensile stress contribute to an appreciable increase in the direct tensile strength of concrete as up to 133% for the addition of 6% by weight of smooth, straight SFs. However, for more or less randomly distributed fibers, the increase in strength is much smaller, ranging from as low as no increase in some instances to perhaps 60%, with many investigations indicating intermediate values, as shown in Figure 5. Splitting-tension test of SFRC show similar result. Thus, adding fibers merely to increase the direct tensile strength is probably not worthwhile. However, as in compression, steel fibers do lead to major increases in the post-cracking behaviour or toughness.

Depending on the content and type of the fibers, the tensile strength of UHPC is normally in the range of 7 to 15 MPa. Due to the crack-bridging effect of fibers, the tensile behavior of UHPC becomes ductile. Graybeal and Baby proposed an idealized tensile stress-strain response of UHPC which is shown in Figure 10. This response is based on direct tension tests of two UHPCs with multiple fiber contents. The behavior can be divided into four phases. Phase I is the elastic phase, when the matrix stands the loads. Phase II is the multi-cracking phase, wherein multiple tightly-spaced cracks form in the UHPC matrix. The cracks occur when the stress in the matrix exceeds the tensile strength of matrix. Phase III is the strain hardening phase. Individual cracks become wider in this phase, and no new cracks form. Lastly, Phase IV is the strain softening phase. The cracks begin to localize in this phase, and fibers begin to be pulled out from the matrix.

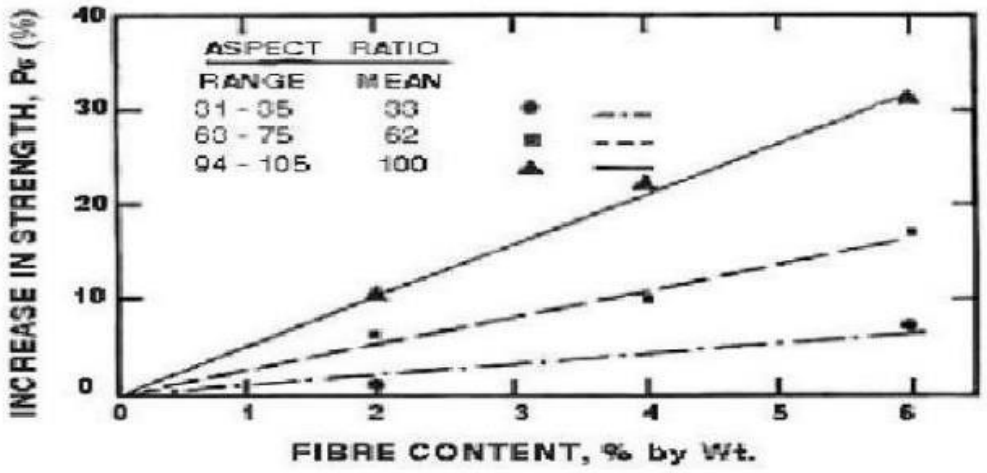


Figure 10 Idealized uniaxial tensile response of UHPC[23]

2.4.3 Flexura Strength

Eventually, the fibers bridging the highly stressed crack began to pull out. Thereafter, the failure of the beam was precipitated by the local bond failure between fibers and the UHPC matrix.

Because the flexural response of the UHPC members is influenced by the mechanical properties of UHPC, the nonlinearity of the UHPC is significant. Nonlinear material stress-strain curves obtained from the material tests of UHRC are used as input data. A sectional analysis is performed to calculate the moment-curvature relationship of the section. The cross section of the member is simulated with the so-called multi-layer method. Because of the plane section assumption, the sectional strain distribution can be defined by the strain at the top face and the strain at the bottom face. The two variables that define the linear strain distribution are the sectional curvature (ț) and the neutral axis depth (c). For a given cross section, sectional curvature and the depth of the neutral axis are first assumed. Then, the strain over the height of the section is defined and is assumed to be linearly distributed. Figure 11 show the moment-curvature relations from the test and the analytical approach for the test beam R12-2. The curvature from the test is calculated using strain gauge output. The maximum bending moment predicted by the developed numerical procedure agreed well with that found in the experimental results.

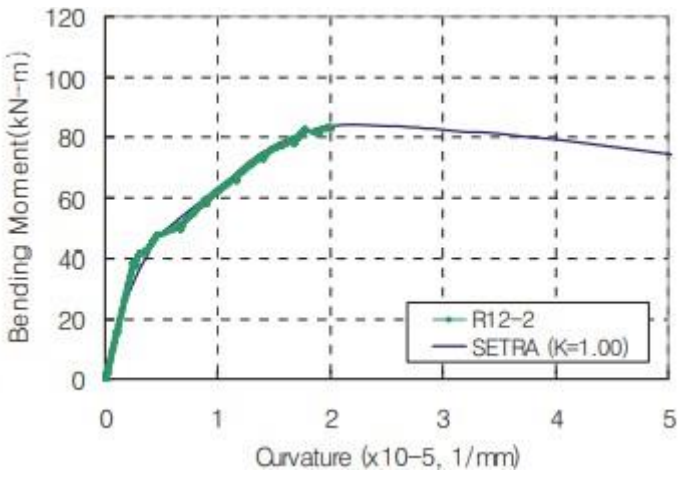


Figure 11 Moment-curvature relationship (R12-2) .[24]

Fig. 12 shows the change in compressive and ultimate flexural strengths of UHPC with different straight fiber contents at 3, 7, 28, and 90 d. It can be seen that both the compressive and ultimate flexural strengths increased gradually with fiber content and age. The compressive and flexural strengths of reference UHPC sample (A0) were 70.3 and 10.5 MPa, respectively, at 3 d. They increased to 105 and 19 MPa at 90 d. However, 3% straight steel fibers significantly increased the 90 d compressive and flexural strengths over 150 and 40 MPa. As we know, increased steel fiber content could decrease average space between fibers, which made more [25]

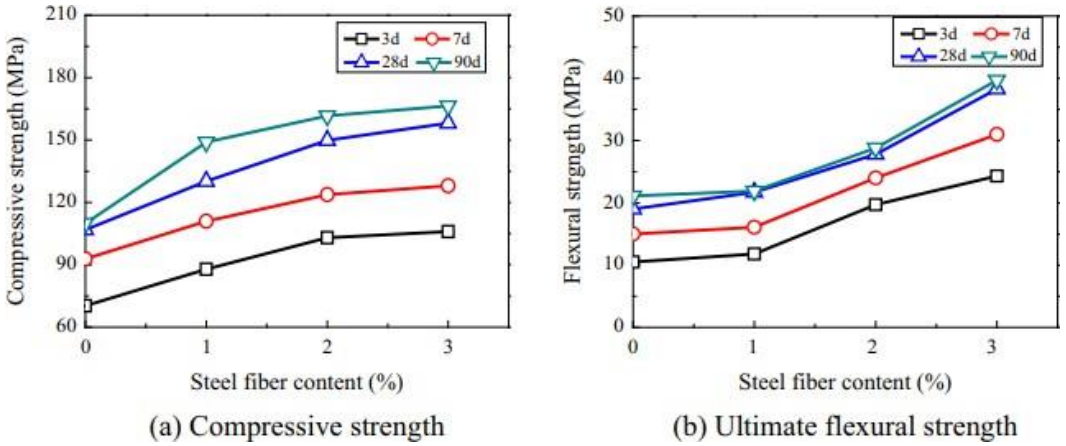


*Figure **12** Effects of fiber content on compressive and flexural strengths of UHPC with straight steel fiber[25].*

The flexural strength of UHPC-CA under loading rate of 0.2 mm/min is shown to analyze the macroscopic flexural performance of UHPC-CA under the quasi-static loading condition. As shown in Fig. 13, the flexural strength increases with the increase of curing age. It can be attributed to the

synergistic effect of the improvements of ITZ and matrix, the increasing rate of flexural strength with the curing age decreases with the curing age. The flexural strength of UHPC-CA increases from 9.3 MPa to 15.2 MPa, with 5.9 MPa, in the early 7 days, while, it increases from 15.2 MPa to 20.9 MPa, with 5.7 MPa, as the curing age increases from 7 days to 28 days. It might be due to that less C–S–H is generated in the later age of the hydration due to the limited water for hydration [26]

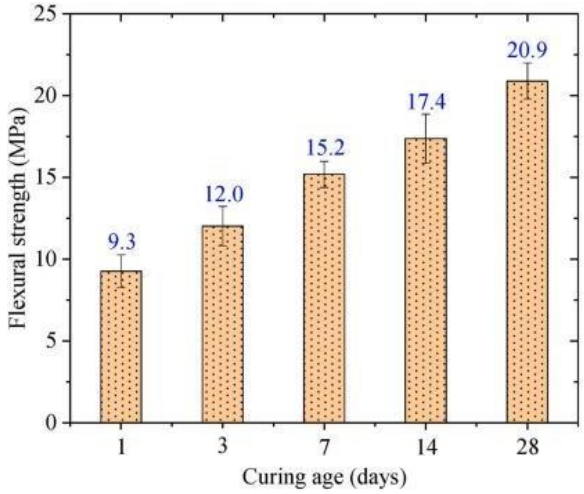


Figure 13 The quasi-static flexural strength of UHPC-CA at different curing ages[26].

It can be seen from Fig. 14 that the influence of CA type on the first flexural strengths for UHPFRC mixtures is fluctuating. The CA type had a great effect on flexural strength. Generally, when CA content was lower than 30%, UHPFRC mixtures with basalt and granite aggregates have higher first crack and flexural strengths compared with that containing limestone and steel slag. The mixtures with basalt aggregate inclusions show the highest first crack strengths at both CA contents of 15% and 30%. However, the opposite results are observed with respect to the UHPFRC mixtures with 40% CA content, where the first crack and flexural strengths of the specimens containing steel slag and limestone are slightly higher than that containing granite and basalt aggregates. The addition of CA decreases the flexural strengths, in comparison to the referenced mixture UR00, the flexural strengths of specimens were decreased by 19.9%, 9.9% and 30.7%, with the incorporation of 15%, 30% and 40% granite aggregate, Nevertheless, the effect of CA content on the first crack strength is not clear.[27]

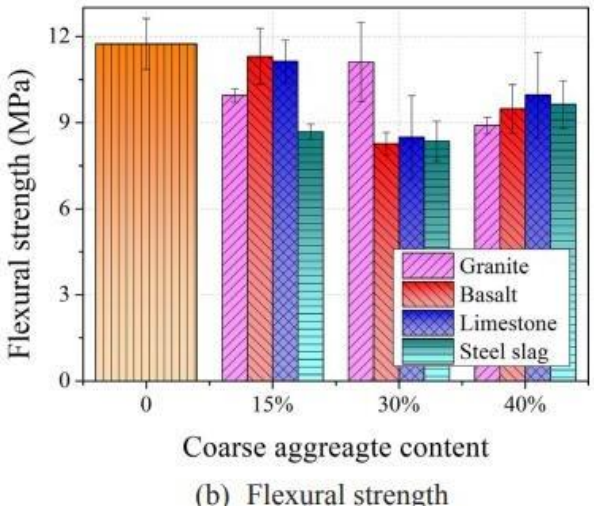


Figure 14 Effects of CA type and content on first crack and flexural strength of UHPFRC.[27].

Fig. 15 presents the flexural strength of the all mixtures with different steel fibres (0%, 1% and 2%) and Nanosilica (NS) contents (0%, 2%, 4%, 6%) at 28 days. the flexural strength increased with the higher steel fibre and NS contents. When the NS content reached 6% regardless of the percentages of the steel fibre (0%, 1% and 2%), the specimens attained the maximum flexural strength.[28]

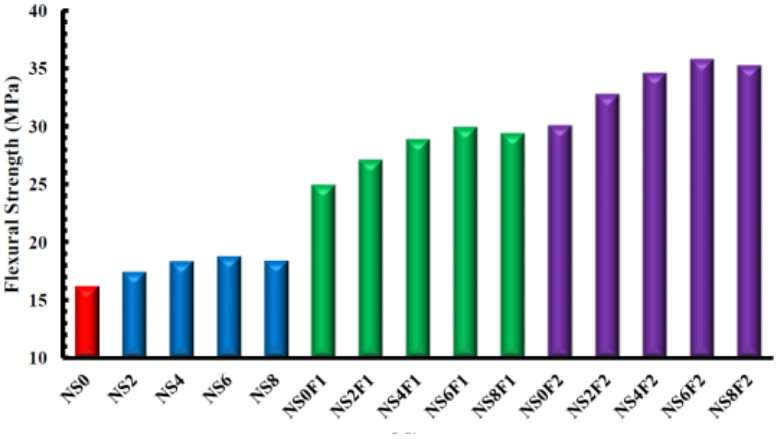


*Figure **15** Results of flexural strength of all mixes at 28 days[28]*

2.4.4 Microstructure

Fig. 16 shows the micromorphology of high elastic modulus UHPC (HEMUHPC) with different contents of alumina micro-powder. As can be seen from Fig. 16, the microstructure of different types of HEMUHPC was relatively compact, and there were no micro cracks and holes (the cracks in HEMU20 were caused artificially during sampling), which corresponded to the low porosity of HEMUHPC. Although there were no obvious cracks in the microstructure of HEMU0, its interfacial

transition zone (ITZ) was poor in compactness and uniformity. Compared with HEMU0, the ITZ of HEMU10 was more compact and uniform [28]

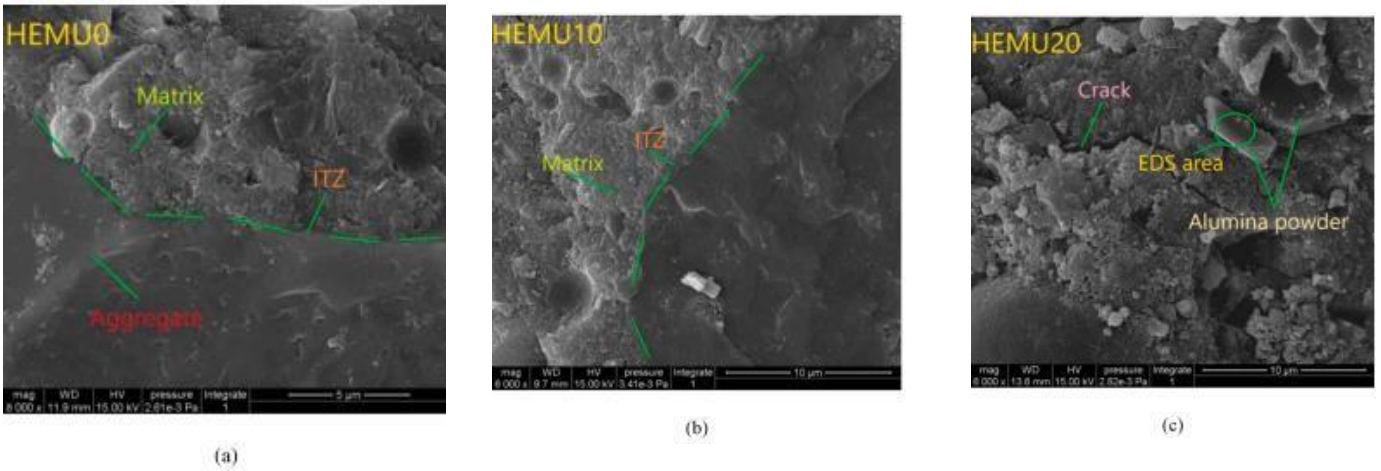


Figure 16 Micrographs of different kinds of HEMUHPSC at 28 days[28].

Fractured surfaces and polished sections were analysed in the scanning electron microscope in low vacuum mode. The interface to the quartz grains is good and the dense microstructure becomes obvious (Fig. 17a). The reaction rim of the slag particles (Fig. 17c) are dark showing a depletion of calcium and aluminium and as slight increase of the content of potassium compared to the core of the slag particle. This could be determined by EDX-analyses. The silica fume particles show a dark reaction rim, too. In case of small silica fume particles only dark spots are visible due to a reaction. Therefore, a high reaction degree of the fines is reasonable.[29]

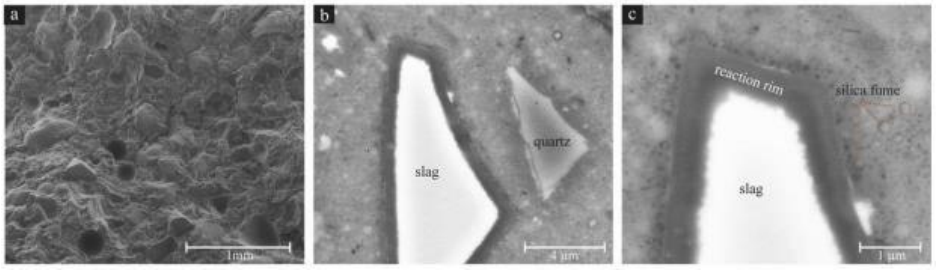
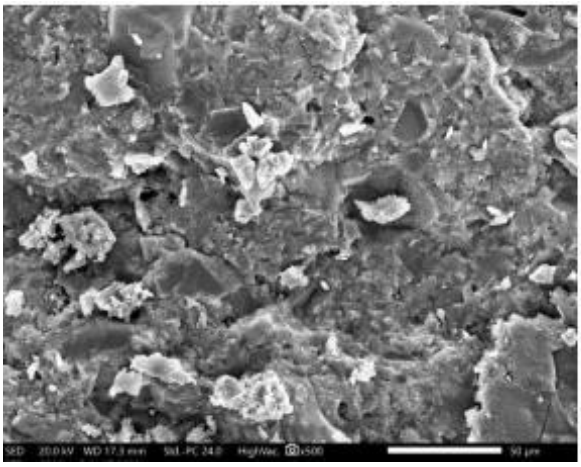
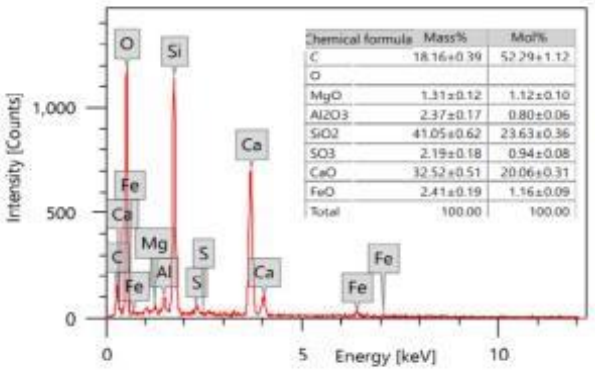


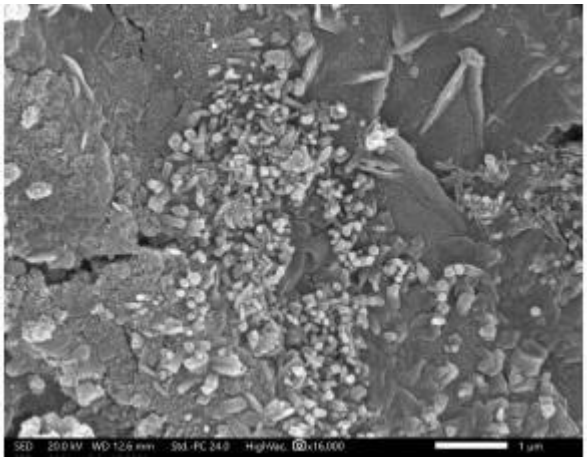
*Figure **17** Microstructure in SEM: a) fractured face (SE mode), b) thin section (BSE mode) and c) detail of b[29]*

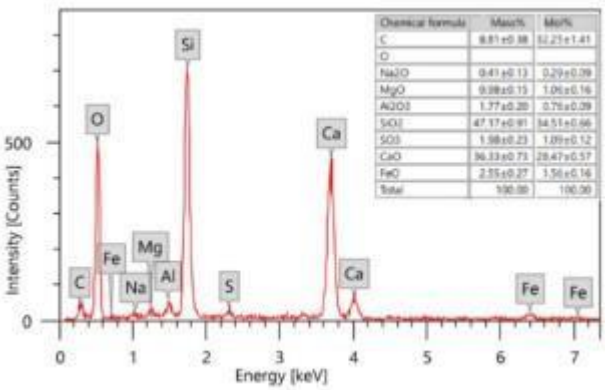
As shown in Figs. 18(a)-(c), the SEM and EDX findings for the UHPC mixtures verify the effects of adding 2% and 6% NS on the microstructures with respect to the reference concrete mixture on day 7 The texture of the hydration products of the cement paste with 2% and 6% NS particles were much more

homogeneous, dense and compact (without visible pores). Furthermore, CSH gel with fine features, which was probably generated from the pozzolanic reaction of NS with CH, was observed. The microvoids were reduced owing to the high percentage of SiO2 in the NS additive incorporated into the cement. The NS materials reacted with Ca(OH)2, which is a cement hydration product, but they compensated the decrease in CS-H. The C-S-H gel was more widely distributed in the NS2 and NS6 mixtures, and they exhibited better strength compared with the reference mixture[24]









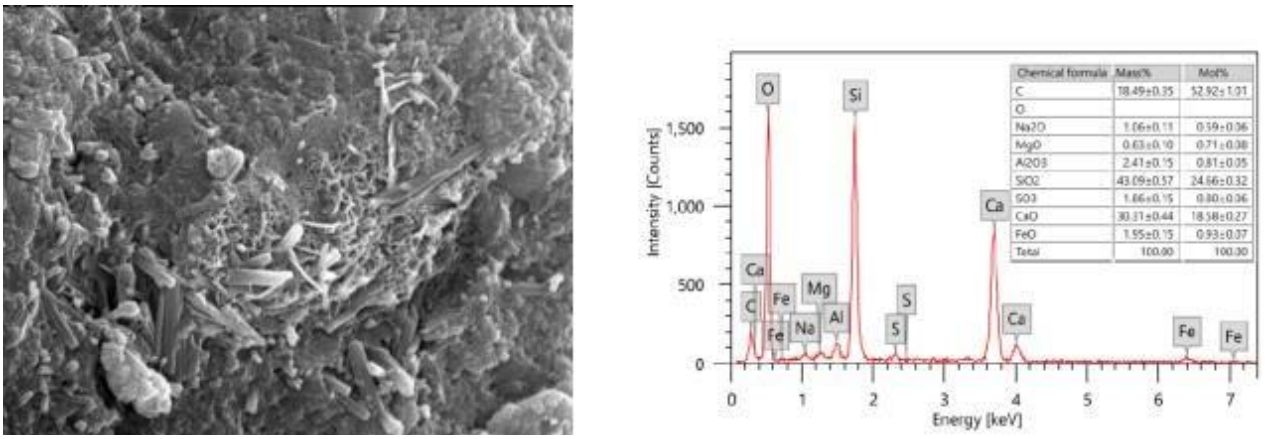


*Figure **18** SEM and EDX images: (a) reference sample, (b) UHPC with 2% NS and (c) UHPC with 6% NS[24]*

Chapter3
Experimental Work

3.1 Introduction

In recent years, the term "Ultra High Performance Concrete" (UHPC) has gained significant attention. But what does it actually refer to? Is high performance concrete truly distinct from regular concrete, or is it simply a type of concrete designed for specific applications? This paper aims to delve into the concept of high performance concrete and provide a balanced perspective on the material. Although concrete enthusiasts and experts have found effective ways to work with it, the past fifty years have not seen any groundbreaking advancements in concrete technology. While modern concrete utilizes various admixtures, air entrainment, and a wider range of cementitious materials, these changes are modest compared to the revolutionary developments in fields like telecommunications or automotive technology. However, this paper does not intend to offer a retrospective analysis, except as it relates to the emergence of high performance concrete. Over the past 15 years, new approaches have surfaced in the field, contributing to the development of high performance concrete.

The hydration of cement plays an important role in strengthening hardened concrete. The extent of hydration depends on the availability of moisture in the concrete, which requires large amounts of water. Different curing methods, such as submerging the samples in water (in a laboratory), covering the concrete panel using wet gunny (outdoor condition), and spraying water on the concrete panel, are commonly used. Zeyad (2019) studied the impact of different curing methods and reported the compressive strength of high- strength concrete of more than 60 MPa after 28 days.

In this study, we selected (Nano Caco3) to investigate its effect on ultra-high- performance concrete (UHPC). Previous research has explored the addition of Nano Caco3 in conventional concrete, providing insights into the optimal dosage. Therefore, the ideal proportion of Nano Caco3 to be used in UHPC can be determined based on findings from the literature.

3.2 Experimental Program

The experimental work in this thesis was organized into two main phases: Phase II was designed to achieve the following objectives:

1. Producing UHPC by incorporating slag, using the optimal mix proportions identified in Phase I.

2. Evaluating the fresh characteristics, mechanical properties, and microstructure of UHPC mixes to assess the impact of substituting sand with slag on UHPC properties, based on the optimal mix from Phase I.

3.3 Materials Used

A primary goal of this research was to select cost-effective materials and simple casting methods for high-performance concrete. This study focused on using materials readily available in Egypt to ensure feasibility and affordability.

3.3.1 Portland Cement

Ordinary Portland Cement (OPC) was used, sourced from Beni Suef Cement Company (BSCC) in Beni Suef, Egypt, and conforms to ASTM C150/C150M standards. Cement is a key component in concrete, providing the binding strength essential for durability. The chosen cement has a grade strength of
52.5 N/mm². Tables (3-1), (3-2), and (3-3) present detailed information on its composition, as well as its physical and mechanical properties.

Chapter3: ***Experimental Work***

According to the European Guidelines for Self-Compacting Concrete (SCC), issued in May 2005, any cement type meeting EN 197 standards is suitable, with the selection based on specific concrete requirements such as strength and durability. When the C_3A content exceeds 10%, workability challenges may arise. Typical cement content for SCC ranges from 350 to 450 kg/m³, with amounts above 500 kg/m³ potentially causing shrinkage issues. Conversely, cement contents below 350 kg/m³ may be viable if additional fine fillers like fly ash or pozzolan are incorporated【SCCEPG, 2005】.

Table 3-1 The Chemical Components of the Cement

Chemical Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	L.O.I.	Free Lime
Average (%)	21.1	5.5	3.20	63.5	0.71	2.4	2.3	1.14

Table 3-2 The Mineral Compositions of the Cement

Chemical Composition	C_3S	C_2S	C_3A	C_4AF
Average (%)	51.87	17.34	8.78	10.41

Table 3-3 Physical and Mechanical Properties of the Cement

Property	**Value**	**Limits**
1- Specific gravity	3.15	--
2- Setting time		
Initial (min.)	149	Not less than 45 min
Final (hrs.)	3:16 (196min.)	Not more than 10 hrs
3- Blaine Fineness	3179 cm^2/gm	Not less than 2500cm^2/gm
4- Expansion (mm)	0.58	Not more than 10 mm
5- Compressive strength		
2 days	317 Kg/cm^2	$\geq$ 300 Kg/cm^2
28 days	317 Kg/cm^2	$\geq$ 525 Kg/cm^2

3.3.2 Sand

Naturally occurring quartz sand was used as the fine aggregate in the concrete mix throughout this experimental program. The physical properties of the sand employed are detailed in Table 3-4. The grading of the fine aggregate is provided in Table 3-5.

Table 3-4 Sand's physical characteristics

Property	Value
Specific gravity (t/m^3)	2.75
Volumetric weight (t/m^3)	1.70
Voids ratio (%)	40.3%
Absorption (%)	1%
Clay and Fine Materials%	1%

Table 3-5 Grading of the used sand

Sieve size (mm)	Grading % Passing	Specification limits (ASTM C33) % passing
4.75	100	95-100
2.36	97.4	80-100
1.18	83.9	50-85
0.61	54.08	25-60
0.31	22.18	5-30
0.16	1.7	0-10

3.3.3 Silica Fume

Silica fume (SF) is a noncombustible, amorphous silica (SiO_2) byproduct from the production of silicon and silicon alloys. The silica fume used in this study was sourced from the Egyptian Ferro Alloys Corporation (EFACO). The chemical composition of the silica fume is provided in Table 3-6. The utilized silica fume had a density of 2210 kg/m^3 and a fineness of 23.52 m^2/g. It met the primary requirements outlined in ASTM C 1240.

Table 3-6 The Used Silica Fume's Chemical Components Analysis

Chemical Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	L.O.I.
Average (%)	97	0.1	1	0.2	0.15	0.1	0.2	2.2

3.3.4 Water

In accordance with the Egyptian Code of Practice, clean, potable, fresh, and impurity-free tap water was used for mixing and curing the concrete samples in this study.

3.3.5 Super-plasticizer

Sika Viscocrete 3425, a polycarboxylate-based superplasticizer (SP), was used in this study. It is supplied by Sika Egypt, a construction chemicals company. This superplasticizer is classified as a Type 3 (third group) SP for concrete and mortar, meeting the standards of ASTM C494, Types G and F (ASTM C494, 2003). The main physical properties of the used superplasticizer are clearly presented in Table 3-7.

Table 3-7 Physical properties of the used super-plasticizer

Property	Value
Appearance / colour	Clear liquid
Density Kg/lit (ASTM C494)	1.08
pH value	4.0
Solid Content (by weight)	40%

High Range Water Reducers (HRWRs) are used to provide fluidity in concrete mixtures, as per ACI guidelines. Viscosity Modifying Admixtures (VMAs) enhance the viscosity, or cohesiveness, of the mixture, improving its stability. In certain cases, HRWRs can serve a dual purpose by not only improving fluidity but also maintaining the viscosity required for Ultra-High Performance Concrete (UHPC). To further enhance stability, the admixture is used in combination with additional proportioning strategies, such as optimizing the combined gradation of aggregates, increasing the fine aggregate content, or adjusting the powder content, or both.

According to the European UHPC Guidelines, the most essential admixtures for Ultra-High Performance Concrete (UHPC) are high range water reducers (superplasticizers), which are used to achieve a water reduction of more than 20%. When the powder content is limited, incorporating a Viscosity Modifying Admixture (VMA) provides additional options to control segregation. This combination of superplasticizers and VMAs helps ensure high homogeneity in the mix while reducing the potential for segregation.

3.3.7 Steel Fiber

Steel fiber lengths (lf = 30 mm) with hooked-end were used, which has a diameter of 0.75 mm

Improve bonding:

Steel fibers bond well with concrete paste, resulting in even load distribution. Increased durability:

It resists environmental factors such as corrosion and humidity better compared to regular concrete.

Ease of mixing with concrete:

They can be easily added during the mixing process without significantly affecting the work.

Thickness saving:

Thanks to its high strength, the thickness of concrete slabs or other components can be reduced without sacrificing rigidity.

3.3.8 Nano $CaCO_3$

1. Increased Mechanical Strength:

- Nano $CaCO_3$ particles fill the micro-pores within the cement paste, improving concrete density and reducing porosity.
- This leads to a notable increase in compressive and tensile strength, making the concrete more durable under high loads.

2. Accelerated Hydration Process:

- Nano $CaCO_3$ particles help speed up the hydration reaction, resulting in early-age strength gain in concrete.
- This is particularly useful for projects that require short setting times and fast completion.

3. Enhanced Corrosion Resistance:

- Due to reduced porosity and increased concrete density, the concrete becomes more resistant to the penetration of harmful substances like chlorides and sulfates.

- This improves the concrete's durability, extending its service life and making it more resistant to harsh environmental factors.

4. Reduced Cracking and Shrinkage:

- Nano $CaCO_3$ helps in minimizing shrinkage-induced cracking during the drying phase of concrete.
- Its ability to enhance particle distribution within the concrete reduces the likelihood of micro-cracks.

5. Improved Workability:

- Despite enhancing concrete density, adding Nano $CaCO_3$ contributes to improved workability, making the concrete easier to pour and spread without needing a high water content.

6. Increased Carbonation Resistance:

- Nano $CaCO_3$ improves concrete's resistance to carbonation, a process that can corrode embedded steel reinforcement over time.
- This makes the concrete more resistant to long-term degradation.

7. Enhanced Bonding with Other Materials:

- Nano $CaCO_3$ particles improve the bond between cement and other aggregates, resulting in a stronger, more cohesive concrete mixture.

Applications of Nano $CaCO_3$ in Concrete:

Nano Calcium Carbonate is used in high-performance concrete for applications requiring enhanced properties, such as skyscrapers, bridges, tunnels, and marine structures. It offers better corrosion resistance, increased strength, and improved sustainability.

Due to its unique properties, Nano $CaCO_3$ is a valuable additive that enhances concrete's performance, making it an ideal choice for projects requiring high strength and durability.

3.4 Mixtures Proportions and designation

The mixing ratios were calculated using recommendations and specifications from several distinct methodologies described in the literature. Table 3.9 summarises the UHPC mixture proportions employed in this test programme. A reference mix was prepared (C0) according to the EFNARC 2005 requirements

Table 3-G Mixtures Proportions in (Kg/m3)

Mix	C	Cemat	Water	Sand	Steel fiber	Sp	Qz	Sf	Caco3
Mix 1	0%	726.47	191.2	798.5	221.76	23.52	145.29	221.7	0
Mix 2	1%	726.47	191.2	798.5	221.76	23.52	145.29	221.7	7.35

Mix 3	2%	726.47	191.2	798.5	221.76	23.52	145.29	221.7	14.7
Mix 4	3%	58.8	23.2	94.32	25.92	20.6	17.28	26.17	2.53

3.5 Samples Mixing

An electric mixer with a capacity of 135 liters was used for mixing the concrete. To ensure accurate batching of the concrete constituents and minimize variations in mix quality and test results, each material was weighed precisely using a sensitive balance with an accuracy of up to 10 grams. Mixing was carried out using a small rotary drum mixer with high efficiency, as shown in Figure 3-3.

For specimen preparation, the procedure followed the guidelines set by EFNARC (2005), with 4 minutes allowed for mixing to fully activate the superplasticizer. Although this duration is longer than traditional concrete mixing, it ensures complete activation of the superplasticizer. To obtain UHPC, the following six specific mixing steps were carried out in sequential order:

1. Materials were mixed separately at high speed for 1 to 3 minutes, either with water and superplasticizer or with water alone.

2. The next step involved 1 minute of dry mixing of cement and silica fume.

3. Afterward, mixing continued for 4 minutes with the addition of half of the calculated mixing water. For self-curing mixtures, Nano Caco3 was incorporated into this half portion of the water.

4. The samples were then cast and cured in a controlled room environment at 20°C and at least 95% relative humidity for 24 hours.



Figure 3-3 The Tilting Mixer

3.6 Casting of Samples

In this research, the specimens were divided into two main groups. The first group consisted of specimens cast to investigate the primary mechanical properties of various High Performance Concrete (HPC) mixes, specifically those incorporating self-curing materials. The mechanical properties examined for this group included compressive strength, flexural strength, and indirect tensile strength.

The cubic specimens were cast in steel molds, while the cylindrical molds were made of polyethylene, and the prism molds were constructed from wood. Figure 3-4 illustrates the molds used in the study. Special attention was given to the finishing of the faces of the specimens, particularly the cylindrical ones, which were carefully struck off with a trowel.

For the compressive strength test, the specimens were cast in steel cube molds, as shown in Figure 3-4(a). The cubes had a side length of 15 cm and a cross-sectional area of 225 cm^2, which was suitable for the maximum allowable load of the 200-ton compression testing machine in the laboratory. Three cubes were cast for each mix to be tested at the ages of 7 and 28 days.



(a) Cube Moulds



(b) Cylinder Moulds



(c) Prism Moulds

Figure 3-4 The Used Moulds

The tensile strength test specimens were cylindrical, as shown in Figure 3-4(b). These specimens were cast in split polyethylene tubes with a 10 cm diameter and 20 cm height, secured with a steel strap 4 cm high to prevent any movement of the split sides during the filling process. Nine cylinders were cast for each mix, with three cylinders tested at 28 days to determine the tensile strength.

For the flexural strength test, samples were cast in steel prism molds with dimensions of 10x10x50 cm, as shown in Figure 3-4(c). Six prisms were cast for each mix to be tested at 7 and 28 days. The interior surfaces of all molds were coated with a thin layer of oil to prevent the concrete from sticking to the molds.

3.7 Curing of the Concrete Specimens

After demolding, the concrete specimens were subjected to curing immediately. The specimens intended for conventional curing were placed in curing tanks in the Civil Engineering Laboratory at Nahda University. Other specimens, designated for external self-curing, were placed outside the water curing tanks for the application of the curing agent PEG 400.

The specimens reserved for conventional water curing were kept submerged in water until the testing days, which were set at 7 and 28 days. Figure 5 illustrates the curing process.

3.8 Testing Procedures

All experiments in this study were conducted at the Construction Materials Laboratory, Civil Engineering Department, Faculty of Engineering, Nahda University. The tests in this research were divided into four main groups:

1. The first group focused on investigating the fresh properties of UHPC and self-curing concrete.

2. The second group involved testing the mechanical properties of UHPC and self-curing concrete.

3. The third group was dedicated to exploring the microstructure of UHPC and self-curing concrete.

Figure 3-6 illustrates the testing procedure for these groups.









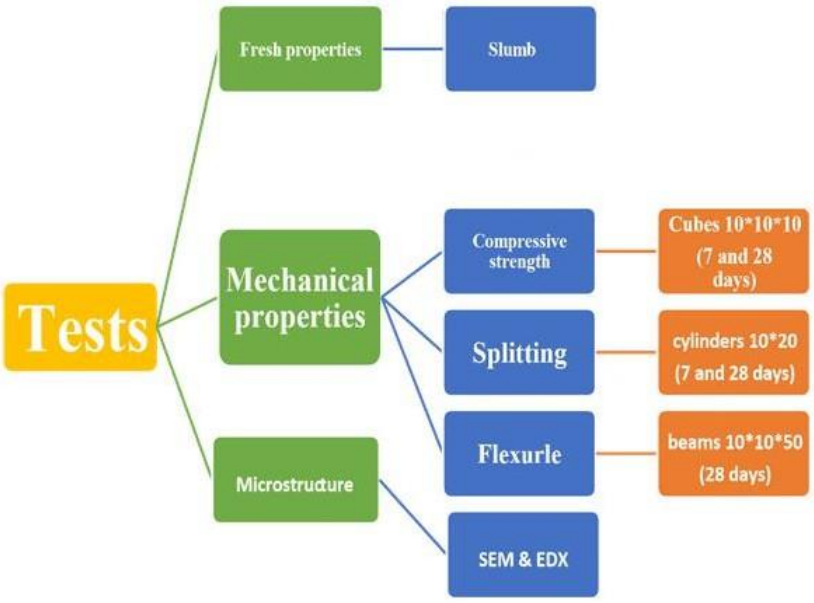


Figure 3-6 Testing Procedures

The following properties of High Performance Concretes (UHPC) were studied:

1. **Slump Test**: To assess the workability and fluidity of the fresh concrete mix.

2. **Compressive Strength**: Measured using 10 x 10 x 10 cm cubes to determine the material's ability to withstand axial loading.

3. **Indirect Tensile Strength**: Evaluated using 10 x 20 cm cylindrical specimens to assess the concrete's resistance to tensile forces.

4. **Flexural Strength**: Tested using beams of 10 x 10 x 50 cm dimensions to determine the concrete's ability to resist bending.

5. **Scanning Electron Microscope (SEM)**: Used to analyze the microstructure of the concrete samples for a detailed understanding of the material at a microscopic level.

Fresh Concrete Testing

3.8.1.1 Slump Test

The slump test is conducted using a metal mold in the shape of a conical frustum, known as a slump cone. This cone is open at both ends and has attached handles. The typical dimensions of the cone are an internal diameter of 100 mm at the top, 200 mm at the bottom, and a height of 300 mm. The cone is placed on a firm, non-absorbent surface.

The test procedure involves filling the cone with fresh concrete in three layers. Each layer is tamped 25 times using a 600 mm long bullet-nosed metal rod with a diameter of 16 mm. After tamping the third layer, the surface of the concrete is struck off flush with the top of the mold. The cone is then carefully lifted vertically upwards, ensuring that the concrete cone is not disturbed. The slump is measured by determining the difference in height between the top of the cone and the highest point of the settled concrete.



Figure 3-7 The slamp

3.8.2 Hardened Concrete Test Methods

3.8.2.1 Compression Test

A compressive strength test was carried out on UHPC (100 x 100 x 100 mm) cube specimens by a compressive testing machine (capacity = 3000 KN) at the ages of 7, 28 days due to ASTM C39 [44], see Figure 3-8.

The compressive strength was calculated by:

$\sigma c = Pc / Ac$

Where σc is the compressive strength in kg/cm2,

Ac is the average perpendicular cross-section area = $10 \times 10 = 100\ cm^2$, And PC is the maximum compressive load in kg.



3.8.2.2 Splitting Tension Test

The splitting tension test was performed on concrete cylinders of 10 cm diameter and 20 cm length for 28 days as stated by ASTM C 494/C495M [45], see figure 3-9. The splitting tensile strength was calculated by:

$$\dot{O}T = 2P/\pi DL$$

Where:

$\dot{O}T$ is the splitting tensile strength in kg/cm^2,

P = maximum applied load indicated by the testing machine in kg,

L = length in cm, D = average diameter of the cylinder at the fracture in cm.



Figure 3-9 Splitting tension test and The Crushed Specimens

3.8.2.3 Flexural Test

A standard flexural (bending) test was conducted on concrete beam specimens with a square cross-section of 10 cm and a total length of 50 cm, following ASTM C1609/C1609 M. The beams were tested under a central load with a clear span of 40 cm between supports, as illustrated in Figure 3-10. Load–deflection curves for the tested specimens were recorded from the testing machine's chart recorder, as well as from a dial gauge placed at the center of the specimen's bottom face.

Prism Flexure Strength= 3 PL/2bd2 Where:

Prism flexure strength calculated in kg/cm2

P = maximum applied load indicated by the testing machine in kg, L = span length in cm (50cm in this research), b = average width of specimen at the fracture in cm. d = average depth of specimen at the fracture in cm

The flexural (bending) strength was calculated using the three-point loading formula:



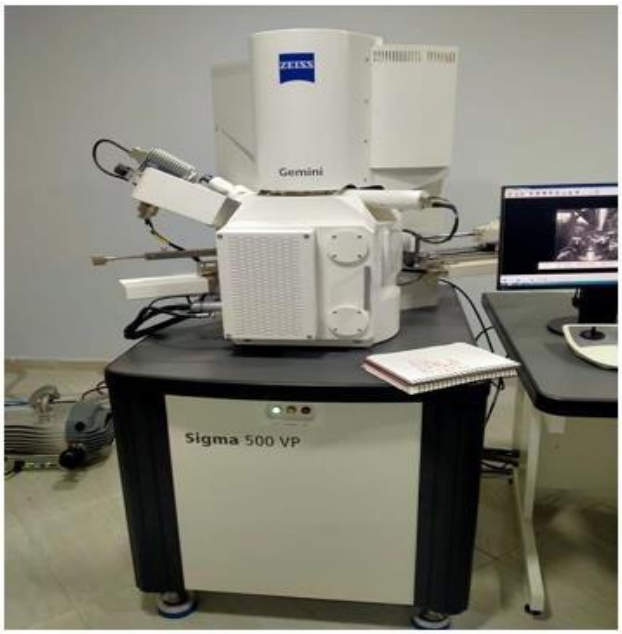
3.8.3 Microstructural Analysis

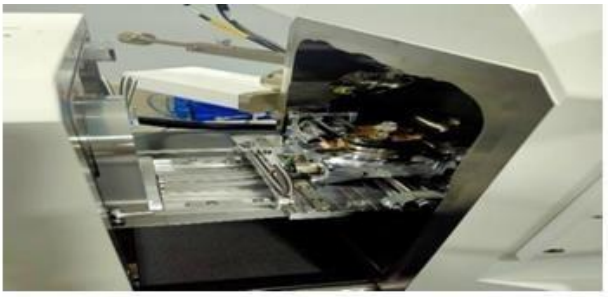
3.8.3.1 Scanning Electron Microscope (SEM)

A Carl Zeiss Sigma 500vp SEM (Scanning Electron Microscope) and Energy Dispersive X-ray (EDX) analysis were employed for microstructural observation. Small concrete fragments,

measuring 10 x 10 x 10 mm, were

extracted from the center of the concrete cubes for SEM and EDX analysis. These techniques were used to examine the detailed microstructure of the concrete and analyze its elemental composition.







Chapter 4

ANALYSIS OF THE TEST RESULTS

Introduction

In this study, the effects of nano-calcium carbonate (CaCO3) addition on the properties of ultra-high-performance concrete were investigated. The nano-CaCO3 was added at rates of 0, 1, 2 and 3% as addition volume. The results of a workability test, as well as the compressive strength, tensile strength, and flexural strength, are analysed. The microstructure of UHPC mixtures was studied using SEM and energy-dispersive X-ray (EDX). The corrosion resistance of HSS implanted in UHPC specimens cured in 3.5 percent NaCl solution is compared to the reference mix without nanoparticles for hardened UHPC specimens including nanoparticles.

The effect of Nano $caco_3$ on fresh properties of UHPC

Figure 4-1 shows changes in the slump of UHPC mixtures incorporating different addition rates of nano-CaCO3. Flowability increased initially up to a nano-CaCO3 addition rate of 1% and then decreased thereafter with higher amounts of nano-CaCO3. For instance, increasing the addition rate of nano-CaCO3 from 0 to 2% resulted in about 46% enhancement in the flow index, while increasing the addition this rate from 2 to 3% resulted in a 15% reduction in the flow index. Nano-CaCO3 is characterised by very fine particles and, consequently, very high surface area (around 40 m^2/g). Hence, nano-CaCO3 can produce a lubricating effect between cement grains, leading to higher flowability (Elkhadiri et al., 2002; Esping, 2008). However, this high surface area, when adding more than 2% nano-CaCO3, will eventually increase the water demand, leading to a higher yield stress and viscosity, and, consequently, lower flowabilty (Benachour et al., 2008; Esping, 2008). The interaction between the two mechanisms can explain the results in Figure 4-1.

Table 0-1 Results of Slump Test for UHPC- Concrete Mixtures

Code	Slump (mm)
NUHPC0	65
NUHPC1	80
NUHPC2	95
NUHPC3	55

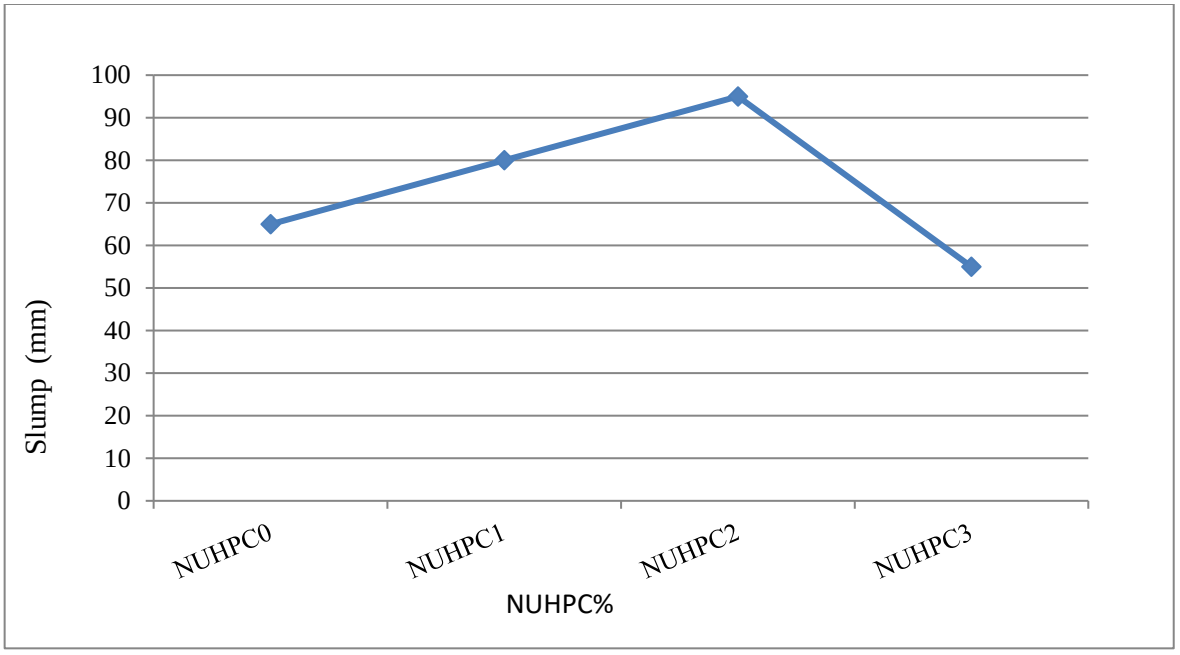


Figure 0-1Effect of Using Nano caco₃ on slump of UHPC

The effect of Nano caco3 on mechanical properties of UHPC

1.3.1. compressive strength

All mixtures incorporating nano-CaCO3 were consistent in producing significantly higher 7&28 days compressive strengths compared with that of the control mixture cured as shown in Figures 4-2 and 4-3. In addition, the achieved increase in compressive strength was directly proportional to the added amount of nano-$CaCO_3$. This strength gain accelerating effect can be attributed to the nucleation of hydration products and the nano-filler effects induced by the incorporation of nano-$CaCO_3$. Nano-$CaCO_3$ is known to act as nucleation sites on which hydration products form (Kadri and Duval, 2002). The well-crystalline nano-$CaCO_3$ particles act as seeds for the nucleation of calcium silicate hydrates (CSH), thereby accelerating the formation of the major strength-providing reaction product of cement hydration. However, at that low level of w/c, it is quite possible that not all of the nano-CaCO3 reacts chemically, leaving the remainder to act as a nano-filler. Therefore, in the meso-porous environment of concrete, the remaining nanoparticles can act as fillers, thus producing denser structure, which will further increase the compressive strength (Li et al., 2004; Matschei et al., 2007).

Table 0-2 Compressive Strength Results

Code	7-days Compressive str (Mpa)	28-days Compressive str (Mpa)
NUHPC0	61.34	100.1
NUHPC1	83.26	111.6
NUHPC2	74.69	105.6

NUHPC3	65.62	100.3

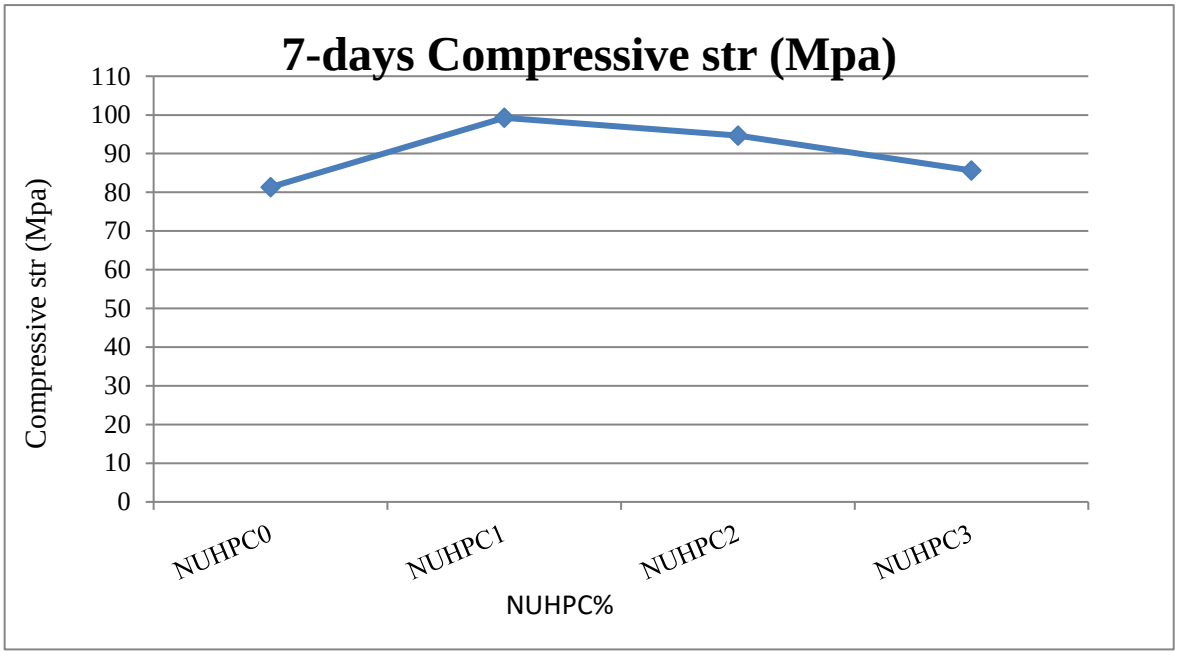


Figure 0-2 Effect of Using Nano caco3 on 7-days compressive strength of UHPC

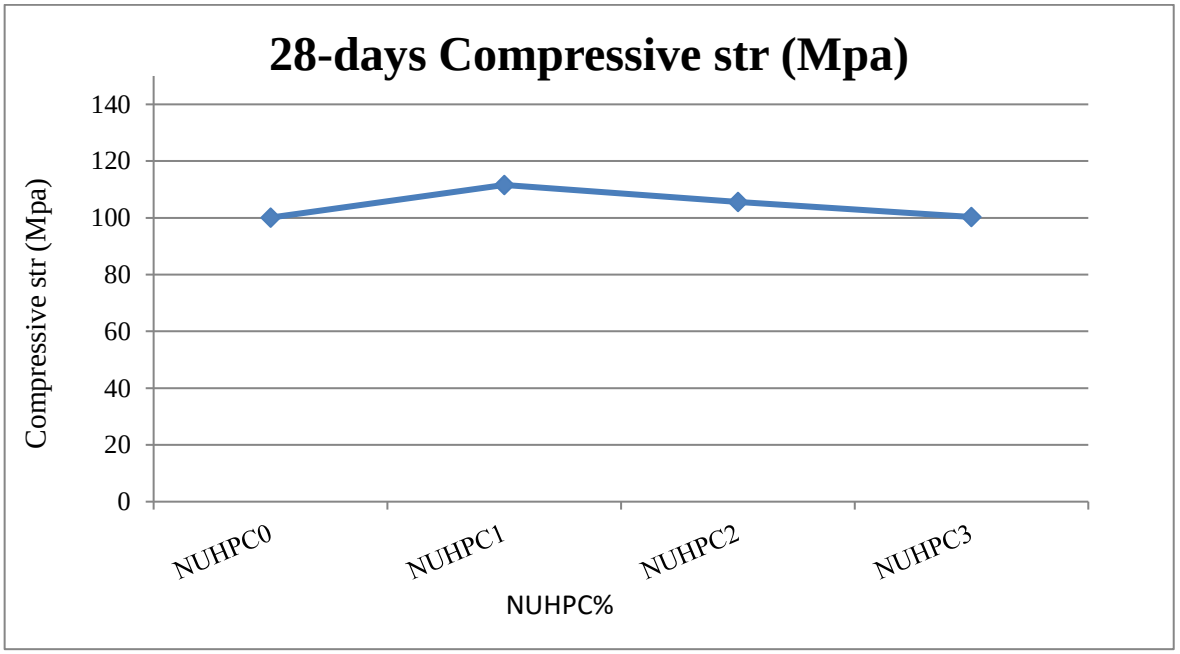


Figure 0-3 Effect of Using Nano caco3 on 28-days compressive strength of UHPC

1.3.2. splitting tensile strength

The research found that incorporating nano-CaCO3 into concrete mixtures significantly increased the 28-day splitting tensile strength compared to the control mixture. The increase in strength was directly proportional to the amount of nano-CaCO3 added. This enhancement in tensile strength is attributed to two main effects: (1) nano-CaCO3 acting as nucleation sites for the formation of calcium silicate hydrates (CSH), which accelerates the hydration process and strengthens the material, and (2) the remaining nano-CaCO3 particles filling the meso-pores in the concrete, leading to a denser structure. These combined

effects resulted in higher tensile strength due to the accelerated hydration and the improved microstructure as shown in figure 4-4.

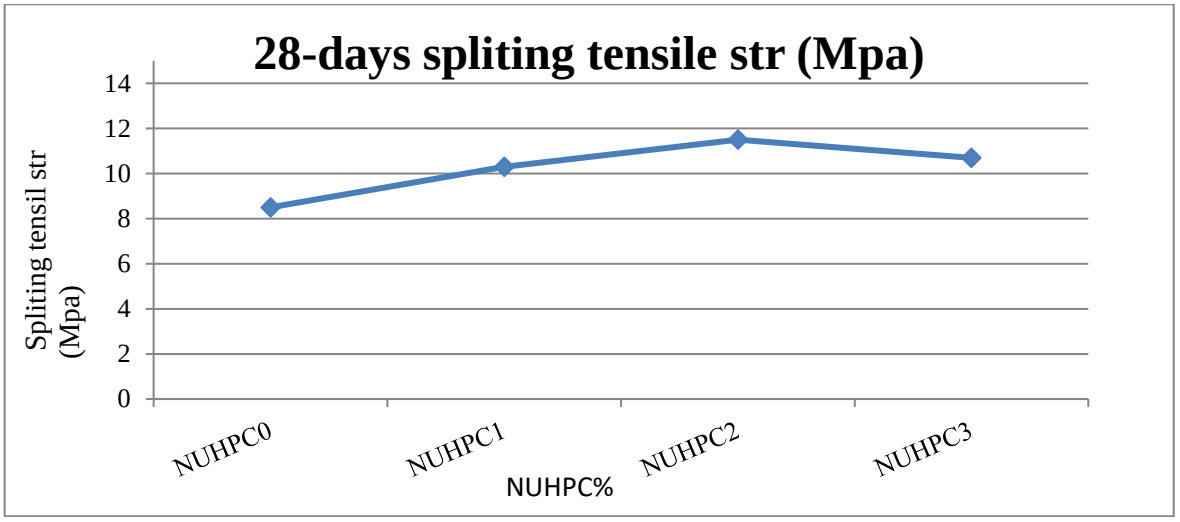


Figure 0-4 Effect of Using Nano caco3 on 28-days splitting tensile strength of UHPC

1.3.3. Flexural strength

Figure 4-5 shows the effect of using Nano caco3on the flexural strength of the tested UHPC mixes. According to the test results shown in the table, it is noticed that the flexural strength of UHPC concrete produced by using Nano caco3 get increased up to 3% of Nano caco3.

It could be found that using Nano caco3 with the percentages of (1, 2, 3) % the flexural strength increased by (20%, 28%, 10%) respectively at the age of 28 days.

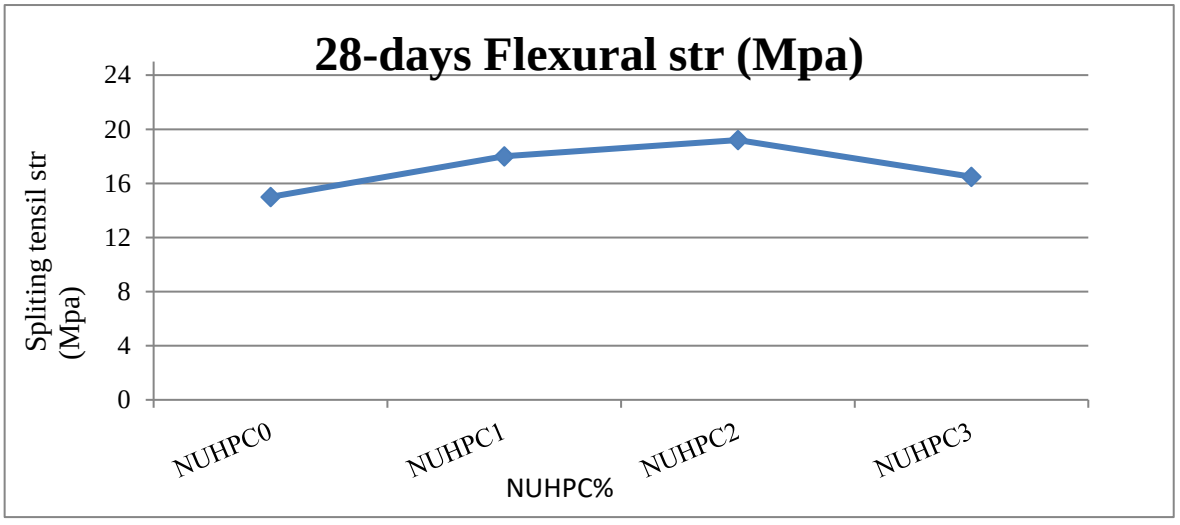


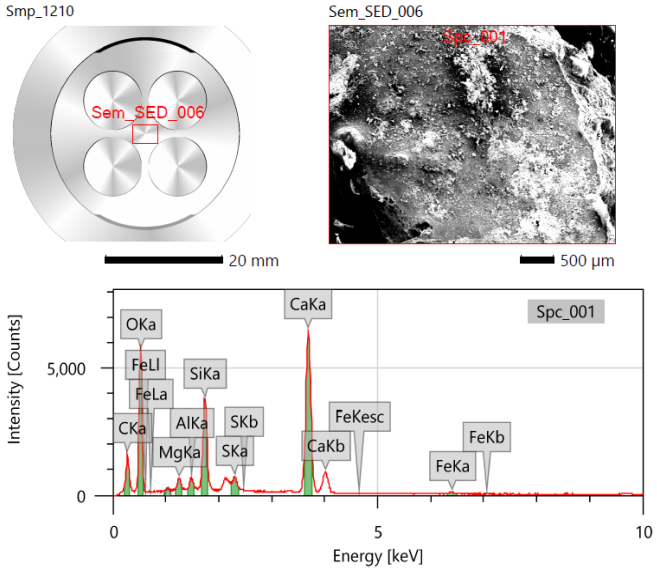
Figure 0-5 Effect of Using Nano caco3 on Flexural strength of UHPC

The effect of nano Caco3 on the microstructure properties of UHPC

The microstructural characteristics were analyzed and discussed, as follows:

The scanning electron microscope (SEM) and energy dispersive X-ray spectroscopy EDS

Figure 4-6 shows the results of EDX for reference mixture NUHPC0. The results have been analyzed and evaluated. The UHPC mixtures was evaluated using SEM micrographs, as shown in Figures 4-7. Figure 4-7 shows that UHPC without Nano caco3 was more likely to experience ettringite formation, the presence of micro-cracks, and generate larger voids, and the overall structure was more incompact.



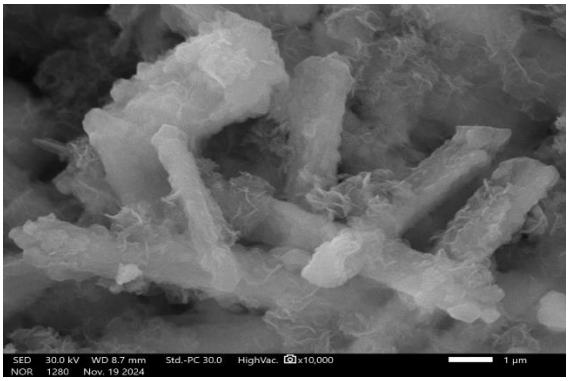
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WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

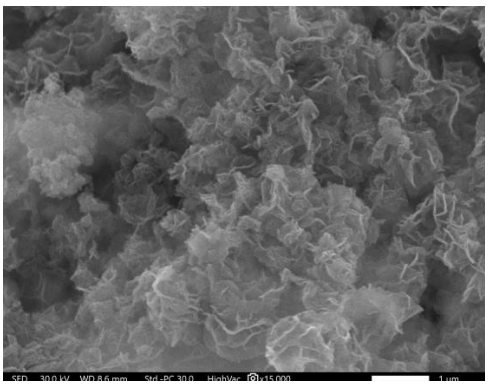
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Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	31.18 seconds
Dead time	4.00
Count rate	9703.00 CPS

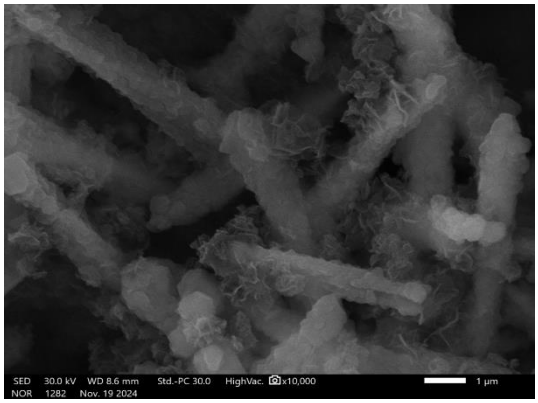
Display name	Standard data	Quantification method	Result Type
Spc_001	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	13.88±0.09	21.49±0.13
O	K	52.18±0.27	60.66±0.31
Na	K	0.35±0.03	0.29±0.02
Mg	K	1.12±0.03	0.86±0.02
Al	K	0.99±0.03	0.68±0.02
Si	K	7.05±0.06	4.67±0.04
S	K	0.98±0.02	0.57±0.01
Ca	K	22.77±0.11	10.56±0.05
Fe	K	0.68±0.03	0.23±0.01
Total		100.00	100.00
Spc_001			Fitting ratio 0.0228

Figure 4-6 shows the results of EDX for reference mixture NUHPC0







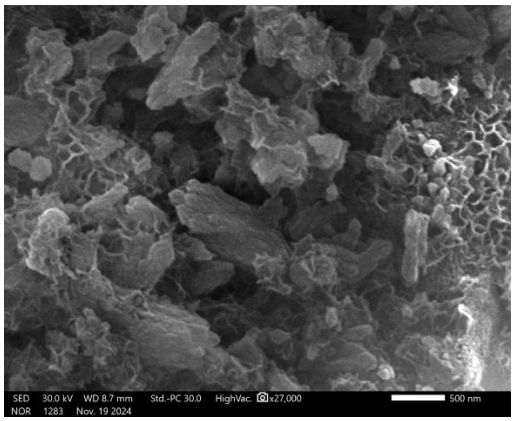
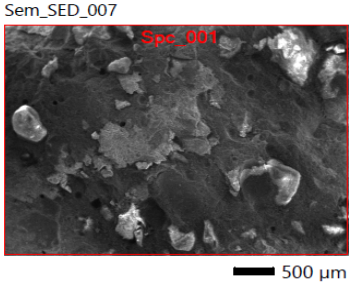


Figure 4-7 shows the results of SEM for reference mixture NUHPC0

Figures 4-8 to 4-13 shows the results of EDX and SEM for mixtures NUHPC1, NUHPC2 and NUHPC3 respectively. as shown, many hydration products were formed on the surface of the cement particles, and it appears that a network-type structure was formed by these hydrates as a result of the accelerated hydration of cement by nano-CaCO 3.Furthermore, some small piles, which may be composed of nano-CaCO 3, hydrates, can be observed in the network. ,is may also indicate nano-CaCO 3 was helpful for accelerating the hydration process as a result of its high hydration activity and ability to provide nucleation sites. In addition, researchers have found that nano-CaCO 3 can increase the content of C-S-H gel at the interface and im-prove the orientation of Ca (OH) 2 crystals, resulting in a transition in the hydration structure at the interface position from a planar arrangement to a spatial structure. Moreover, nano-CaCO 3 filled up the pores of loose net structure around the cement particles, thereby decreasing the porosity of concrete and increasing the density degree. ,us, it can be concluded that nano-CaCO3 was helpful for in-creasing the hydration degree and enhancing the strength of UHPC at early ages. With continued progress of the hydration, the micro-structure became more compact at 28 d, as shown in Figures. A comparison of control mix and adding nano CaCO3 to UHPC, with the generation of new C-S-H gels and the growth of ettringite crystals, the internal pores in the cement became more completely filled. After 28 d, the C-S-H gels and ettringites attached to each other and needle-like ettringites were wrapped by the C-S-H gels, which also contributed to increasing the density. ,is may be a result of the pozzolanic effect of the fly ash, which plays an important role in the improvement of strength at later ages. Based on the above analysis, it can be concluded that UHPC containing nano-CaCO3 can accelerate the hydration process and lead to a denser microstructure, consequently enhancing the mechanical properties and durability of the UHPC. ,is may be the result of a few mechanisms: the seeding effect, filling effect, and pozzolanic effect

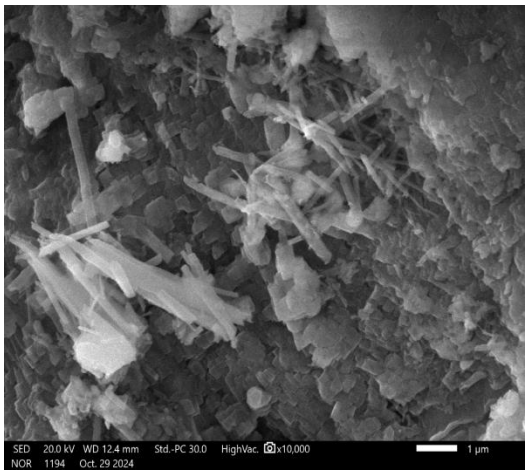


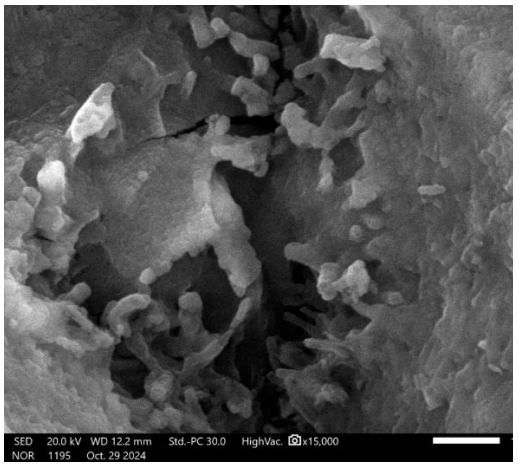


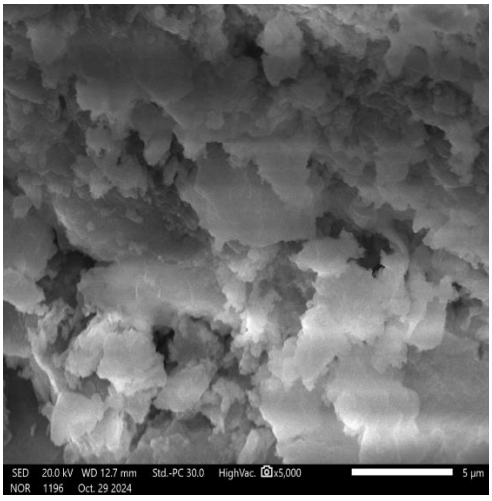
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WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

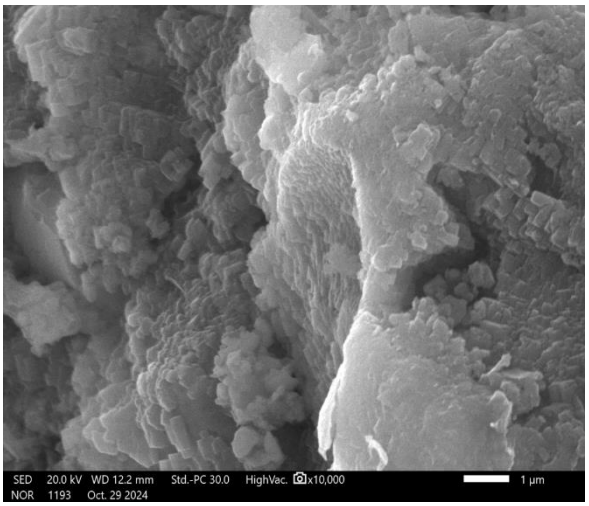
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measurement conditions	
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Probe current	0.00 nA
Magnification	x 30
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Measurement detector	First
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Dead time	2.00
Count rate	3482.00 CPS

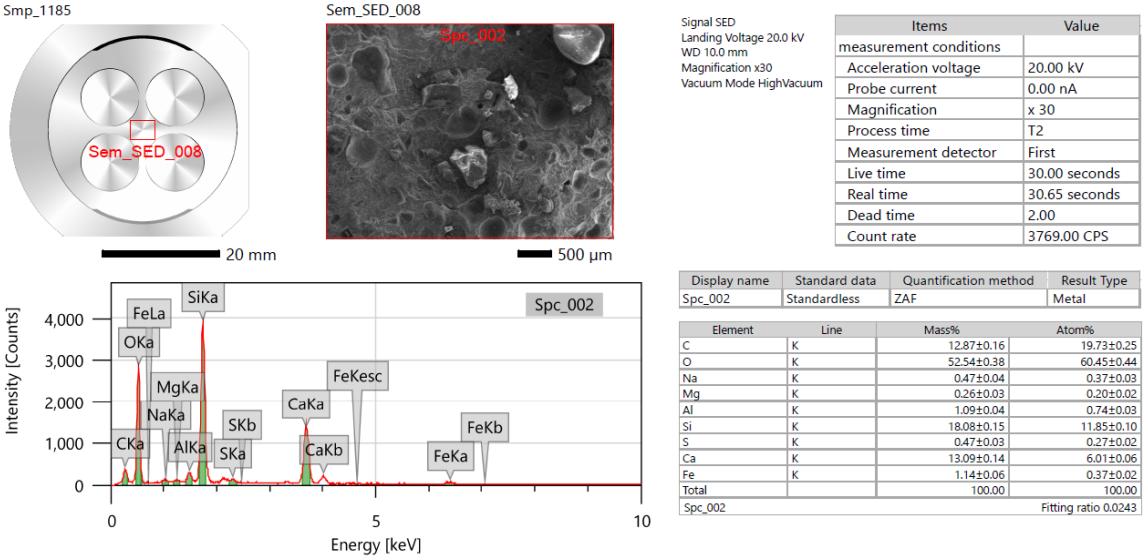
Figure 4-8 shows the results of EDX for reference mixture NUHPC1











Items	Value
measurement conditions	
Acceleration voltage	20.00 kV
Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	30.65 seconds
Dead time	2.00
Count rate	3769.00 CPS

Display name	Standard data	Quantification method	Result Type
Spc_002	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	12.87±0.16	19.73±0.25
O	K	52.54±0.38	60.45±0.44
Na	K	0.47±0.04	0.37±0.03
Mg	K	0.26±0.03	0.20±0.02
Al	K	1.09±0.04	0.74±0.03
Si	K	18.08±0.15	11.85±0.10
S	K	0.47±0.03	0.27±0.02
Ca	K	13.09±0.14	6.01±0.06
Fe	K	1.14±0.06	0.37±0.02
Total		100.00	100.00
Spc_002			Fitting ratio 0.0243

Figure 4-10 shows the results of EDX for reference mixture NUHPC2

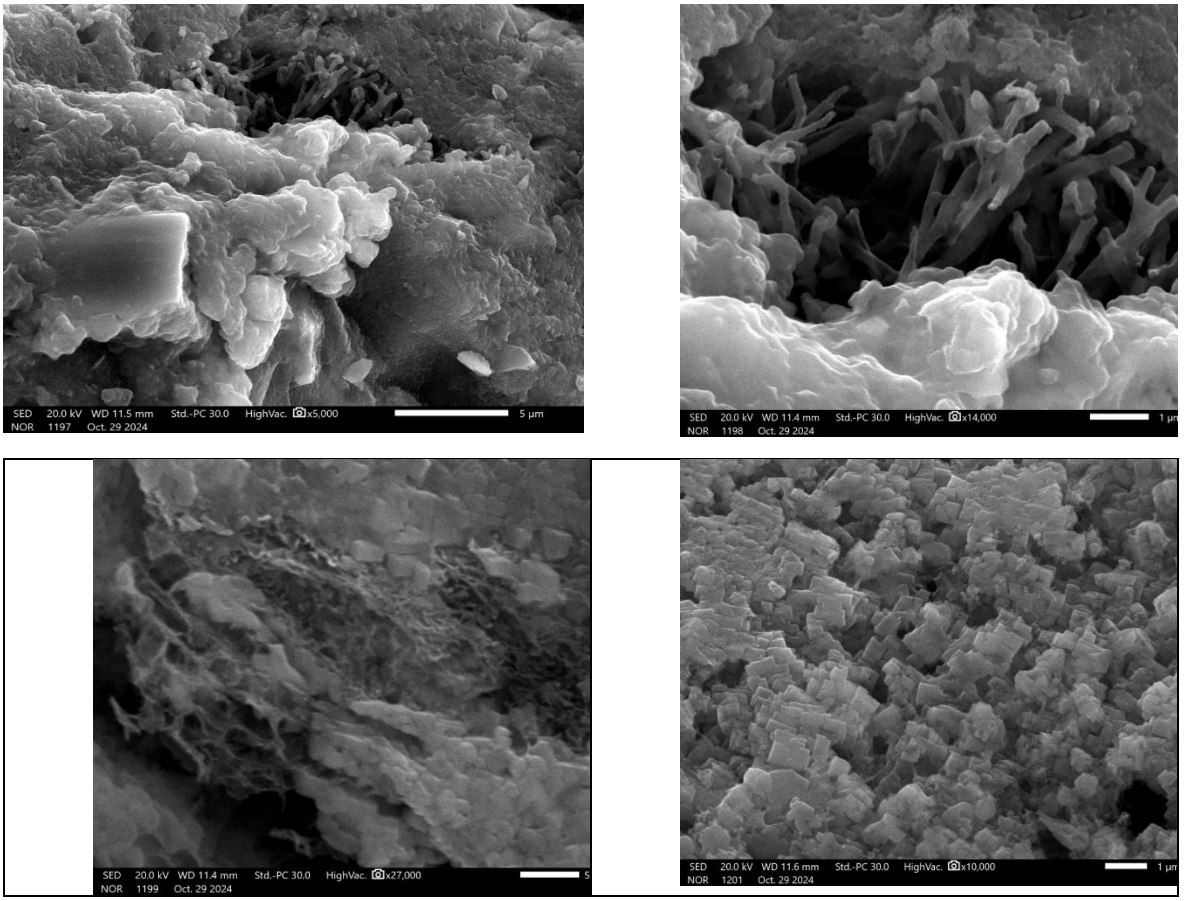
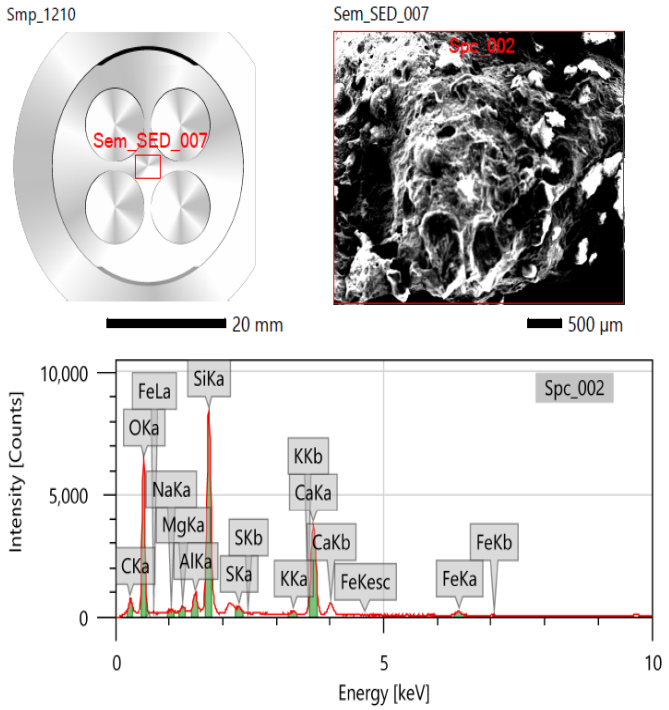


Figure 4-11 shows the results of SEM for reference mixture NUHPC2



Signal SED
Landing Voltage 20.0 kV
WD 10.0 mm
Magnification x30
Vacuum Mode HighVacuum

Items	Value
measurement conditions	
Acceleration voltage	20.00 kV
Probe current	0.00 nA
Magnification	x 30
Process time	T2
Measurement detector	First
Live time	30.00 seconds
Real time	31.19 seconds
Dead time	4.00
Count rate	9607.00 CPS

Display name	Standard data	Quantification method	Result Type
Spc_002	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	8.88±0.09	14.17±0.15
O	K	52.86±0.25	63.30±0.31
Na	K	0.53±0.03	0.44±0.02
Mg	K	0.60±0.02	0.48±0.02
Al	K	1.70±0.03	1.21±0.02
Si	K	17.74±0.10	12.10±0.07
S	K	0.46±0.02	0.28±0.01
K	K	0.45±0.02	0.22±0.01
Ca	K	15.16±0.10	7.25±0.05
Fe	K	1.62±0.05	0.55±0.02
Total		100.00	100.00
Spc_002			Fitting ratio 0.0197

Figure 4-12 shows the results of EDX for reference mixture NUHPC3

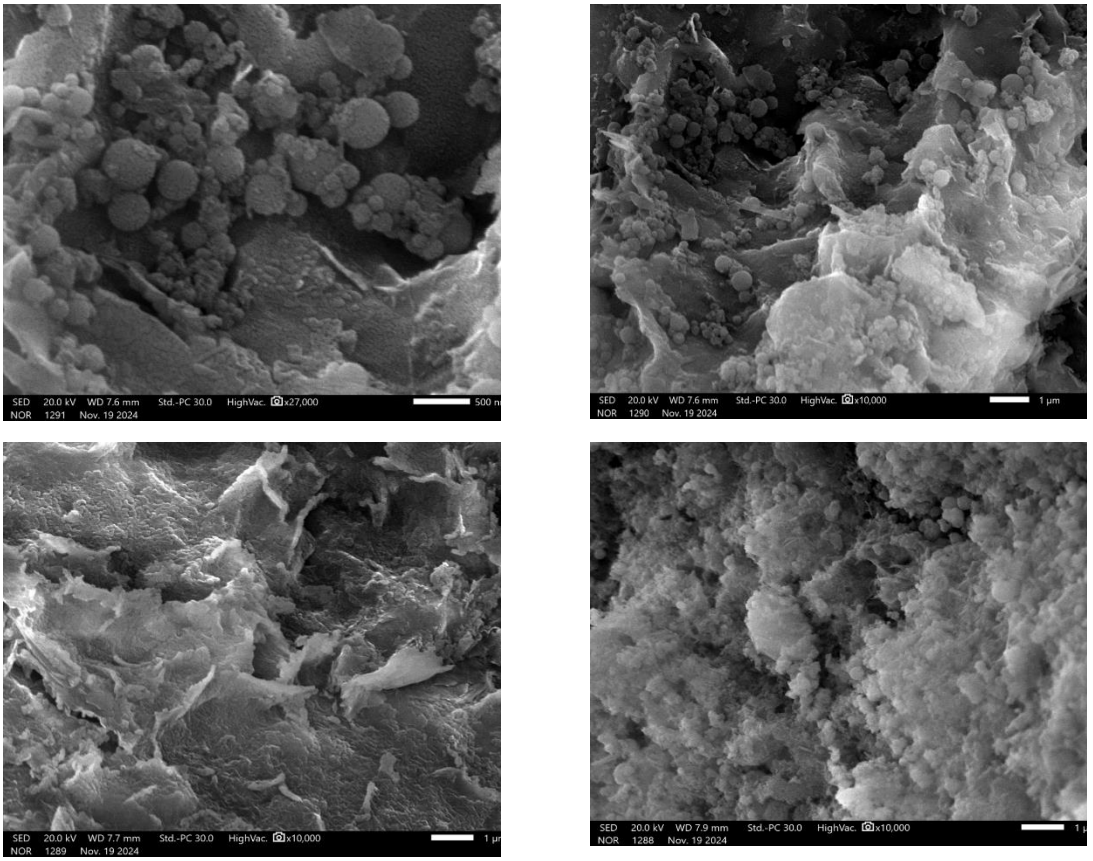


Figure 4-13 shows the results of SEM for reference mixture NUHPC3

Electrochemical measurements of SCC

potentiodynamic polarization measurements

Chapter 5

Conclusions and Future Work

Conclusions

Based on the results of the study, the following conclusions can be made:

1. Adding nano-CaCO3 improved the flowability of UHPC mixtures and exhibited better workability than that induced by control admixture.

2. The addition of nano-CaCO3 had a strong acceleration effect on the early-age setting and hardening process. Hence, nano-CaCO3 addition can be considered as a setting and hardening accelerator.

3. Mixtures incorporating nano-CaCO3 showed comparable and/ or better early-age compressive, tensile and flexural strength results than that of the control.

4. SEM analysis reveals that nano-CaCO3 was helpful for increasing the compressive strength of the UHPC at early ages due to the acceleration of cement hydration by the seeding effect and the tighter pore structure of cement as a result of nano filling. On the other hand, the pozzolanic effect of the Nano-CaCo3 at later ages can further enhance the mechanical strength of concrete, making up for the limited effect of the nano-CaCO3.

Future Work

As a more recent trend, future studies will be focused on the:

1) Studying the effect of using different types of waste materials as CRM materials on the behavior of UHPC.
2) Studying the effect of using Nano CaCO3 on the behaviour of UHPC structural elements like slabs, columns, walls, and frames.
3) Durability studies for UHPC modified by adding waste materials.
4) Studying the effect of elevated temperature on the behaviour of the UHPC.

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Nahda University

Faculty of Engineering

Department of Civil Engineering

Concepts of concrete design and analysis
Engineering Graduation Project 1

Submitted for Partial Fulfillment of the

B.Sc. Degree in Civil Engineering

By

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Project Advisor two

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Dr. Fatma Ramadan

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Second Semester 2024/2025

Jan 2025

FACULTY OF ENGINEERING
NAHDA UNIVERSITY
BANISUEF, EGYPT
FEBRUARY - 2024

PROJECT (1)

Material Structural Engineering

Under Supervision of:

Prof. Dr. Naglaa Galal Eldin
&
Dr. Reham Maged Hussien

Submitted by:-

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2-Mahmoud Mohamed Said

3-Mohamed Hamdy Mahmoud

4-Yossef Mohamed Salah

Out lines

- Abstract
- Introduction
- Advantages
- Disadvantages
- Used Materials
- Experimental Work
- Attachment

Abstract:

- Fungi-based self-healing concrete is an innovative solution to repair cracks in concrete naturally. By adding fungal spores to the concrete mix, the fungi stay dormant until moisture triggers them to grow and seal cracks. This process helps improve the concrete’s strength and durability, reducing the need for repairs and extending its lifespan. While this method offers environmental benefits and can make concrete more sustainable, challenges like controlling fungal growth and ensuring effective healing under different conditions still need to be addressed. This presentation explores the potential and challenges of using fungi for self-healing in concrete.

Introduction



Concrete, Despite it's widely use in construction, is highly vulnerable to damage over years due to factors such as stress, temperature changes , and chemical reactions.
which makes it a serious challenge for its performance through years. Solutions for this life-threatening issue was collected but weren't used due it's high cost and not always being sustainable.
One of the solutions involved the use of fungi and water to promote healing in fractured concrete.
This healing method was invented in 2006 by a microbiologist named "professor Henk Jonkers

Advantages of fungi water in concrete self-healing:

- **Longer Lifespan:** Fungi help concrete heal cracks, This helps protect the concrete from damage over time, improving its durability.
- **Cost-Effective Repair**: By using fungi to heal cracks autonomously, the need for costly and labor-intensive repairs is reduced, saving both time and money.
- **Eco-Friendly Solution:** As fungi are natural organisms that don't involve harmful chemicals. which helps decrease pollution and waste**.**
- **Stronger Concrete:** Fungi contribute in healing of microcracks, keeping it strong and safe. This prevents further damage and helps the structure stay solid over time.

Disadvantages of fungi water in concrete self-healing:

- **Limited Healing Range:** Fungi may not be effective for all types of cracks, particularly large or deep ones, or in areas with severe structural damage.
- **Slow Healing Process :** The healing process can take time as fungi need to grow and produce the bio-mineral material to seal cracks, potentially delaying repairs.
- **Health and Safety Risks:** Some fungi can pose health risks to workers during installation or maintenance, as spores or fungal growth can be harmful if not handled properly.
- **Environmental Dependency:** Fungi require specific conditions, such as moisture and temperature, to activate and grow, which can limit their effectiveness in dry or cold environments.
- **Long-Term Effectiveness:** There is still uncertainty about the long-term durability of fungi-based healing and whether it will continue to be effective over the entire lifespan of the concrete structure.

Used Materials

Water: Addition of water enriched with algae and fungi











Fine Aggregate

One type of fine aggregate (sand) conforming to ASTM C 33 (Standard Specification for Concrete Aggregates) was used in this study. The fine aggregates were Natural Sand provided by Arrow Concrete and with the following properties and sieve analysis.

Table 3-5Properties of fine aggregates

Source and Basic Properties	
SSD Specific Gravity	2.61
Bulk Specific Gravity	2.59
Apparent Specific Gravity	2.65
Absorption	1.0 %

Table 3-6 Sieve analysis for natural river sand

.Sieve Size		Wt. retained	Amount Retained	Cumulative amount retained	Cumulative amount Passing
		(gm.)	(wt. %)	(%)	(%)
9.5 mm	3/8 "	0.00	0.00	0.00	100.00
4.75 mm	No. 4	25.50	4.98	4.98	95.02
2.36 mm	No. 8	58.30	11.39	16.37	83.63
1.18 mm	No. 16	55.10	10.76	27.13	72.87
600 µm	No. 30	90.80	17.74	44.87	55.13
300 µm	No. 50	217.30	42.45	87.32	12.68
75 µm		60.30	11.78	99.10	0.90

(1 mm = 0.039 in., 1 gm = 2.205×10^{-3} lb, 1 µm = 3.937×10^{-5} in)



Coarse Aggregate

One type of graded coarse aggregates was used in this study conform the ASTM C 33 (Standard Specification for Concrete Aggregates). The properties and sieve Analysis described in Table 3.3 (a) for crushed #8 dolomite with a maximum size of 9.5 mm (3/8 in) and Table 3.3 (b) sieve analysis of #8 limestone aggregate



Table 3-3Properties of Coarse Aggregates

Properties	Value
Absorption (%)	0.53
SSD Specific Gravity	2.69
Bulk Specific Gravity	2.68
Apparent Specific Gravity	2.719

Table 3-4 Sieve analysis for C.A

Sieve Size		Wt. retained	Amount Retained	Cumulative amount retained	Cumulative amount Passing
		(gm.)	(wt. %)	(%)	(%)
12.5 mm	3/4	0.00	0.00	0.00	100.00
9.5 mm	3/8 "	4.50	0.41	0.41	91.26
4.75 mm	No. 4	127.20	11.45	11.46	88.14
2.36 mm	No. 8	827.20	74.47	86.33	13.67
1.18 mm	No. 16	140.60	12.76	98.98	1.02

(1 mm = 0.039 in., 1 gm = 2.205×10^{-3} lb, 1 µm = 3.937×10^{-5} in)

CEMENT

For this specific testing commercially available Type I portland cement, which conforms the ASTM C 150 (Standard Specification for portland cement) was used. It was supplied by Beni Suef Cement Company BSCC (Beni Suef city, Egypt). The basic physical properties and compound composition of cement are presented in Table 3.1 and 3.2 respectively.

Table 3-1 Basic Physical Properties of Type I portland cement Used

Specific Gravity	Fineness	Setting time	
		Initial (min.)	Final (min.)
3.15	320 m^2/kg (1561 ft^2/lb)	90	260

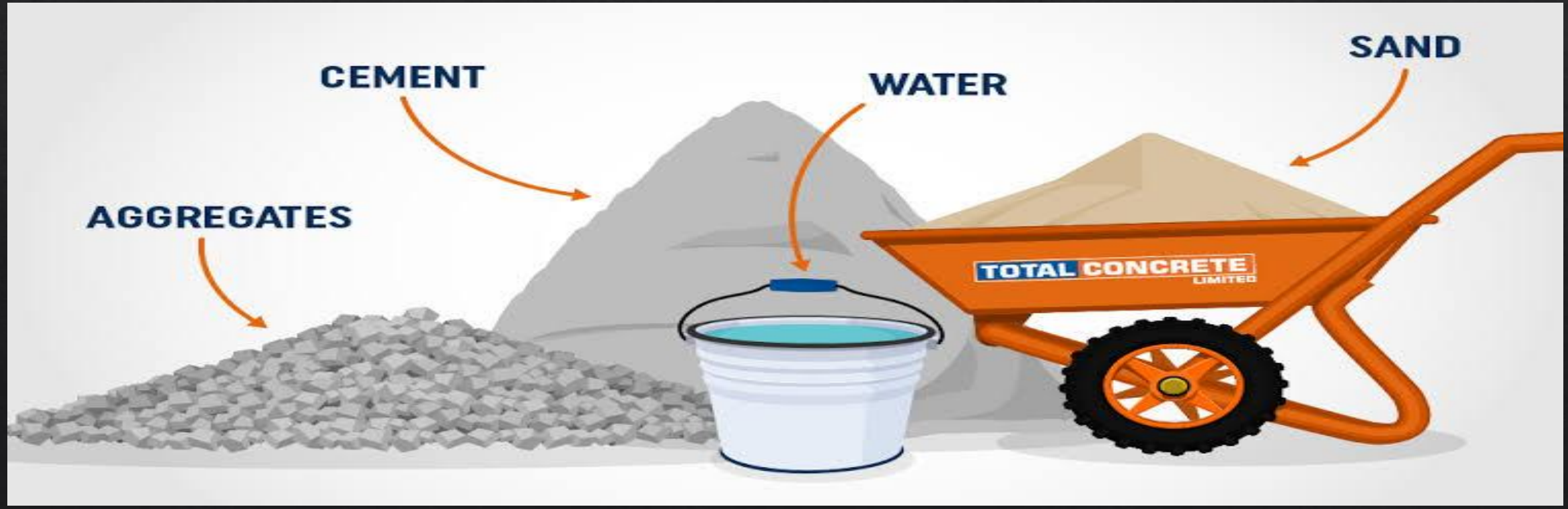
Table 3-2Compound Composition of Type I portland Cement Used.

Compounds	percentage by mass
Tricalcium Silicate (C_3S)	49.0
Dicalcium Silicate (C_2S)	25.0
Tricalcium Aluminate (C_3F)	12.0
Tetracalcium Aluminoferrite (C_4AF)	8.0
Calcium Sulfate (CSH_2)	2.2
Calcium Oxide (CaO)	0.8
Magnesium Oxide (MgO)	2.0
Others	1.0

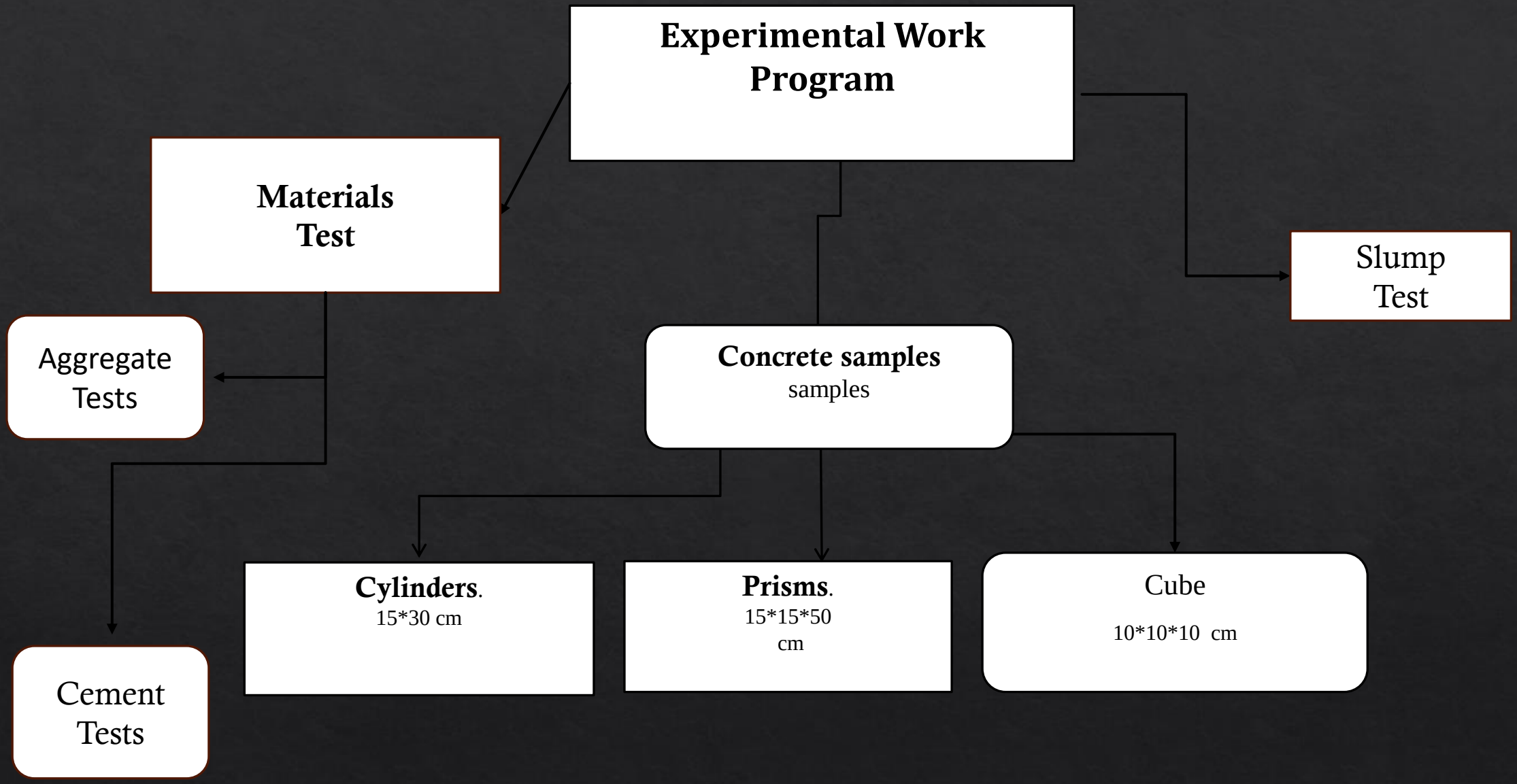


Admixtures

- **Air-entraining admixtures**: Protect concrete from freeze-thaw damage, improve workability, and reduce bleeding, but are unsuitable for hard-troweled interior floors.
- **Water reducers**: Decrease water content while maintaining workability, enabling self-consolidating concrete (SCC) for smooth, decorative surfaces.
- **Retarders & accelerators**: Control setting time based on temperature; retarders are useful for preventing rapid hardening in decorative concrete work.



Experimental Work


Experimental Work Program
Materials Test
Slump Test
Aggregate Tests
Concrete samples
samples
Cylinders.
15*30 cm
Prisms.
15*15*50 cm
Cube
10*10*10 cm
Cement Tests

Cement

- *Fineness Test*
- *Consistency Test*
- *Setting Time Test*
- *Strength Test*
- *Soundness Test*
- *Heat of Hydration Test*
- *Tensile Strength Test*
- *Chemical Composition Test*









Aggregate

- Crushing test
- Abrasion test
- Impact test
- Soundness test
- Shape test
- Specific gravity and water absorption test
- Bitumen adhesion test





Mixing

Mix	Cement kg	Sand kg	Aggregate kg	Water kg	Ethyleneg
Mix 1	22.90	41.00	48.40	10.30	0
Mix 2	11.450	20.50	24.20	5.150	51.150





Compressive strength


BLOWUP





Mix 1 D
High concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
D10	8.3
D11	5.2

Strength Test

	Sample Cube Water	Compression Strength Ton\cm^2
7 days	D 10	0.8956
28 days	D 10	1.0923
90 days	D 10	2.0386

	Sample Cube Air	Compression Strength Ton\cm^2
7 days	D 10	0.8956
28 days	D 10	1.05
90 days	D 10	1.8066

	Sample Cube Ethylene	Compression Strength Ton\cm^2
7 days	D 11	0.4067
28 days	D 11	0.9579
90 days	D 11	1.1098

Mix 2 E

Low concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
E10	4.8
E11	5.9

Strength Test

	Sample Cube Water	Compression Strength Ton\cm^2
7 days	**E 10**	1.324
28 days	**E 10**	2.4065
90 days	**E 10**	3.414

	Sample Cube Air	Compression Strength Ton\cm^2
7 days	**E 10**	1.324
28 days	**E 10**	1.14
90 days	**E 10**	2.7356

	Sample Cube Ethylene	Compression Strength Ton\cm^2
7 days	E 11	0.9477
28 days	E 11	1.2467
90 days	E 11	2.1089

Mix 3 F

Medium concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
F10	4.4
F11	6.9

Strength Test

	Sample Cube Water	Compression Strength Ton\cm^2
7 days	**F 10**	1.1067
28 days	**F 10**	2.2076
90 days	**F 10**	2.9359

	Sample Cube Air	Compression Strength Ton\cm^2
7 days	**F 10**	1.1067
28 days	**F 10**	1.200
90 days	**F 10**	2.4315

	Sample Cube Ethylene	Compression Strength Ton\cm^2
7 days	F 11	2.0161
28 days	F 11	2.4382
90 days	F 11	3.2042

Tensile strength

Mix 1 D

High concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
D10	4.4
D11	6.9

Strength Test

	Sample Cylinder Water	Tensile Strength Ton\cm^2
7 days	**D 10**	0.123
28 days	**D 10**	0.127
90 days	**D 10**	0.160

	Sample Cylinder Air	Tensile Strength Ton\cm^2
7 days	**D 10**	0.0877
28 days	**D 10**	0.119
90 days	**D 10**	0.153

	Sample Cylinder Ethylene	Tensile Strength Ton\cm^2
7 days	D 11	0.133
28 days	D 11	0.152
90 days	D 11	0.168

Mix 2 E

Low concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
E10	4.4
E11	6.9

Strength Test

	Sample Cylinder Water	Tensile Strength Ton\cm^2
7 days	**E 10**	0.141
28 days	**E 10**	0.176
90 days	**E 10**	0.212

	Sample Cylinder Air	Tensile Strength Ton\cm^2
7 days	**E 10**	0.134
28 days	**E 10**	0.156
90 days	**E 10**	0.241

	Sample Cylinder Ethylene	Tensile Strength Ton\cm^2
7 days	E 11	0.130
28 days	E 11	0.169
90 days	E 11	0.268

Mix 3 F

Medium concentration

Slump test

Mix 10=without Ethylene 11=with Ethylene	Slump cm
F10	4.4
F11	6.9

Strength Test

	Sample Cylinder Water	Tensile Strength Ton\cm^2
7 days	**F 10**	0.108
28 days	**F 10**	0.140
90 days	**F 10**	0.187

	Sample Cylinder Air	Tensile Strength Ton\cm^2
7 days	**F 10**	0.139
28 days	**F 10**	0.164
90 days	**F 10**	0.198

	Sample Cylinder Ethylene	Tensile Strength Ton\cm^2
7 days	F 11	0.107
28 days	F 11	0.173
90 days	F 11	0.236

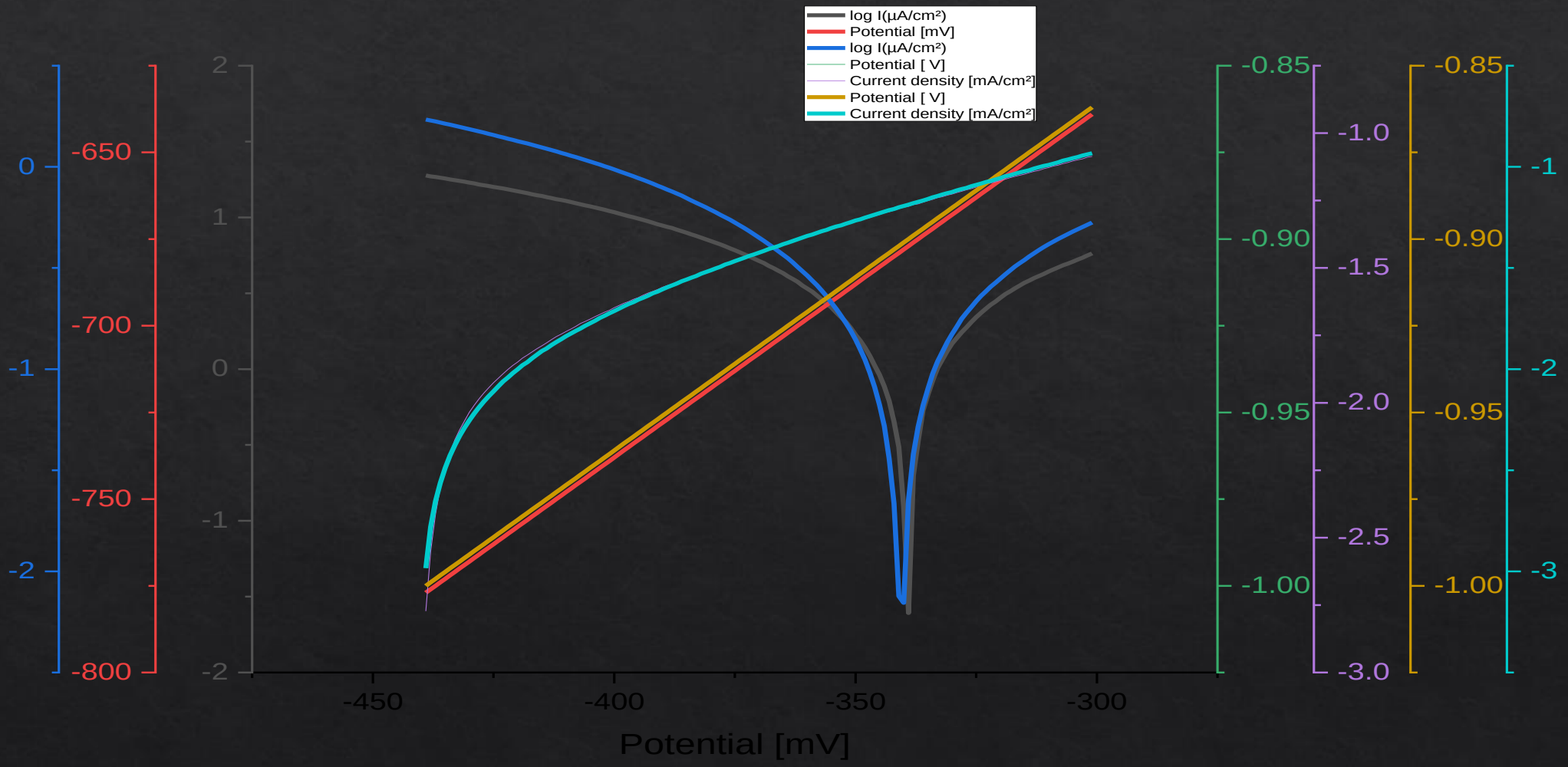
Iron Corrosion Test



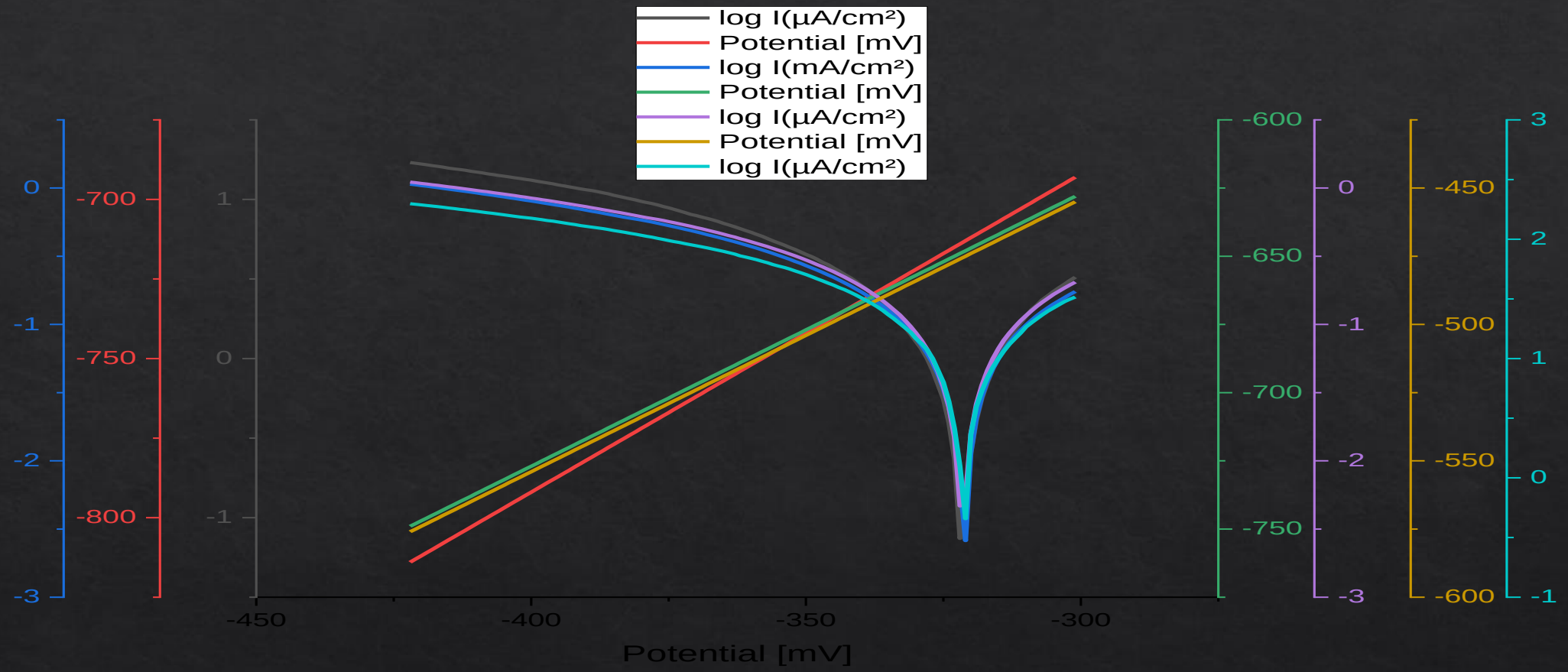




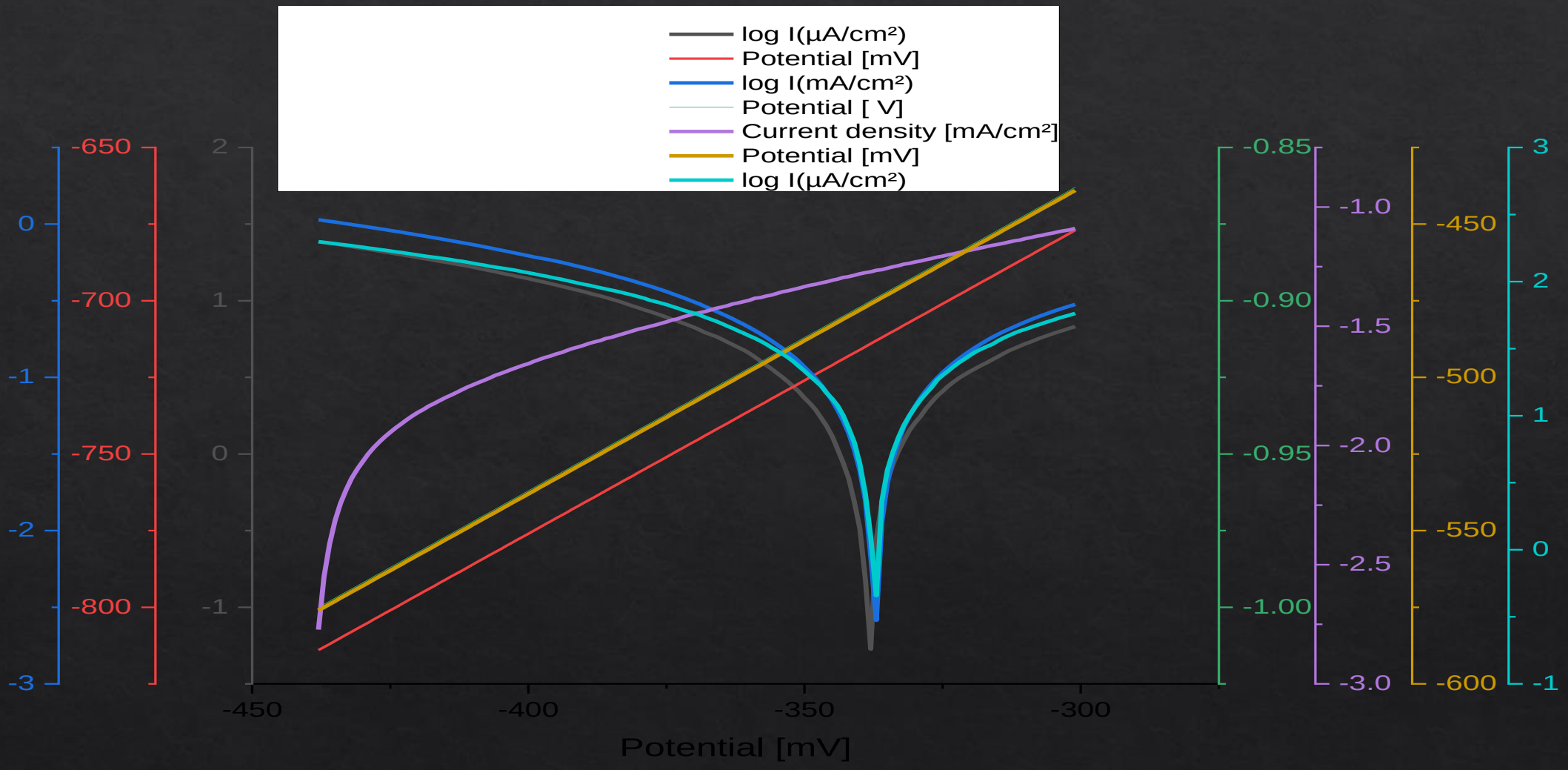
CONTROL Ethylene



CONTROL WATER

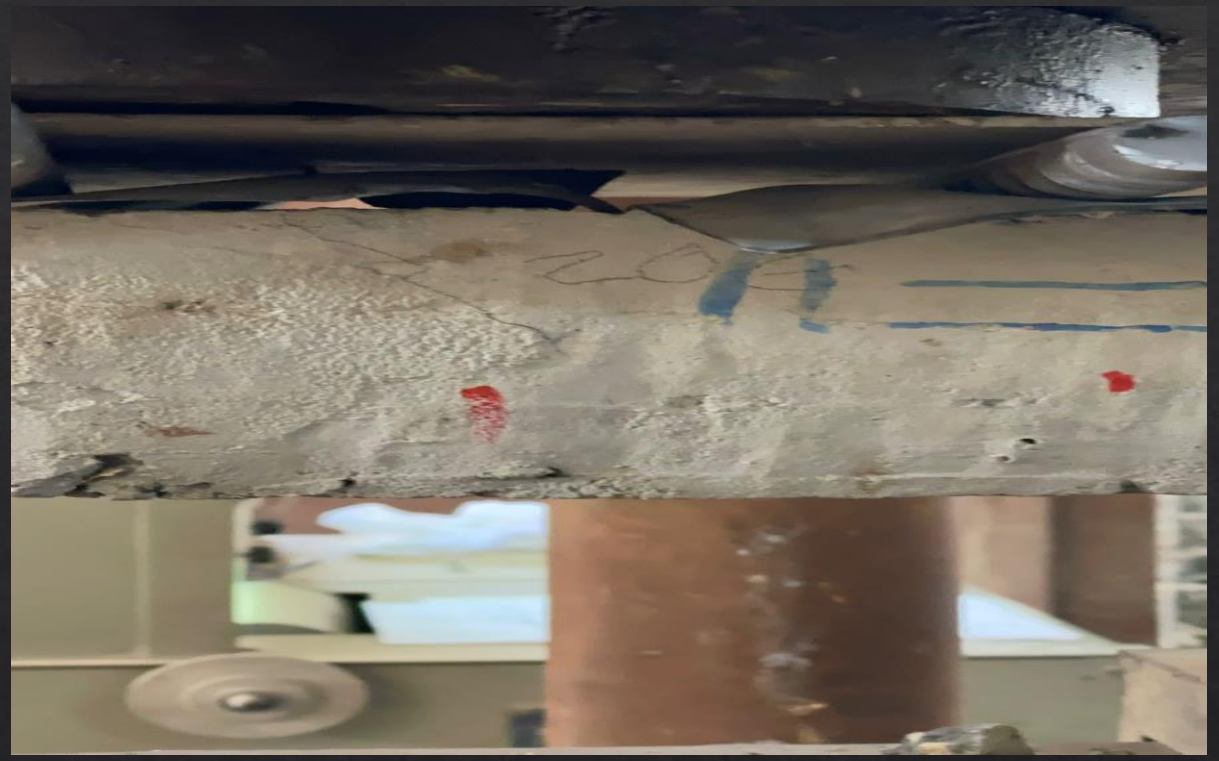


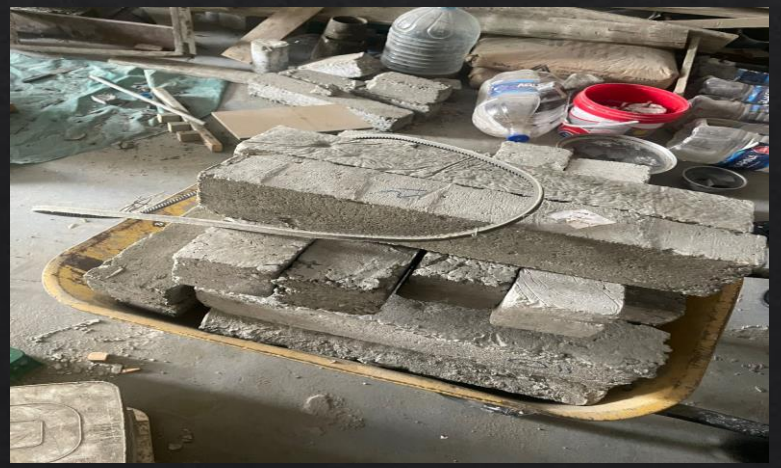
CONTROL AIR

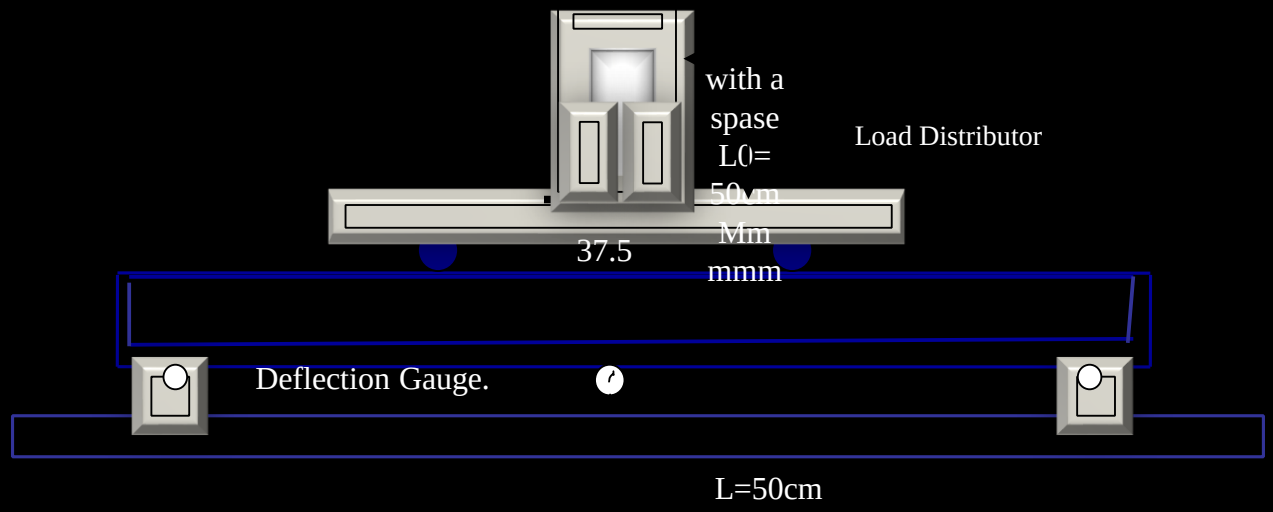

log I(µA/cm²)
Potential [mV]
log I(mA/cm²)
Potential [V]
Current density [mA/cm²]
Potential [mV]
log I(µA/cm²)
-650
-700
-750
-800
2
1
0
-1
0
-1
-2
-3
-0.85
-0.90
-0.95
-1.00
-1.0
-1.5
-2.0
-2.5
-3.0
-450
-500
-550
-600
3
2
1
0
-1
-450
-400
-350
-300
Potential [mV]

Prism Test

Sample prism	Bending failure ton\cm^2	Crack ton
13 air	17.481	50-60 Two cracks
11 air	14.814	20 One crack
13 water	17.037	36 One crack
7 water	17.629	35 One crack
14 Ethylene	19.111	10-46 Two cracks
8 Ethylene	17.777	20-50 Two cracks






with a
spase
L0=
50cm
Mm
mmm
Load Distributor
37.5
Deflection Gauge.
L=50cm

Conclusion

Adding fungi to concrete aims to enhance its properties through the chemical compounds produced by fungi. This results in several benefits, including improved resistance to moisture, heat, and microorganisms, as well as enhanced mechanical strength.



1.Enhanced Concrete Performance – The addition of fungi improves concrete's durability by increasing its resistance to moisture, heat, and microbial growth.

2.Mechanical Benefits – Fungi contribute to improving the compressive and tensile strength of concrete, making it a more sustainable building material.

3.Practical Applications – This technique can be applied in building construction, road construction, and historic building restoration, contributing to more resilient and long-lasting structures.

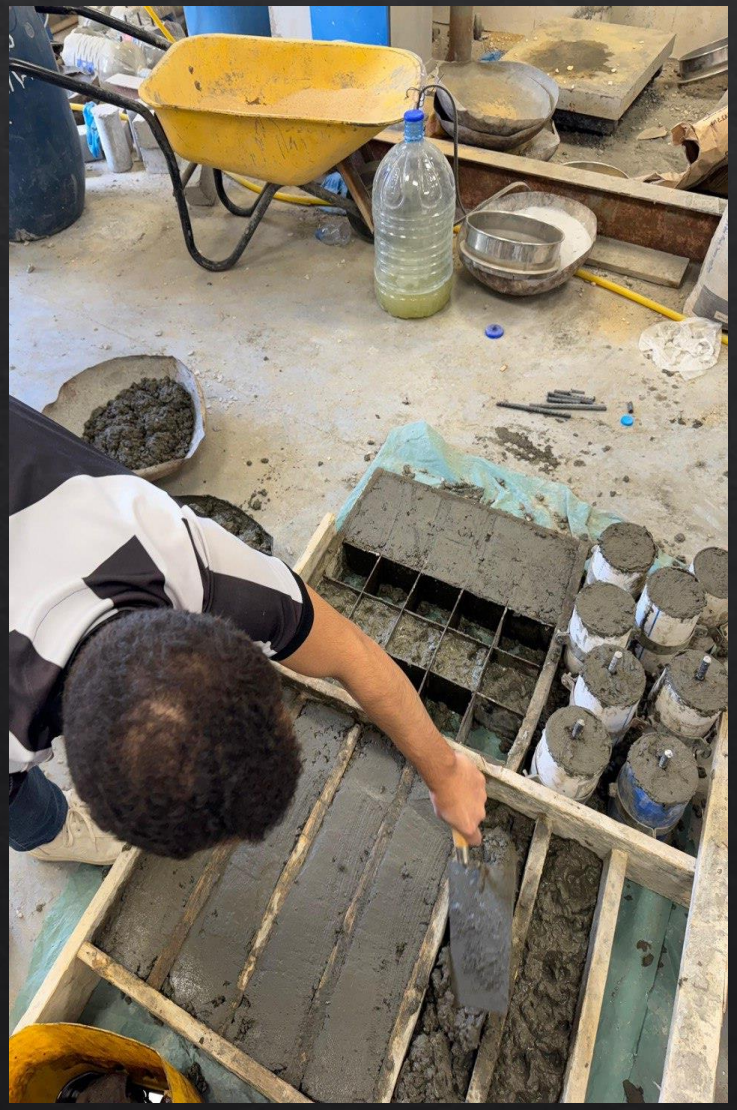
Beneficial Fungi for Self-Healing Concrete These fungi help in self-healing concrete by producing compounds that seal cracks and enhance durability.

- Trichoderma Reese – Produces enzymes that promote crack repair and strengthen concrete.
- Sproutarian Pasteurian – Facilitates calcium carbonate precipitation, which helps seal cracks in concrete.
- Pseudomonas fluorescens – Enhances microbial-induced calcite precipitation (MICP), aiding in self-healing.
- Bacillus subtilis – Contributes to the natural repair process by forming limestone-like deposits in cracks.

Types of Fungi and Their Effects on Concrete1. Harmful Fungi for ConcreteThese fungi negatively affect concrete by degrading its components, leading to structural deterioration over time.

- 1.Aspergillus spp. – Causes concrete corrosion by producing organic acids that weaken its structure.
- 2.Penicillium spp. – Contributes to crack formation in concrete due to its chemical secretions.
- 3.Fusarium spp. – Can break down certain compounds in concrete, reducing its strength.
  4.Cladosporium spp. – Leads to surface deterioration in humid environments.2.

Attachment








BLOWUP



Thank you