STRUCTURAL ANALYSIS

PROJECT TITLE : PROPOSED RESIDENTIAL BUILDING
LOCATION : GAMUTON, LANUZA SURIGAO DEL SUR
OWNER : MARIA CLAIRE D. MILITANTE

SOFTWARES

Midas Gen provides design capabilities for various materials and member types according to the international standards, leading to optimal design. Midas Gen offers advanced seismic analyses such as pushover analysis, nonlinear time history analysis, boundary nonlinear analysis and fiber analysis, as well as conventional seismic analysis such as static seismic and response spectrum analysis.

MIDAS DESIGN + **:** midas Design+ is a unit member design software developed by MIDAS. It caters to the engineers' design needs for quick and efficient design of various building components such as beams, columns, staircases, steel connections, slabs, basement walls, footings, etc. After obtaining the design results and the reports, the engineers can get the AUTOCAD drawings for the designed members.

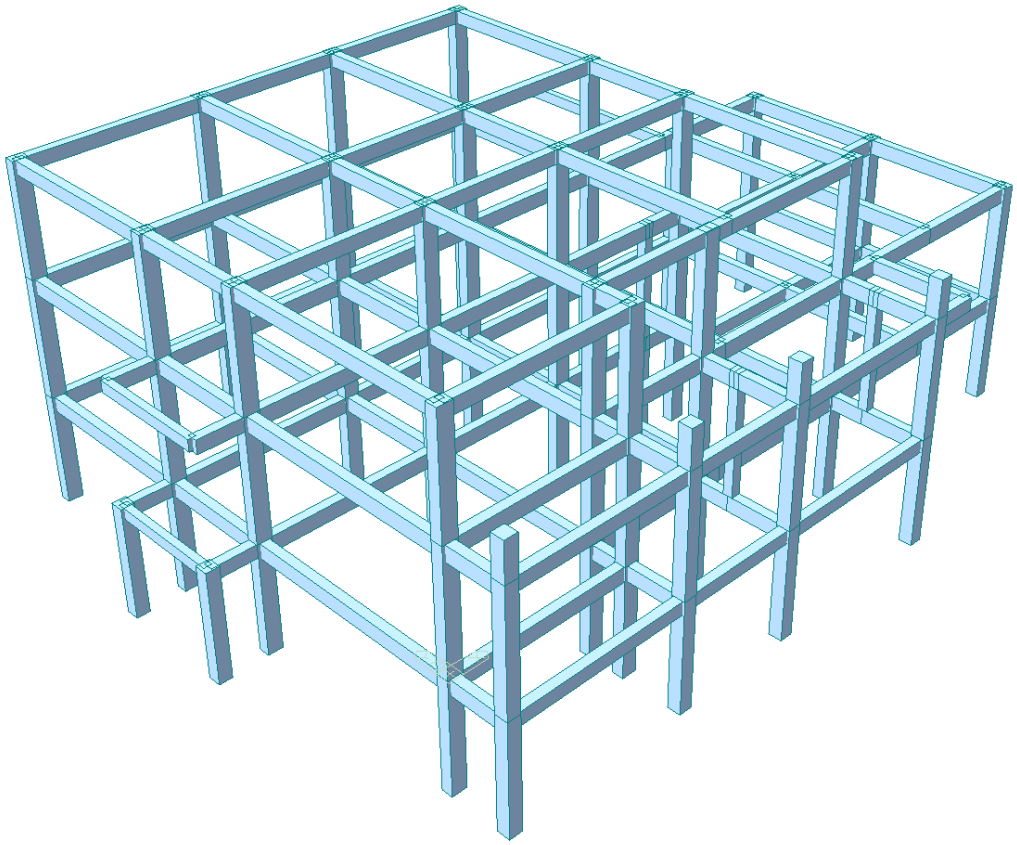
STRUCTURAL ANALYSIS (RC DESIGN)
DESIGN CRITERIA

I. Structural Design and Analysis

A. Standards and References

1. National Structural Code of the Philippines (NSCP 2015) Vol.1, 7th Edition,2015.
2. American Society of Civil Engineers (2010 Edition) (ASCE7-10)
3. International Building Code (2012 Edition) (IBC 2012)
4. Uniform Building Code (UBC) 1997 Vol.2

B. 3D Model



C. LOADINGS

5. Dead Loads (NSCP 2015 Chapter 2, Section 204,205,207 and 208)

5.1 Ceiling and Utilities(5psf)	= 0.24 kpa
5.2 Partitions	= 1.2 kpa
5.3 Floor finishes	= 1.2 kpa
5.4 Dead Load slab (100mm)	= 2.35 kpa
5.5 Dead Load slab (130mm)	= 3.01 kpa
5.6 Steel Deck	= 0.14 kpa

5.3 Girder/Beam Loads

5.3.1 150 mm THK CHB Wall	= 3.11 kpa
5.3.2 100 mm THK. CHB Wall	= 2.98 kpa
5.3.3 Glass walls	= 0.64 kpa
5.3.4 Water tank	= 6 kpa

6. Live load (NSCP 2015 Chapter 2, Section 204,205,207 and 208)

6.1 Roof	= 1.0 kpa
6.2 Residential	= 1.9 kpa
6.3 Library(Reading Room)	= 2.9 kpa
6.4 Exterior Balconies	= 2.9 kpa
6.5 Roof Deck	= 1.9 kpa

7. Wind Load Parameters (IBC2012/ASCE7-10)

7.1 Basic Wind Speed (250kph)	= 155.34 mph
7.2 Exposure Category	= D
7.3 Exposure Classification	= Partially Enclosed Building
7.4 Mean Roof Height	= 9.26 m

7.5 Directional Factor, kdx-kdy	= 0.85
7.6 Gust Effect factor, Gx Gy	= 0.85
7.7 Occupancy Category	= IV

8. Seismic Load Parameters (UBC 1997)

Seismic Zone Factor (Z)	= 0.40
Importance Factor (I)	= 1.00
Soil Profile Type	= SC
Seismic Source Type	= A
Closest Distance To Known Seismic Source [km]	= 50.30
Near Source Factor, Na (UBC-97 Table 16-S)	= 1.00
Near Source Factor, Nv (UBC-97 Table 16-T)	= 1.00
Seismic Coefficient, Ca (UBC-97 Table 16-Q)	= 0.40
Seismic Coefficient, Cv (UBC-97 Table 16-R)	= 0.56
Fundamental Period Associated With X-dir. (Tx)	= 0.3863
R Factor of Lateral System for X-direction (Rx)	= 8.5000
Seismic Coefficient for X-dir. UBC-97(Para.1630.2.1)	= 0.117647

9. Geotechnical Investigation Report

9.1 Soil bearing capacity	= 150 kpa
9.2 Type of footing	= Isolated/Combined
9.3 Seismic Zone Factor, Z	= 4(0.4)
9.4 Near Source Factor, Na	= 1.0
9.5 Near Source Factor, Nv	= 1.0
9.6 Seismic Coefficient, Ca	= 0.40
9.7 Seismic Coefficient, Cv	= 0.56
9.8 Soil Profile Type	= Sc

D. Load Combinations

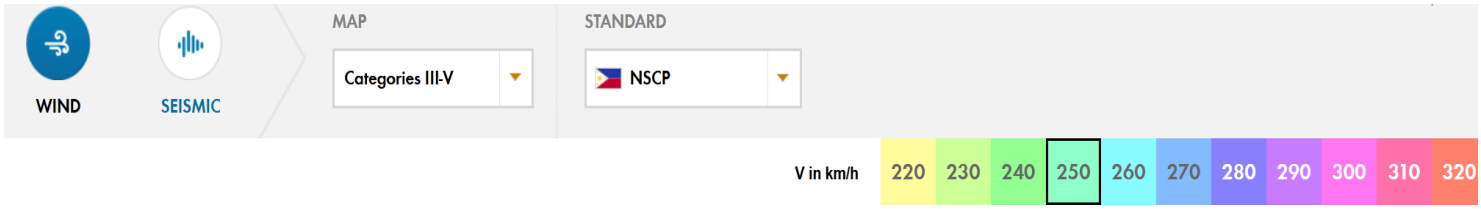
LIST OF LOAD COMBINATIONS

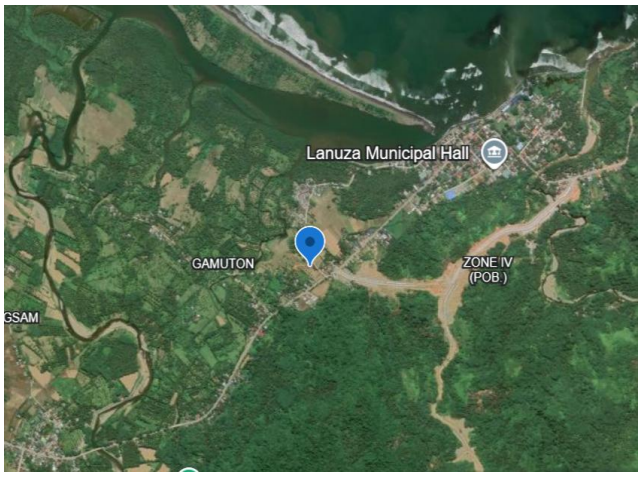
Load Combination List

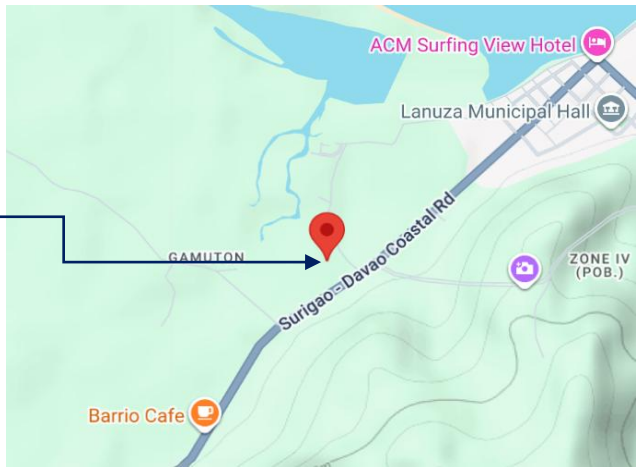
	No	Name	Activ	Type	DL(ST)	LL(ST)	WL-X(ST)	WL-Y(ST)	EQ-X(ST)	EQ-Y(ST)	cLCB1(CBC)
▸	1	cLCB	Stre	Add	1.4000						
	2	cLCB	Stre	Add	1.2000	1.6000					
	3	cLCB	Stre	Add	1.2000	0.5000	1.0000				
	4	cLCB	Stre	Add	1.2000	0.5000		1.0000			
	5	cLCB	Stre	Add	1.2000	0.5000	-1.0000				
	6	cLCB	Stre	Add	1.2000	0.5000		-1.0000			
	7	cLCB	Stre	Add	1.2000	0.5000			1.0000	0.3000	
	8	cLCB	Stre	Add	1.2000	0.5000			1.0000	-0.3000	
	9	cLCB	Stre	Add	1.2000	0.5000			0.3000	1.0000	
	10	cLCB	Stre	Add	1.2000	0.5000			-0.3000	1.0000	
	11	cLCB	Stre	Add	1.2000	0.5000			-1.0000	-0.3000	
	12	cLCB	Stre	Add	1.2000	0.5000			-1.0000	0.3000	
	13	cLCB	Stre	Add	1.2000	0.5000			-0.3000	-1.0000	
	14	cLCB	Stre	Add	1.2000	0.5000			0.3000	-1.0000	
	15	cLCB	Stre	Add	0.9000		1.0000				
	16	cLCB	Stre	Add	0.9000			1.0000			
	17	cLCB	Stre	Add	0.9000		-1.0000				
	18	cLCB	Stre	Add	0.9000			-1.0000			
	19	cLCB	Stre	Add	0.9000				1.0000	0.3000	
	20	cLCB	Stre	Add	0.9000				1.0000	-0.3000	
	21	cLCB	Stre	Add	0.9000				0.3000	1.0000	
	22	cLCB	Stre	Add	0.9000				-0.3000	1.0000	
	23	cLCB	Stre	Add	0.9000				-1.0000	-0.3000	
	24	cLCB	Stre	Add	0.9000				-1.0000	0.3000	
	25	cLCB	Stre	Add	0.9000				-0.3000	-1.0000	
	26	cLCB	Stre	Add	0.9000				0.3000	-1.0000	
	27	cLCB	Ser	Add	1.0000						
	28	cLCB	Ser	Add	1.0000	1.0000					
	29	cLCB	Ser	Add	1.0000	0.7500					
	30	cLCB	Ser	Add	1.0000		0.6000				
	31	cLCB	Ser	Add	1.0000			0.6000			
	32	cLCB	Ser	Add	1.0000		-0.6000				
	33	cLCB	Ser	Add	1.0000			-0.6000			
	34	cLCB	Ser	Add	1.0000				0.7143	0.2143	
	35	cLCB	Ser	Add	1.0000				0.7143	-0.2143	
	36	cLCB	Ser	Add	1.0000				0.2143	0.7143	
	37	cLCB	Ser	Add	1.0000				-0.2143	0.7143	
	38	cLCB	Ser	Add	1.0000				-0.7143	-0.2143	
	39	cLCB	Ser	Add	1.0000				-0.7143	0.2143	
	40	cLCB	Ser	Add	1.0000				-0.2143	-0.7143	
	41	cLCB	Ser	Add	1.0000				0.2143	-0.7143	

BASIC WIND SPEED

LOCATION : GAMUTON, LANUZA SURIGAO DEL SUR
OCCUPANCY CATEGORY : IV
EXPOSURE CATEGORY : D
BASIC WIND SPEED (V) = 250 km/hr



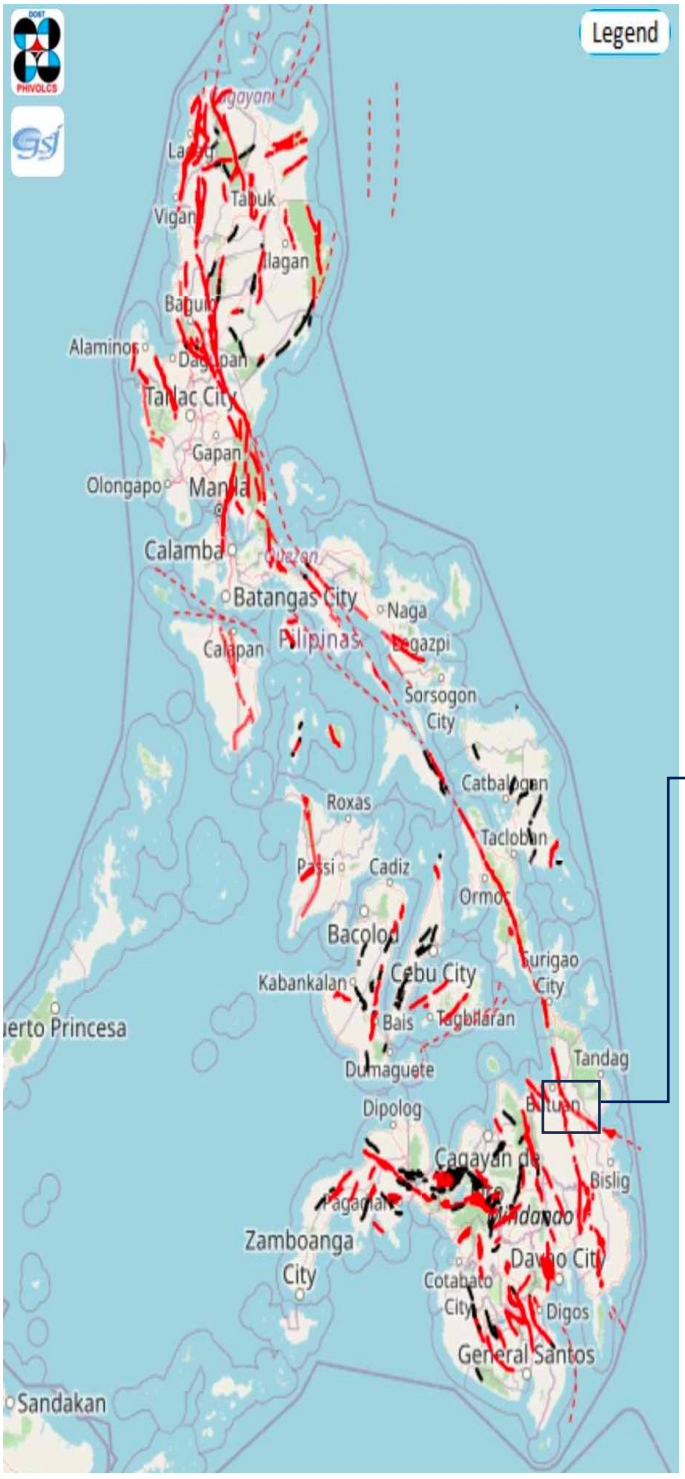




https://www.dlubal.com/en/load-zones-for-snow-wind-earthquake/wind-nscp.html#&center

ACTIVE FAULT LINE LOCATION

LOCATION : GAMUTON, LANUZA SURIGAO DEL SUR
NEAREST ACTIVE FAULT LINE : 50.3 km



Assessment Results

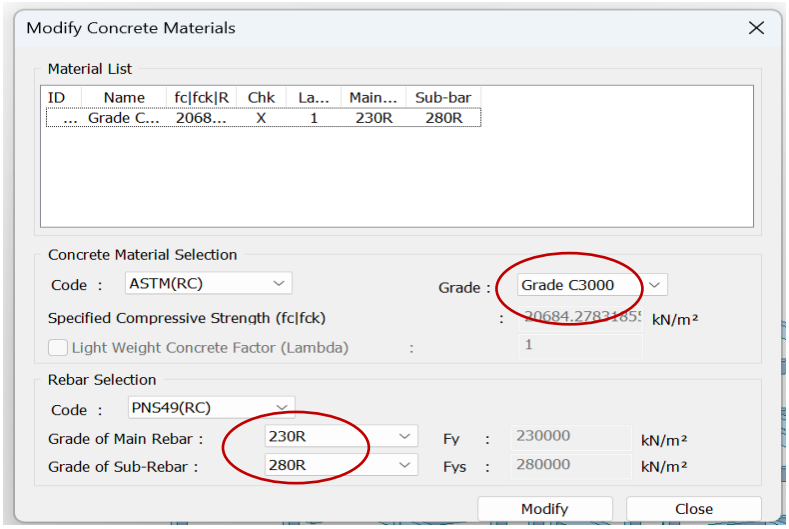
SEISMIC HAZARD ASSESSMENT	
Nearest Active Fault	Approximately 50.3 km east of the Philippine Fault: Surigao Segment
Ground Rupture	Safe
Ground Shaking	Prone; Intensity VII
Earthquake-Induced Landslide	Temporarily Unavailable
Liquefaction	Highly Susceptible
Tsunami	Prone; Inundation depth: 3 to 3.99 meters

https://faultfinder.phivolcs.dost.gov.ph/

REINFORCED CONCRETE ANALYSIS

*DESIGN ANALYSIS INPUTS

RC DESIGN ANALYSIS STRESSES

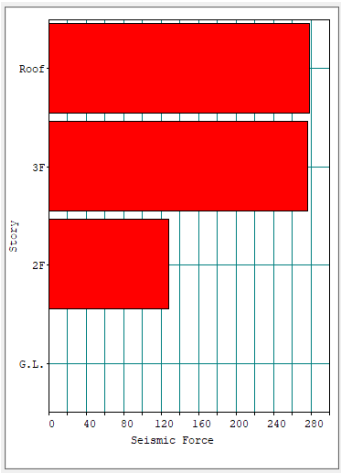


SECTION STIFFNESS SCALE FACTOR

Member and Condition	Moment of Inertia
Columns	0.7Ig
Beams	0.35Ig
Table 406.6.3.1(a) (NSCP 2015)	

	No	Name	fAre	fAsy	fAsz	flxx	flyy	flzz	fWg	Part	Group
	1	RB	1.0	1.0	1.0	0.7	0.7	1.0	1.0	Befor	Default
	2	B1	1.0	1.0	1.0	0.7	0.7	1.0	1.0	Befor	Default
	3	B3	1.0	1.0	1.0	0.7	0.7	1.0	1.0	Befor	Default
	5	GB	1.0	1.0	1.0	0.7	0.7	1.0	1.0	Befor	Default
	6	C1	1.0	1.0	1.0	0.3	0.3	1.0	1.0	Befor	Default
	7	C2	1.0	1.0	1.0	0.3	0.3	1.0	1.0	Befor	Default
	8	SC	1.0	1.0	1.0	0.3	0.3	1.0	1.0	Befor	Default

I. SEISMIC ANALYSIS REPORT



MASS GENERATION DATA FOR LATERAL ANALYSIS OF BUILDING [UNIT: kN, m]

STORY NAME	TRANSLATIONAL MASS (X-DIR)	(Y-DIR)	ROTATIONAL MASS	CENTER OF MASS (X-COORD)	(Y-COORD)
Roof	152.702775	152.702775	6555.27631	6.24949849	7.29320781
3F	223.845212	223.845212	12830.7609	8.3670858	6.40499401
2F	214.635405	214.635405	11545.3252	7.72234396	6.52444149
1F	0.0	0.0	0.0	0.0	0.0
TOTAL :	591.183392	591.183392			

STORY NAME	TRANSLATIONAL MASS (X-DIR)	(Y-DIR)
Roof	0.0	0.0
3F	0.58871773	0.58871773
2F	0.0	0.0
1F	12.2008747	12.2008747
TOTAL :	12.7895924	12.7895924

EQUIVALENT SEISMIC LOAD IN ACCORDANCE WITH UNIFORM BUILDING CODE 1997 [UNIT: kN, m]

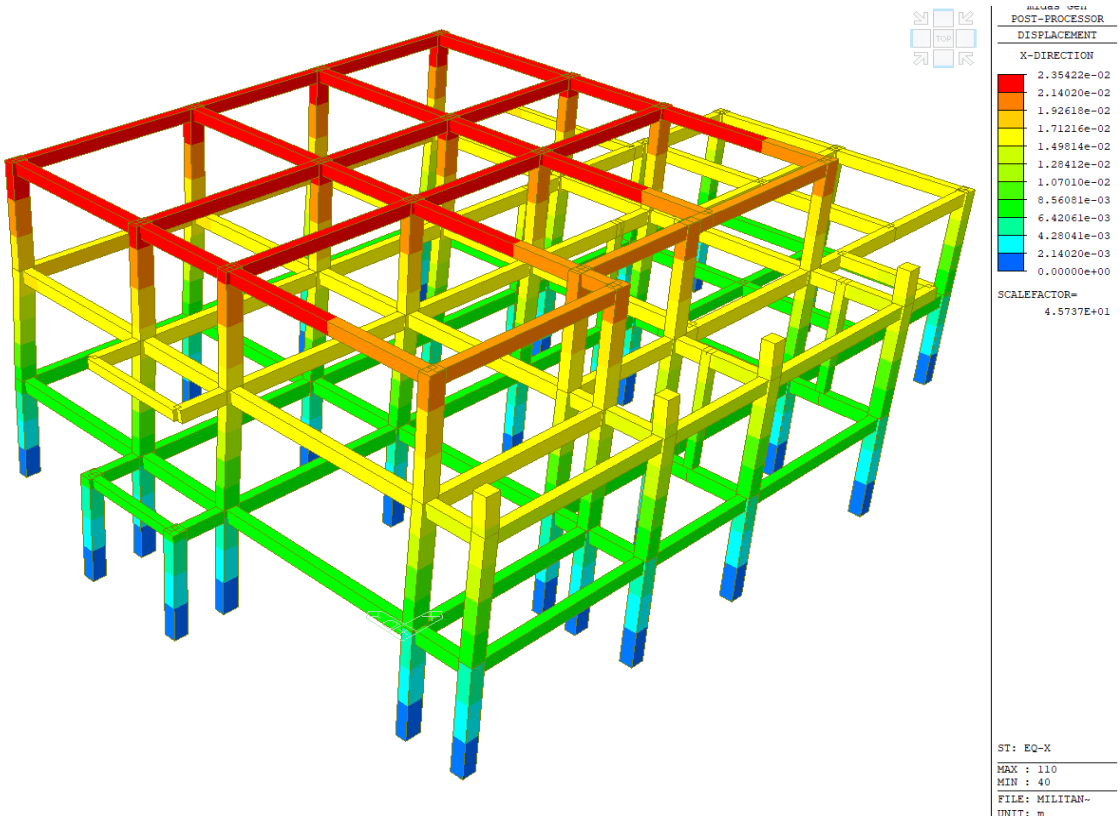
Seismic Zone Factor (Z)	: 0.40
Importance Factor (I)	: 1.00
Soil Profile Type	: SC
Seismic Source Type	: A
Closest Distance To Known Seismic Source [km]	: 50.30
Near Source Factor, Na (UBC-97 Table 16-S)	: 1.00
Near Source Factor, Nv (UBC-97 Table 16-T)	: 1.00
Seismic Coefficient, Ca (UBC-97 Table 16-Q)	: 0.40
Seismic Coefficient, Cv (UBC-97 Table 16-R)	: 0.56
Fundamental Period Associated With X-dir. (Tx)	: 0.3863
R Factor of Lateral System for X-direction (Rx)	: 8.5000
Seismic Coefficient for X-dir. UBC-97(Para.1630.2.1)	: 0.117647
Fundamental Period Associated With Y-dir. (Ty)	: 0.3863
R Factor of Lateral System for Y-direction (Ry)	: 8.5000
Seismic Coefficient for Y-dir. UBC-97(Para.1630.2.1)	: 0.117647
Total Effective Weight For X-dir. Seismic Loads (Wx)	: 5802.917305
Total Effective Weight For Y-dir. Seismic Loads (Wy)	: 5802.917305
Scale Factor For X-directional Seismic Loads	: 1.00
Scale Factor For Y-directional Seismic Loads	: 0.00
Accidental Eccentricity For X-direction (Ex)	: None
Accidental Eccentricity For Y-direction (Ey)	: None
Torsional Amplification for Accidental Eccentricity	: Do not Consider
Torsional Amplification for Inherent Eccentricity	: Do not Consider
Total Base Shear Of Model For X-direction	: 682.696154
Total Base Shear Of Model For Y-direction	: 0.000000
Summation Of Wi*Hi Of Model For X-direction	: 33735.210225
Summation Of Wi*Hi Of Model For Y-direction	: 0.000000

S E I S M I C L O A D G E N E R A T I O N D A T A X - D I R E C T I O N

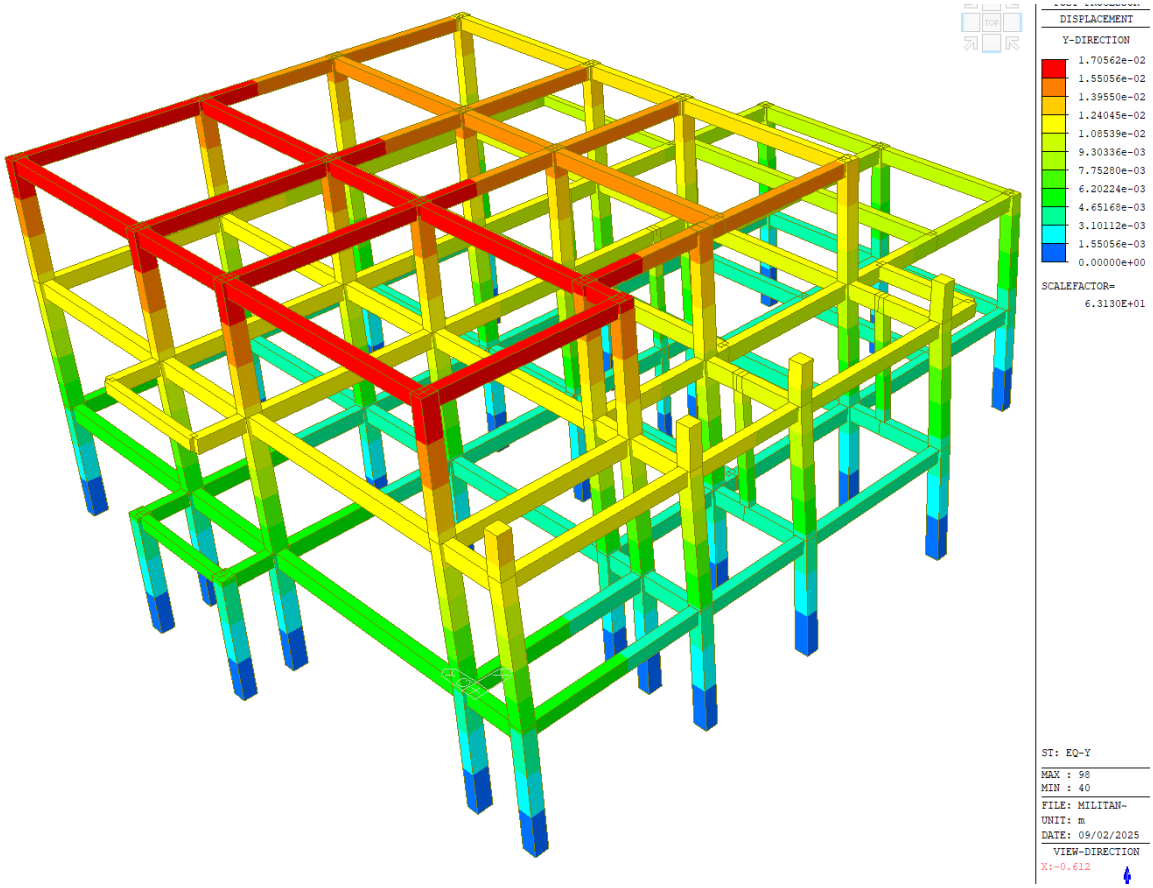
STORY NAME	STORY WEIGHT	STORY LEVEL	SEISMIC FORCE	ADDED FORCE	STORY FORCE	STORY SHEAR	OVERTURN. MOMENT	ACCIDENT. TORSION	INHERENT TORSION	TOTAL TORSION
Roof	1497.403	9.2	278.7858	0.0	278.7858	0.0	0.0	0.0	0.0	0.0
3F	2200.799	6.2	276.1316	0.0	276.1316	278.7858	836.3575	0.0	0.0	0.0
2F	2104.715	3.0	127.7787	0.0	127.7787	554.9174	2612.093	0.0	0.0	0.0
G.L.	--	0.0	--	--	--	682.6962	4660.182	---	---	---

S E I S M I C L O A D G E N E R A T I O N D A T A Y - D I R E C T I O N

STORY NAME	STORY WEIGHT	STORY LEVEL	SEISMIC FORCE	ADDED FORCE	STORY FORCE	STORY SHEAR	OVERTURN. MOMENT	ACCIDENT. TORSION	INHERENT TORSION	TOTAL TORSION
Roof	1497.403	9.2	278.7858	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3F	2200.799	6.2	276.1316	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2F	2104.715	3.0	127.7787	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G.L.	--	0.0	--	--	--	0.0	0.0	---	---	---



EQ-X DISPLACEMENT CONTOUR



EQ-Y DISPLACEMENT CONTOUR

II.WINDLOAD ANALYSIS REPORT

WIND LOADS BASED ON IBC2012(ASCE7-10) (Directional Procedure) [UNIT: kN, m]

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Design Wind Loads                                : F    = p * Area
Design Wind Pressure                             : p    = qz*G*Cp1 - qh*G*Cp2
Velocity Pressure at Design Height z [psf]       : qz   = 0.00256*Kz*Kzt*Kd*V^2
Velocity Pressure at Mean Roof Height [psf]      : qh   = 0.00256*Kh*Kht*Kd*V^2
Calculated Value of qh for X-dir [psf]           : qh   = 61.09
Calculated Value of qh for Y-dir [psf]           : qh   = 61.09

Basic Wind Speed [mph]                           : V    = 155.34
Directional Factor for X-dir Wind Loads          : Kdx  = 0.85
Directional Factor for Y-dir Wind Loads          : Kdy  = 0.85
Exposure Category                                : D
Mean Roof Height                                 : H    = 9.20
Gradient Height [ft]                             : Zg   = 700.00
Power Law Exponent                               : Alpha= 11.50
Kz at Mean Roof Height (Kh)                      : Kh   = 1.16

Structural Rigidity                              : Rigid Structure

Gust effect Factor for X-dir Wind Loads          : Gx   = 0.85
Gust effect Factor for Y-dir Wind Loads          : Gy   = 0.85

Topographic Effects for X-dir Wind Loads         : Not Included
Topographic Effects for Y-dir Wind Loads         : Not Included
Accidental Eccentricity for X-direction          : Wx   = None
Accidental Eccentricity for Y-direction          : Wy   = None
Scale Factor for X-directional Wind Loads        : SFx  = 1.00
Scale Factor for Y-directional Wind Loads        : SFy  = 0.00
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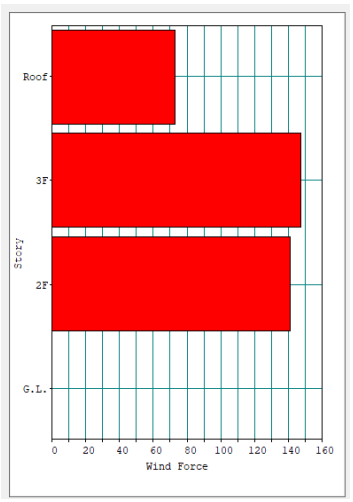


** External Pressure Coefficients at Windward and Leeward Walls (Cp1, Cp2)

STORY NAME	Cp1 (Windward)	Cp2(X-DIR) (Leeward)	Cp2(Y-DIR) (Leeward)
Roof	0.800	-0.447	-0.500
3F	0.800	-0.447	-0.500
2F	0.800	-0.447	-0.500
1F	0.800	-0.430	-0.500

** Velocity Exposure Coefficients at Design Height (Kz)
** Topographic Factors at Windward and Leeward Walls (Kzt)
** Velocity Pressure at Design Height (qz) [Current Unit]

STORY NAME	Kz	Kzt(X-DIR) (Windward)	Kzt(Y-DIR) (Windward)	Kzt(X-DIR) (Leeward)	Kzt(Y-DIR) (Leeward)	qz(X-DIR)	qz(Y-DIR)
Roof	1.163	1.000	1.000	1.000	1.000	2.925	2.925
3F	1.163	1.000	1.000	1.000	1.000	2.925	2.925
2F	1.086	1.000	1.000	1.000	1.000	2.731	2.731
1F	1.030	1.000	1.000	1.000	1.000	2.590	2.590

W I N D L O A D G E N E R A T I O N D A T A X - D I R E C T I O N

STORY NAME	PRESSURE	ELEV.	LOADED HEIGHT	LOADED BREADTH	WIND FORCE	ADDED FORCE	STORY FORCE	STORY SHEAR	OVERTURN`G MOMENT
Roof	3.10103	9.2	1.5	15.68	72.936233	0.0	72.936233	0.0	0.0
3F	3.10103	6.2	3.1	15.68	147.42499	0.0	147.42499	72.936233	218.8087
2F	2.969099	3.0	3.1	15.68	141.06159	0.0	141.06159	220.36122	923.96461
G.L.	2.830478	0.0	1.5	15.68	0.0	0.0	--	361.42281	2008.2331

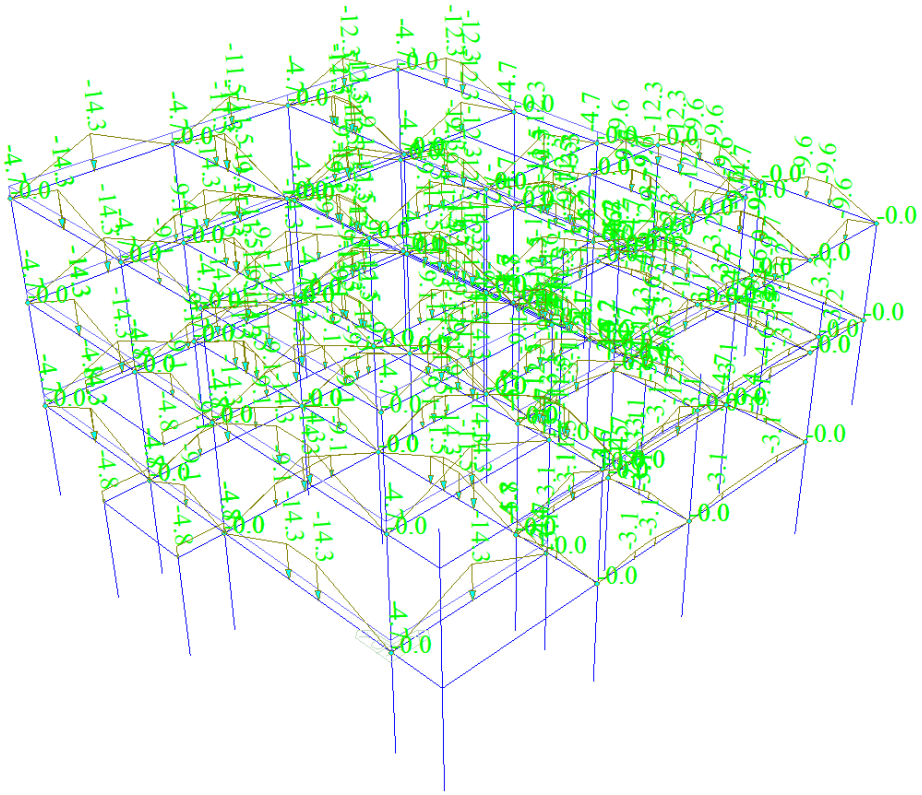
W I N D L O A D G E N E R A T I O N D A T A Y - D I R E C T I O N

STORY NAME	PRESSURE	ELEV.	LOADED HEIGHT	LOADED BREADTH	WIND FORCE	ADDED FORCE	STORY FORCE	STORY SHEAR	OVERTURN`G MOMENT
Roof	3.231997	9.2	1.5	19.81	96.038798	0.0	0.0	0.0	0.0
3F	3.231997	6.2	3.1	19.81	194.29849	0.0	0.0	0.0	0.0
2F	3.100066	3.0	3.1	19.81	193.61473	0.0	0.0	0.0	0.0
G.L.	3.004255	0.0	1.5	21.16	0.0	0.0	--	0.0	0.0

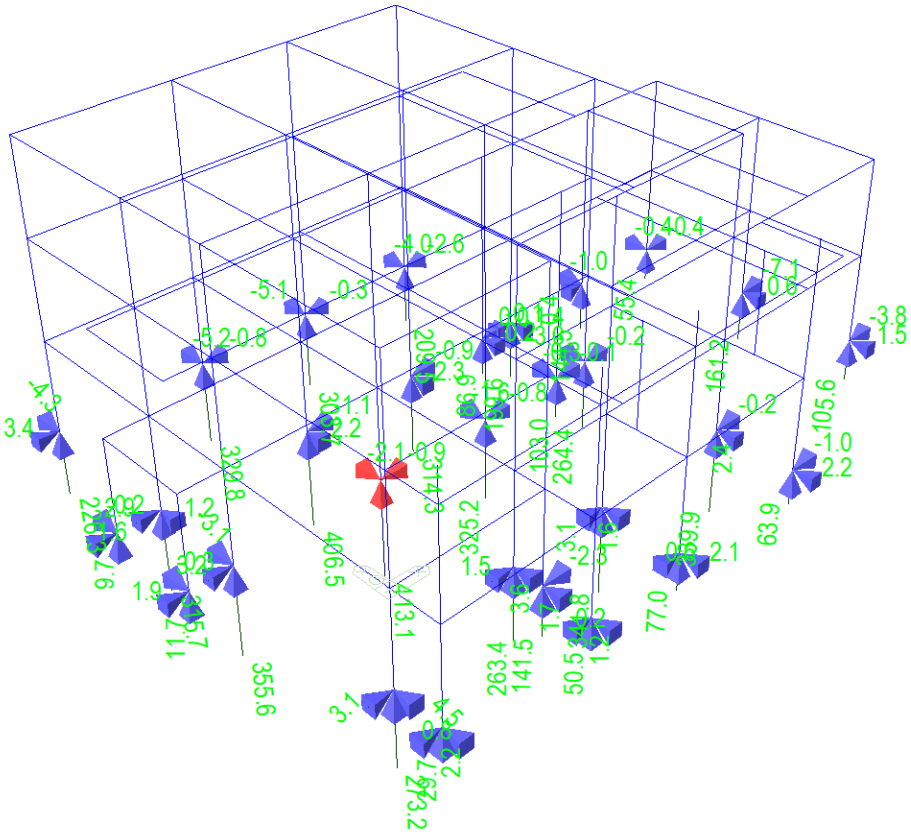
W I N D L O A D G E N E R A T I O N D A T A RZ - D I R E C T I O N

STORY NAME	TORSIONAL PRESSURE	ELEV.	LOADED HEIGHT	LOADED BREADTH	WIND TORSION	ADDED TORSION	STORY TORSION	ACCUMULATED TORSION
Roof	0.0	9.2	1.5	15.68	0.0	0.0	0.0	0.0
3F	0.0	6.2	3.1	15.68	0.0	0.0	0.0	0.0
2F	0.0	3.0	3.1	15.68	0.0	0.0	0.0	0.0
G.L.	0.0	0.0	1.5	15.68	0.0	0.0	--	0.0

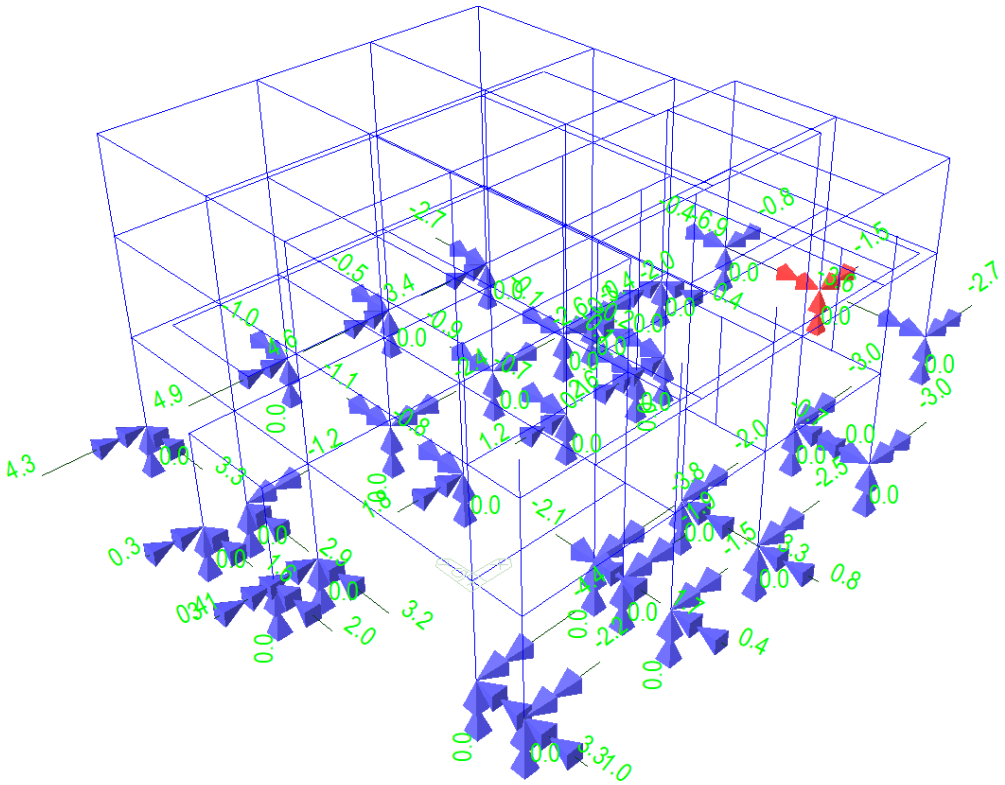
FRAME REACTIONS



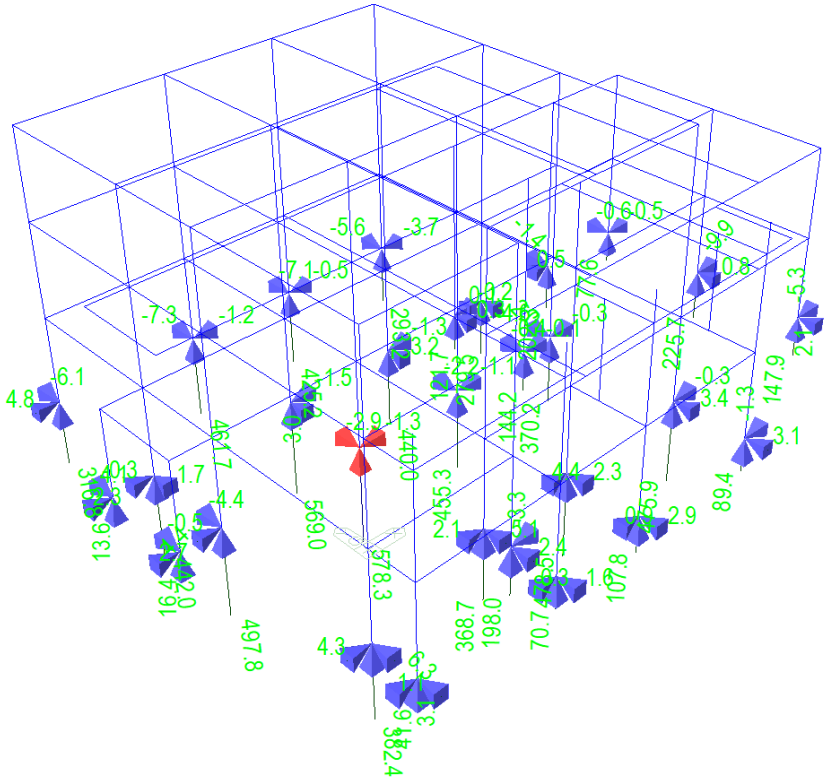
DL,LL & LINE LOADINGS



SUPPORT REACTIONS Fx,Fy & Fz (DL)



SUPPORT REACTIONS Mx,My & Mz(DL)



SUPPORT REACTIONS Fx,Fy & Fz(1.2DL)

STRUCTURAL STEEL ANALYSIS

ANALYSIS OF PURLINS :

Using 50 mm x 100 mm x 1.5 mm C-Purlins

General

Member Name: PURLIN

Apply this Member to: Dwg & Report

Section | Force | Design

Material

Material: A36

Member Type

Beam | Column | Brace

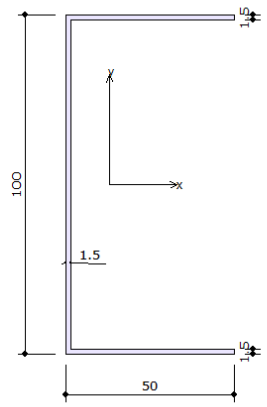
Section

Shape: Channel

Use DB: C-100x50x1.5x1.5

H	100.00	mm
B	50.00	mm
tw	1.50	mm
tf	1.50	mm
r1	0.00	mm
r2	0.00	mm

Double click to Zoom



Section Property

Area	295.500	mm²	Asx	100.000	mm²
Xbar	13.060	mm	Asy	150.000	mm²
Ybar	50.000	mm	Sx	9558.933	mm³
Ix	477946.625	mm⁴	Sy	2022.458	mm³
Iy	74710.324	mm⁴	Zx	10915.875	mm³
J	221.625	mm⁴	Zy	3640.824	mm³
ix	40.217	mm	Cw	126767881.183	mm⁶
iy	15.901	mm	Ixy	0.000	mm⁴

MIDAS DESIGN + CALCULATOR

WIND LOAD PROFILE

Story Name	Elev.	Pressure	Loaded H	Loaded B
Roof	9.2	3.1010303	1.5	15.68
3F	6.2	3.1010303	3.1	15.68
2F	3.0	2.9690991	3.1	15.68
G.L.	0.0	2.8304776	1.5	15.68

STORY NAME	Cp1 (Windward)	Cp2 (X-DIR) (Leeward)	Cp2 (Y-DIR) (Leeward)
Roof	0.800	-0.447	-0.500
3F	0.800	-0.447	-0.500
2F	0.800	-0.447	-0.500
1F	0.800	-0.430	-0.500

Max Spacing = 0.70 m
Pitch = 21.59 °
Wind load coefficients :
Windward = 0.80
Leeward = -0.45

Deadload:

Weight of purlins (1.56 kg/m) = 15.30 N/m
Weight of roofing + accessories (50pa) = 50 N/m
Total Deadload **= 65.03 N/m**
Roof Liveload = 1000Pa (0.7) = 700 N/m
Windload = 3.10kpa(0.70) = 2170 N/m

I. Normal Load Windward side (Wn) :

1.2DL = 78.04 N/m
1.6LL = 1,120 N/m
0.5W = 1085 N/m
Wn = (78.04+1120)cos21.59^0-0.80(1085)
Wn = 245.97 N/m

II. Normal Load Leeward side (Wn) :

1.2DL = 78.04 N/m
1.6LL = 1,120 N/m
0.5W = 1085 N/m
Wn = (78.04+1120)cos21.59^0+(-0.45)(1120)
Wn = 609.97 N/m

III. Tangential Load (Wt) :

Wt = (78.04+ 1120) sin21.59^0 - (1120)cos21.59
Wt = 600.59 N/m

Internal Force Calculations:

Bending Moment at x-axis :

Wn = 363.5 N/m
Mx = WnL^2/8 ---------- with sag rods at midspan
Mx = 1,113.33 N.m
Mx = 1.1 kN.m

Shear force :
V = 0.89 kN

Bending Moment at y-axis :

Wt = 600.59 N/m
My = WnL^2/90---------- with sag rods at L/3
My = 163.51 N.m
My = 0.16 kN.m

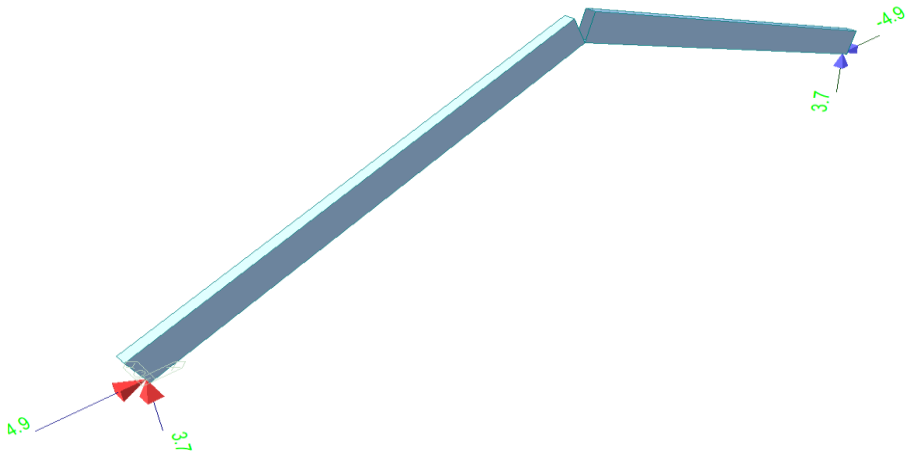
Shear force :
V = 1.3 kN

RAFTER LOAD ANALYSIS :

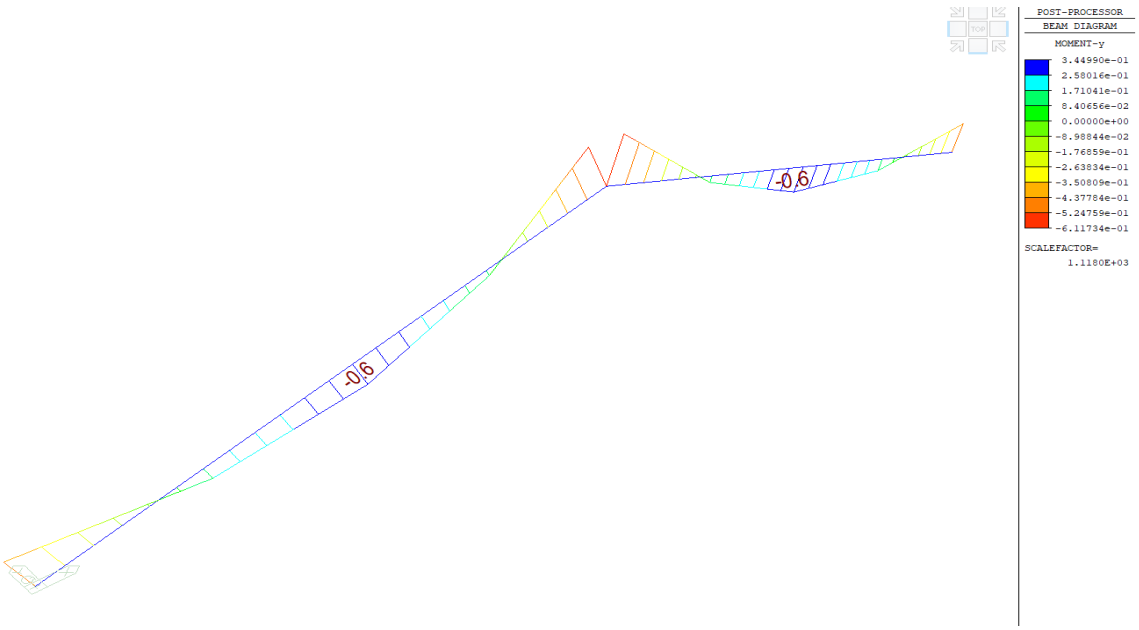
Pitch = 21.59 ^{0}
Rafter Bay Length, L = 2.03 m
N = (2.03/0.70) + 1 = 2.9 say 4pcs
Max spacing = 3.79 m
Load from Purlins,
P = Wn(L)/2
P = (363.5)(4.95)/2
P = 899 N ------- reaction of 1 purlin
Resultant(R) = 899(4)
R = 3,596.0 N
R = 3.59 kN

w = R/L
w = 3.59/2.03
w = 1.76 kN/m

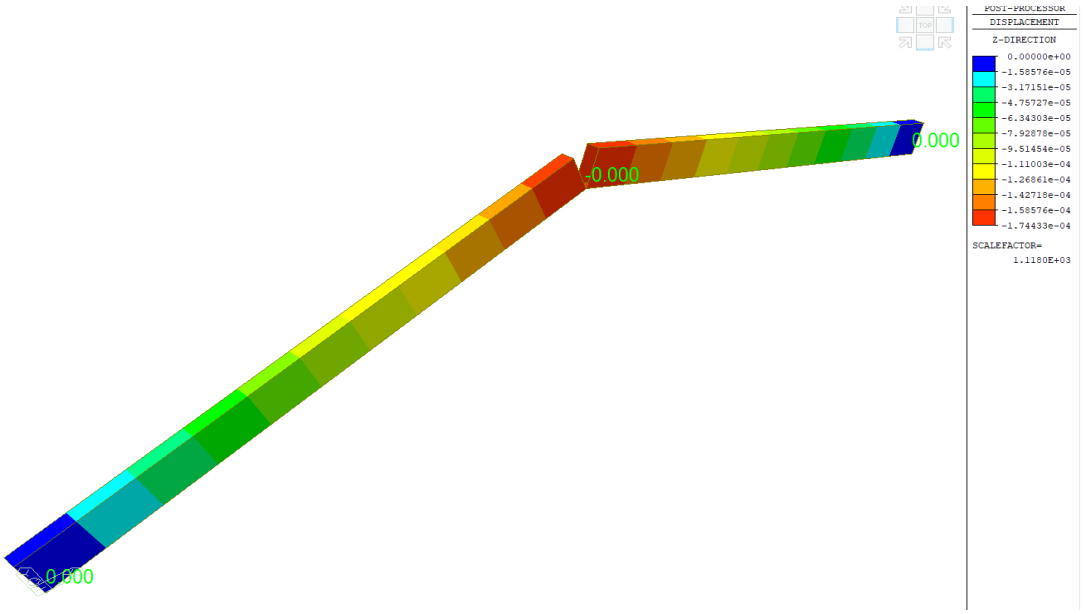
RAFTER LOADING AND REACTION



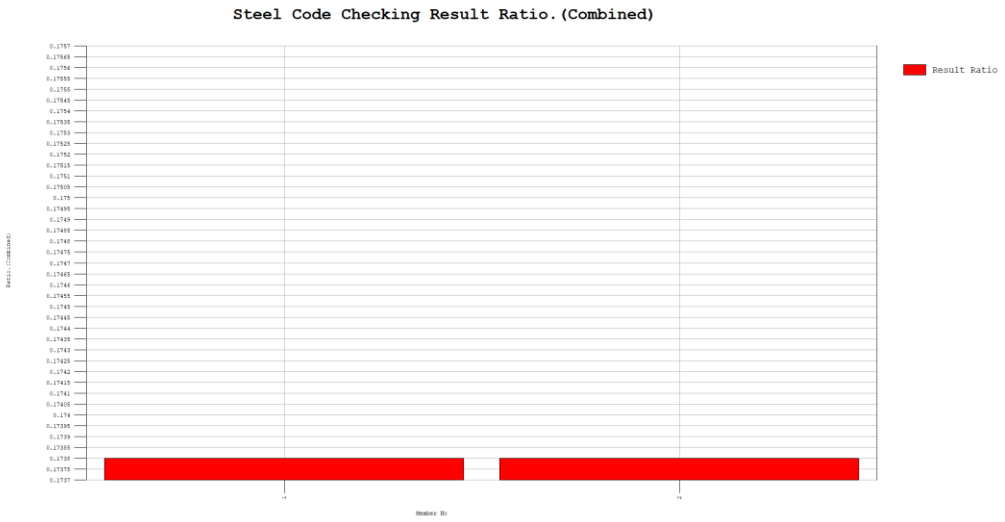
RAFTER REACTIONS



RAFTER BENDING MOMENT



RAFTER DEFLECTED SHAPE



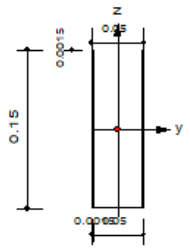
COMBINED STRESS RATIO

ANALYSIS OF RECTUBE RAFTER

(50mm x 150 mm x 1.5 mm THK RECTUBE)

1. Design Information

Design Code	AISC(15th)-LRFD16
Unit System	kN, m
Member No	2
Material	A36 (No:1)
	(Fy = 248211, Es = 199948024)
Section Name	RECTUBE (No:1)
	(Built-up Section).
Member Length	: 2.03802



Depth	0.15000	Web Thick	0.00150
Flg Width	0.05000	Top F Thick	0.00150
Web Center	0.04850	Bot.F Thick	0.00150
Area	0.00059	Asz	0.00045
Qyb	0.00456	Qzb	0.00209
Iyy	0.00000	Izz	0.00000
Ybar	0.02500	Zbar	0.07500
Syy	0.00002	Szz	0.00001
ry	0.05237	rz	0.02218

2. Member Forces

Axial Force	Fxx = -5.4402 (LCB: 2, POS:J)
Bending Moments	My = -0.7393, Mz = 0.00000
End Moments	Myi = -0.5299, Myj = -0.7341 (for Lb)
	Myi = -0.5299, Myj = -0.7341 (for Ly)
	Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces	Fyy = 0.00000 (LCB: 2, POS:I)
	Fzz = 2.15311 (LCB: 2, POS:J)

3. Design Parameters

Unbraced Lengths	Ly = 2.03802, Lz = 2.03802, Lb = 2.03802
Effective Length Factors	Ky = 1.00, Kz = 1.00
Moment Factor / Bending Coefficient	
	Cmy = 1.00, Cmz = 1.00, Cb = 1.00

4. Checking Results

Slenderness Ratio

KL/r = 91.9 < 200.0 (Memb:2, LCB: 2)..... O.K

Axial Strength

Pr/Pc = 5.4402/61.4676 = 0.089 < 1.000 ..... O.K

Bending Strength

Mry/Mcy = 0.73930/5.70512 = 0.130 < 1.000 ..... O.K

Mrz/Mcz = 0.00000/1.34438 = 0.000 < 1.000 ..... O.K

Combined Strength (Compression+Bending)

Pr/Pc = 0.09 < 0.20

Rmax = Pr/(2*Pc) + [Mry/Mcy + Mrz/Mcz] = 0.174 < 1.000 ..... O.K

Shear Strength

Vry/Vcy = 0.000 < 1.000 ..... O.K

Vrz/Vcz = 0.058 < 1.000 ..... O.K

Torsion Strength

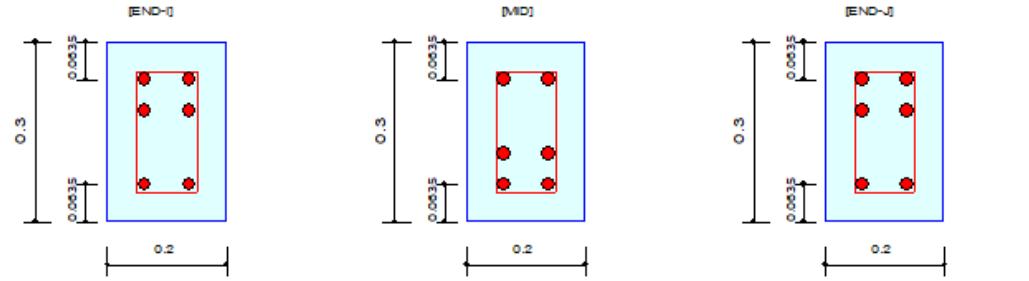
Tr/Tc = 0.00000/0.00000 = 0.000 < 1.000 ..... O.K

REINFORCED CONCRETE ANALYSIS

ANALYSIS OF ROOF BEAM (RB)

1. Design Information

Design Code	NSCP 2015	Unit System	kN, m
Material Data	fc = 20684.3, fy = 230000, fys = 230000 KPa		
Section Property	RB (No : 1)	Beam Span	4.95m



[END-I]	[MID]	[END-J]
TOP 4-D12	TOP 2-D12	TOP 4-D12
BOT 2-D12	BOT 4-D12	BOT 2-D12
STIRRUPS 2-D10 @100	STIRRUPS 2-D10 @150	STIRRUPS 2-D10 @100

2. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	8	8	24
Moment (Mu)	17.85	7.56	0.75
Factored Strength (φMn)	19.03	10.73	19.03
Check Ratio (Mu/φMn)	0.9380	0.7047	0.0392
(+) Load Combination No.	26	8	8
Moment (Mu)	0.00	5.23	7.72
Factored Strength (φMn)	10.73	19.03	10.73
Check Ratio (Mu/φMn)	0.0000	0.2746	0.7199
Using Rebar Top (As.top)	0.0005	0.0002	0.0005
Using Rebar Bot (As.bot)	0.0002	0.0005	0.0002

3. Shear Capacity

	END-I	MID	END-J
Load Combination No.	8	8	12
Factored Shear Force (Vu)	9.37	7.27	3.57
Shear Strength by Conc.(φVc)	24.79	26.89	26.89
Shear Strength by Rebar.(φVs)	59.07	42.72	64.08
Using Shear Reinf. (As/V)	0.0016	0.0010	0.0016
Using Stirrups Spacing	2-D10 @100	2-D10 @150	2-D10 @100
Check Ratio	0.1117	0.1044	0.0392

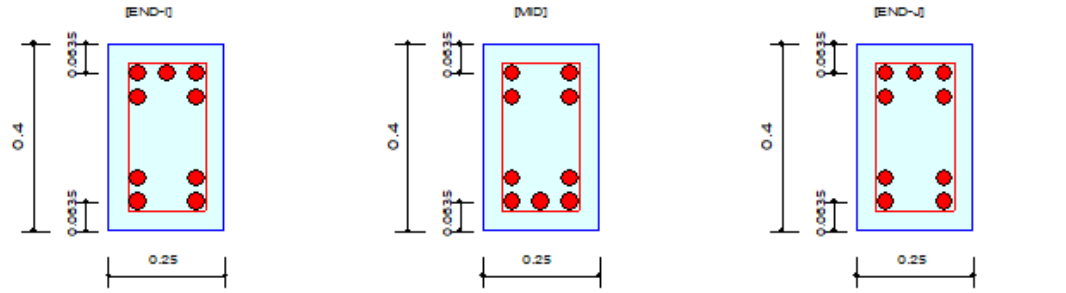
5. Deflection Control

	Short-Time	Long-Time
Deflection	0.0001	0.0014
Deflection Limitation	L/360 = 0.0138	L/480 = 0.0103
Result	O.K	O.K

ANALYSIS OF FLOOR BEAM (B1)

1. Design Information

Design Code	NSCP 2015	Unit System	kN, m
Material Data	fc = 20684.3, fy = 280000, fys = 230000 KPa		
Section Property	B1 (No : 1)	Beam Span	4.95m



[END-I]	[MID]	[END-J]
TOP 5-D20	TOP 4-D20	TOP 5-D20
BOT 4-D20	BOT 5-D20	BOT 4-D20
STIRRUPS 2-D10 @100	STIRRUPS 2-D10 @150	STIRRUPS 2-D10 @100

2. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	8	8	24
Moment (Mu)	31.62	13.54	2.27
Factored Strength (φMn)	106.32	86.42	106.32
Check Ratio (Mu/φMn)	0.2974	0.1567	0.0213
(+) Load Combination No.	20	8	8
Moment (Mu)	0.14	9.62	14.70
Factored Strength (φMn)	86.42	106.32	86.42
Check Ratio (Mu/φMn)	0.0017	0.0905	0.1701
Using Rebar Top (As.top)	0.0016	0.0013	0.0016
Using Rebar Bot (As.bot)	0.0013	0.0016	0.0013

3. Shear Capacity

	END-I	MID	END-J
Load Combination No.	8	8	12
Factored Shear Force (Vu)	16.36	12.86	6.30
Shear Strength by Conc.(φVc)	45.27	44.63	44.63
Shear Strength by Rebar.(φVs)	86.30	56.72	85.08
Using Shear Reinf. (AsV)	0.0016	0.0010	0.0016
Using Stirrups Spacing	2-D10 @100	2-D10 @150	2-D10 @100
Check Ratio	0.1243	0.1269	0.0486

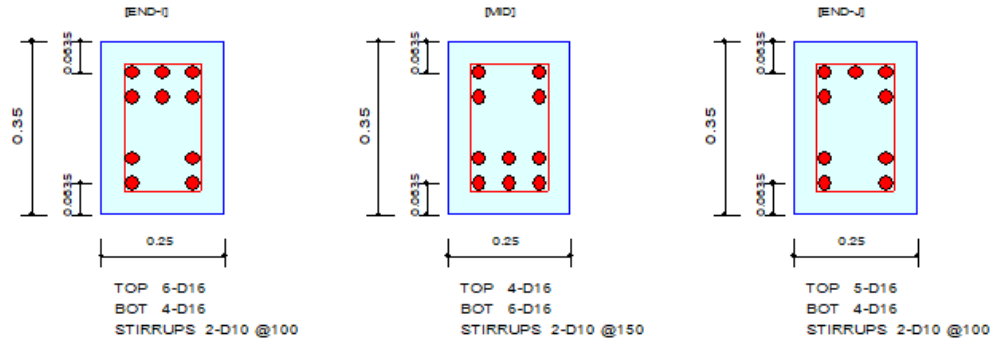
5. Deflection Control

	Short-Time	Long-Time
Deflection	0.0001	0.0006
Deflection Limitation	L/360 = 0.0138	L/480 = 0.0103
Result	O.K	O.K

ANALYSIS FLOOR BEAM (B2)

1. Design Information

Design Code	NSCP 2015	Unit System	kN, m
Material Data	fc = 20684.3, fy = 280000, fys = 230000 KPa		
Section Property	B2 (No : 1)	Beam Span	4.95m



2. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	8	8	24
Moment (Mu)	26.63	11.29	1.72
Factored Strength (φMn)	68.56	48.72	60.31
Check Ratio (Mu/φMn)	0.3885	0.2318	0.0285
(+) Load Combination No.	26	8	8
Moment (Mu)	0.00	8.03	12.00
Factored Strength (φMn)	48.72	68.56	48.72
Check Ratio (Mu/φMn)	0.0000	0.1170	0.2463
Using Rebar Top (As.top)	0.0012	0.0008	0.0010
Using Rebar Bot (As.bot)	0.0008	0.0012	0.0008

3. Shear Capacity

	END-I	MID	END-J
Load Combination No.	8	8	12
Factored Shear Force (Vu)	13.93	10.87	5.46
Shear Strength by Conc.(φVc)	37.81	37.81	37.81
Shear Strength by Rebar.(φVs)	72.08	48.05	72.08
Using Shear Reinf. (AsV)	0.0016	0.0010	0.0016
Using Stirrups Spacing	2-D10 @100	2-D10 @150	2-D10 @100
Check Ratio	0.1268	0.1266	0.0497

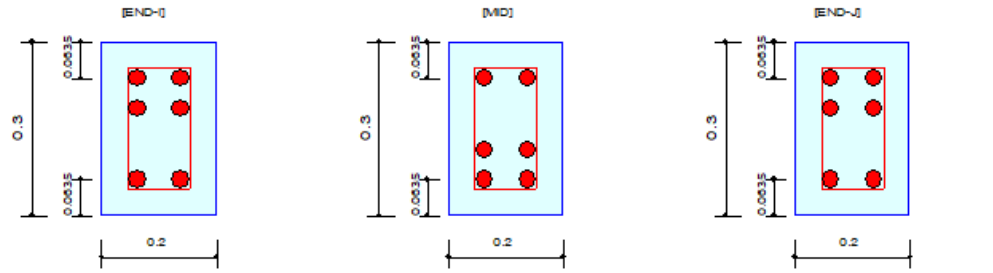
5. Deflection Control

	Short-Time	Long-Time
Deflection	0.0001	0.0008
Deflection Limitation	L/360 = 0.0138	L/480 = 0.0103
Result	O.K	O.K

ANALYSIS FLOOR BEAM (B3)

1. Design Information

Design Code	NSCP 2015	Unit System	kN, m
Material Data	fc = 20684.3, fy = 280000, fys = 230000 KPa		
Section Property	B3 (No : 3)	Beam Span	3.13m



2. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	13	25	9
Moment (Mu)	23.93	11.12	23.58
Factored Strength (φMn)	37.09	22.34	37.09
Check Ratio (Mu/φMn)	0.6454	0.4977	0.6359
(+) Load Combination No.	21	13	25
Moment (Mu)	21.16	11.40	21.42
Factored Strength (φMn)	22.34	37.09	22.34
Check Ratio (Mu/φMn)	0.9470	0.3074	0.9585
Using Rebar Top (As.top)	0.0008	0.0004	0.0008
Using Rebar Bot (As.bot)	0.0004	0.0008	0.0004

3. Shear Capacity

	END-I	MID	END-J
Load Combination No.	14	14	10
Factored Shear Force (Vu)	23.86	21.21	23.64
Shear Strength by Conc.(φVc)	24.56	24.56	24.56
Shear Strength by Rebar.(φVs)	58.53	46.82	58.53
Using Shear Reinf. (AsV)	0.0016	0.0013	0.0016
Using Stirrups Spacing	2-D10 @100	2-D10 @125	2-D10 @100
Check Ratio	0.2872	0.2971	0.2845

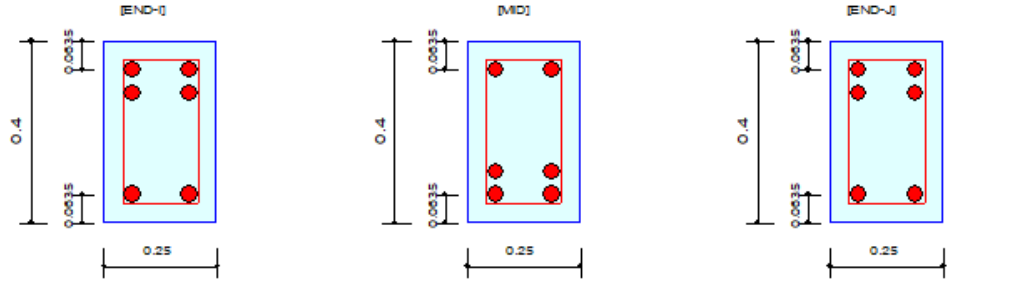
5. Deflection Control

	Short-Time	Long-Time
Deflection	-0.0000	0.0003
Deflection Limitation	L/360 = 0.0087	L/480 = 0.0065
Result	O.K	O.K

ANALYSIS OF TIE-BEAM (GB)

1. Design Information

Design Code	NSCP 2015	Unit System	kN, m
Material Data	fc = 20684.3, fy = 280000, fys = 230000 KPa		
Section Property	GB (No : 5)	Beam Span	3.13m



TOP 4-D20
BOT 2-D20
STIRRUPS 2-D10 @100

TOP 2-D20
BOT 4-D20
STIRRUPS 2-D10 @100

TOP 4-D20
BOT 2-D20
STIRRUPS 2-D10 @100

2. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	13	13	9
Moment (Mu)	65.96	26.33	59.56
Factored Strength (φMn)	86.77	50.11	86.77
Check Ratio (Mu/φMn)	0.7601	0.5254	0.6864
(+) Load Combination No.	21	13	25
Moment (Mu)	33.01	23.47	37.43
Factored Strength (φMn)	50.11	86.77	50.11
Check Ratio (Mu/φMn)	0.6588	0.2705	0.7469
Using Rebar Top (As.top)	0.0013	0.0006	0.0013
Using Rebar Bot (As.bot)	0.0006	0.0013	0.0006

3. Shear Capacity

	END-I	MID	END-J
Load Combination No.	14	14	10
Factored Shear Force (Vu)	73.58	50.64	69.49
Shear Strength by Conc.(φVc)	44.63	47.83	44.63
Shear Strength by Rebar.(φVs)	85.08	91.18	85.08
Using Shear Reinf. (AsV)	0.0016	0.0016	0.0016
Using Stirrups Spacing	2-D10 @100	2-D10 @100	2-D10 @100
Check Ratio	0.5673	0.3643	0.5357

5. Deflection Control

	Short-Time	Long-Time
Deflection	0.0000	0.0001
Deflection Limitation	L/360 = 0.0087	L/480 = 0.0065
Result	O.K	O.K

ANALYSIS OF STAIR

■ MEMBER NAME : STAIR

1. General Information

(1) Design Code : ACI318M-14
(2) Code Unit : N, mm

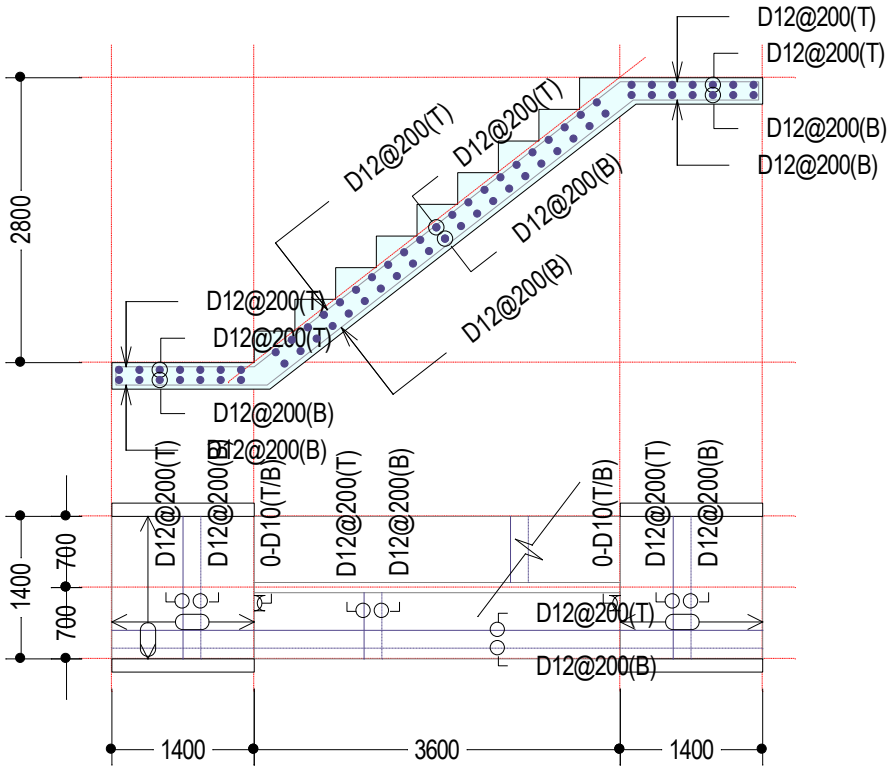
2. Design Data

(1) Material

- F'_c : 20.70MPa
- F_y : 275MPa
- F_{ys} : 400MPa

(2) Design Load

- DL (Stair) : 3.530KPa
- DL (Landing) : 3.060KPa
- Live Load : 2.400KPa



(3) Support : By Landing

(4) Thickness

- Stair : 150mm
- Landing : 130mm
- Cover : 20.00mm

(5) Length

- Landing(Left) : 1.400m
- Landing(Right) : 1.400m
- Stair : 3.600m

(6) Size

- Height : 2.800m
- Width : 1.400m

3. Calculate Design Load

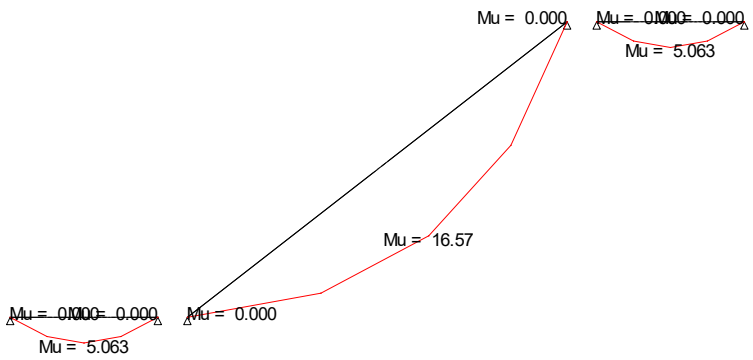
(1) Stair

- $\omega_u = 1.2\omega_D + 1.6\omega_L = 8.076$KPa

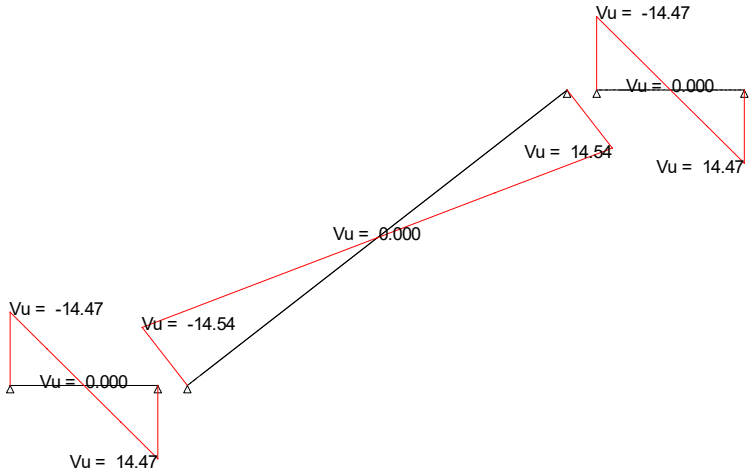
(2) Landing

- $\omega_u = 1.2\omega_D + 1.6\omega_L = 7.512$KPa

4. Moment Diagram



5. Shear Force Diagram



6. Check Stair

(1) Moment Capacity

Rebar	Land(L)	Stair	Land(R)	Min. Land	Min. Stair
M_u (kN·m/mm)	5.063	16.57	5.063	ρ = 0.00200	ρ = 0.00200
D10	@378	@135	@378	@450(458)	@450(458)
D10+12	@450	@162	@450	@450(458)	@450(458)
D12	@450	@191	@450	@450(458)	@450(458)
D12+16	@450	@256	@450	@450(458)	@450(458)
D16	@450	@328	@450	@450(458)	@450(458)

(2) Shear Capacity

-	Land(L)	Stair	Land(R)
V_u (kN/mm)	-14.47	-14.54	14.47
$øV_n$ (kN/mm)	56.85	68.45	56.85
V_u / $øV_n$	0.254	0.212	0.254

ANALYSIS OF STEEL DECK SLAB(S-1)

SLAB ON METAL DECK ANALYSIS / DESIGN

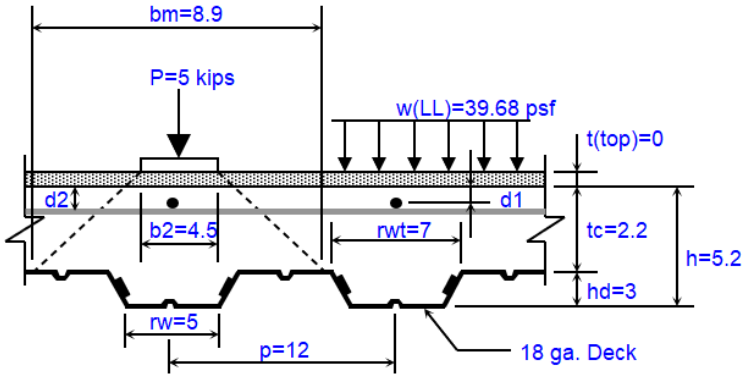
For Composite Steel Deck System without Studs

Subjected to Either Uniform Live load or Concentrated Load

Job Name:		Subject:			
Job Number:		Originator:		Checker:	

Input Data:

Composite Deck Type =	3"x12"	
Composite Deck Gage =	18	
Deck Steel Yield, Fyd =	33.0	ksi
Thk. of Topping, t(top) =	0.0000	in.
Total Slab Thickness, h =	5.2000	in.
Concrete Unit Wt., wc =	150	pcf
Concrete Strength, f'c =	2.9	ksi
Deck Clear Span, L =	5.5000	ft.
Slab Span Condition =	2-Span	
Neg. Mom. Reinf., Asn =	0.200	in.^2/ft.
Depth to Asn, d1 =	2.0000	in.
Distribution Reinf., Ast =	0.200	in.^2/ft.
Depth to Ast, d2 =	2.5000	in.
Reinforcing Yield, fy =	40.0	ksi
Uniform Live Load, w(LL) =	39.68	psf
Concentrated Load, P =	5.000	kips
Load Area Width, b2 =	4.5000	in.
Load Area Length, b3 =	4.5000	in.



Nomenclature

Note: Composite deck is assumed to add to flexural moment capacity of slab, by functioning as positive moment reinforcing. Composite deck shear capacity is included in total beam shear capacity.

Results:

Properties and Data:

hd =	3.000	in.	hd = deck rib height
p =	12.000	in.	p = deck rib pitch (center to center distance between flutes)
rw =	5.000	in.	rw = deck rib bearing width (from SDI Table)
rw(avg) =	6.000	in.	rw(avg) = average deck rib width (from SDI Table)
td =	0.0474	in.	td = deck thickness (inch equivalent of gage)
Asd =	0.810	in.^2	Asd = area of steel deck/ft. width (from SDI Table)
Id =	1.324	in.^4	Id = inertia of steel deck/ft. width (from SDI Table)
yd =	1.500	in.	yd = C.G. of deck
Sp =	0.832	in.^3	Sp = positive section modulus of steel deck/ft. width (from SDI Table)
Sn =	0.832	in.^3	Sn = negative section modulus of steel deck/ft. width (from SDI Table)
tc =	2.200	in.	tc = h-hd = thickness of slab above top of deck ribs
Wd =	2.80	psf	Wd = weight of deck/ft. (from SDI Table)
Wc =	46.25	psf	Wc = ((t(top)+$h-hd)*12+(hd*(rwt+rw)/2))/144*wc (wt. of conc. for 12" width)
w(DL) =	49.05	psf	w(DL) = Wd+Wc = total dead weight of deck plus concrete

Properties and Data:

hd =	3.000	in.	hd = deck rib height
p =	12.000	in.	p = deck rib pitch (center to center distance between flutes)
rw =	5.000	in.	rw = deck rib bearing width (from SDI Table)
rw(avg) =	6.000	in.	rw(avg) = average deck rib width (from SDI Table)
td =	0.0474	in.	td = deck thickness (inch equivalent of gage)
Asd =	0.810	in.^2	Asd = area of steel deck/ft. width (from SDI Table)
Id =	1.324	in.^4	Id = inertia of steel deck/ft. width (from SDI Table)
yd =	1.500	in.	yd = C.G. of deck
Sp =	0.832	in.^3	Sp = positive section modulus of steel deck/ft. width (from SDI Table)
Sn =	0.832	in.^3	Sn = negative section modulus of steel deck/ft. width (from SDI Table)
tc =	2.200	in.	tc = h-hd = thickness of slab above top of deck ribs
Wd =	2.80	psf	Wd = weight of deck/ft. (from SDI Table)
Wc =	46.25	psf	Wc = ((t(top)+$h-hd)*12+(hd*(rwt+rw)/2))/144*wc (wt. of conc. for 12" width)
w(DL) =	49.05	psf	w(DL) = Wd+Wc = total dead weight of deck plus concrete

Bending in Deck as a Form Only for Construction Loads:

P =	0.150	kips	P = 0.75*200 lb. man (applied over 1-foot width of deck)
W2 =	20.00	psf	W2 = 20 psf construction load
Fb(allow) =	31.35	ksi	Fb(allow) = 0.95*Fyd
+Mu =	0.46	ft-kips/ft.	+Mu = (1.6*Wc+1.2*Wd)/1000*0.096*L^2+1.4*(0.203*P*L)
or: +Mu =	0.22	ft-kips/ft.	+Mu = (1.6*Wc+1.2*Wd+1.4*W2)/1000*0.070*L^2
+fbu =	6.62	ksi	+fbu = +Mu(max)*12/Sp **+fbu <= Allow., O.K.**
-Mu =	0.26	ft-kips/ft.	-Mu = (1.6*Wc+1.2*Wd)/1000*0.063*L^2+1.4*(0.094*P*L)
or: -Mu =	0.40	ft-kips/ft.	-Mu = (1.6*Wc/1000+1.2*Wd/1000+1.4*W2/1000)*0.125*L^2
-fbu =	5.75	ksi	-fbu = -Mu*12/Sn **-fbu <= Allow., O.K.**

Beam Shear in Deck as a Form Only for Construction Loads:

ϕVd =	4.88	kips	ϕVd = beam shear capacity of deck alone (LRFD value from SDI Table)
Vu =	0.362	kips	Vu = (1.6*Wc+1.2*Wd+1.4*W2)/1000*0.625*L

Vu <= Allow., O.K.

Shear and Negative Moment Interaction in Deck as a Form Only for Construction Loads:

S.R. =	0.039	S.R. = (Vu/ϕVd)^2+(Mu/(Fb(allow)*Sn/12))^2 **S.R. <= 1.0, O.K.**

Web Crippling (End Bearing) in Deck as a Form Only for Construction Loads:

ϕRd =	2.060	kips	ϕRd = beam shear capacity of deck alone (LRFD value from SDI Table)
Rui =	0.543	kips	Rui = ((1.6*Wc+1.2*Wd+1.4*W2)/1000*1.25*L)*0.75 (allowing 1/3 increase)

Ri <= Rd, O.K.

Deflection in Deck as a Form Only for Construction Loads:

Δ(DL) =	0.011	in.	Δ(DL) = 0.0054*(Wc+Wd)/12000*L^4/(Es*Id) (Es=29000 ksi)
Δ(ratio) =	L/6051		Δ(ratio) = L*12/Δ(DL)

Strong Axis Positive Moment for Uniform Live Load:

+ϕMno =	4.36	ft-kips/ft.	+ϕMno = (0.85*Fyd*Scr)/12
+Mu =	0.36	ft-kips/ft.	+Mu = 1.2*(0.096*w(DL)/1000*L^2)+1.6*(0.096*w(LL)/1000*L^2)

+Mu <= Allow., O.K.

Strong Axis Negative Moment for Uniform Live Load:

-ϕMno =	1.76	ft-kips/ft.	-ϕMno = (0.90*Asn*Fy*((h-d1)-a/2))/12
-Mu =	0.51	ft-kips/ft.	-Mu = 1.4*(0.125*w(DL)/1000*L^2)+1.7*(0.125*w(LL)/1000*L^2)

-Mu <= Allow., O.K.

Beam Shear for Uniform Live Load:

ϕVd =	4.88	kips	ϕVd = beam shear capacity of deck alone (from SDI Table)
Ac =	35.01	in.^2	Ac = h*((rw+2*h*(rwt-rw)/2/hd)+rw)/2
ϕVc =	3.21	kips	ϕVc = 2*0.85*SQRT(f'c*1000)*Ac/1000
ϕVnt =	6.41	kips	ϕVnt = ϕVd+ϕVc <= 4*0.85*SQRT(f'c*1000)*Ac/1000 (without studs)
Vu =	0.42	kips	Vu = 1.2*(0.625*w(DL)/1000*L)+1.6*(0.625*w(LL)/1000*L)

Vu <= Allow., O.K.

Shear and Negative Moment Interaction for Uniform Live Load:

S.R. =	0.090	S.R. = (Vu/ϕVnt)^2+(Mu/(+ϕMno))^2 **S.R. <= 1.0, O.K.**

Deflection for Uniform Live Load:

wa(LL) =	1249.74	psf	wa(LL) = allow. live load = (ϕMno *(1/0.070)/L^2-1.2*w(DL))/1.6
Δ(LL) =	0.001	in.	Δ(LL) = 0.0054*w(LL)/12000*L^4/(Es*Iav) (Es=29000 ksi)
Δ(ratio) =	L/57693		Δ(ratio) = L*12/Δ(LL)

Maximum Effective Slab Strip Width for Concentrated Load:

be(max) =	45.18	in.	be(max) = 8.9*(tc/h)*12

Strong Axis Positive Moment for Concentrated Load:

x =	33.00	in.	x = (L*12)/2 (assumed for bending)
bm =	8.90	in.	bm = b2+2*t(top)+2*tc
be =	30.90	in.	be = bm+4/3*(1-x/(L*12))*x <= be(max)
n =	9		n = Es/Ec = 29000/(33*wc^1.5*SQRT(f'c*1000)/1000), rounded
a =	1.598	in.	a = (-Asd+SQRT((Asd)^2-4*(12/n)/2*(-Asd*(h-yd))))/(2*(12/n)/2)
Z =	2.102	in.	Z = h-yd-a
Icr =	6.72	in.^4	Icr = (12/n)*a^3/3+Asd*Z^2+Id
Scr =	1.86	in.^3	Scr = Icr/(h-a)
+ϕMno =	4.36	ft-kips/ft.	+ϕMno = (0.85*Fyd*Scr)/12
+Mu =	3.64	ft-kips/ft.	+Mu = 1.2*(0.096*w(DL)/1000*L^2)+1.6*(0.203*P*L)*(12/be)

+Mu <= Allow., O.K.

(continued

Strong Axis Negative Moment for Concentrated Load:

x =	33.00	in.	x = (L*12)/2 (assumed for bending)
bm =	8.90	in.	bm = b2+2*t(top)+2*tc
be =	30.90	in.	be = bm+4/3*(1-x/(L*12))*x <= be(max)
b =	6.00	in.	b = 12/p*rw(avg) = width for negative bending
a =	0.541	in.	a = Asn*Fy/(0.85*f'c*b)
-ϕMno =	1.76	ft-kips/ft.	-ϕMno = (0.90*Asn*Fy*((h-d1)-a/2))/12
-Mu =	1.97	ft-kips/ft.	-Mu = 1.4*(0.125*w(DL)/1000*L^2)+1.7*(0.094*P*L)*(12/be)

-Mu > Allow.

Beam Shear for Concentrated Load:

x =	5.20	in.	x = h (assumed for beam shear)
bm =	8.90	in.	bm = b2+2*t(top)+2*tc
be =	13.69	in.	be = bm+(1-x/(L*12))*x <= be(max)
ϕVd =	4.88	kips	ϕVd = beam shear capacity of deck alone (from SDI Table)
Ac =	35.01	in.^2	Ac = h*((rw+2*h*(rwt-rw)/2/hd)+rw)/2
ϕVc =	3.21	kips	ϕVc = 2*0.85*SQRT(f'c*1000)*Ac/1000
ϕVnt =	6.41	kips	ϕVnt = ϕVd+ϕVc <= 4*0.85*SQRT(f'c*1000)*Ac/1000 (without studs)
Vu =	7.21	kips	Vu = 1.2*(0.625*w(DL)/1000*L)+1.6*(P*12/be) **Vu > Allow.**

Shear and Negative Moment Interaction for Concentrated Load:

S.R. = 2.518 S.R. = (Vu/ϕVnt)^2+(Mu/(-ϕMno))^2 **S.R. > 1.0**

Punching Shear for Concentrated Load:

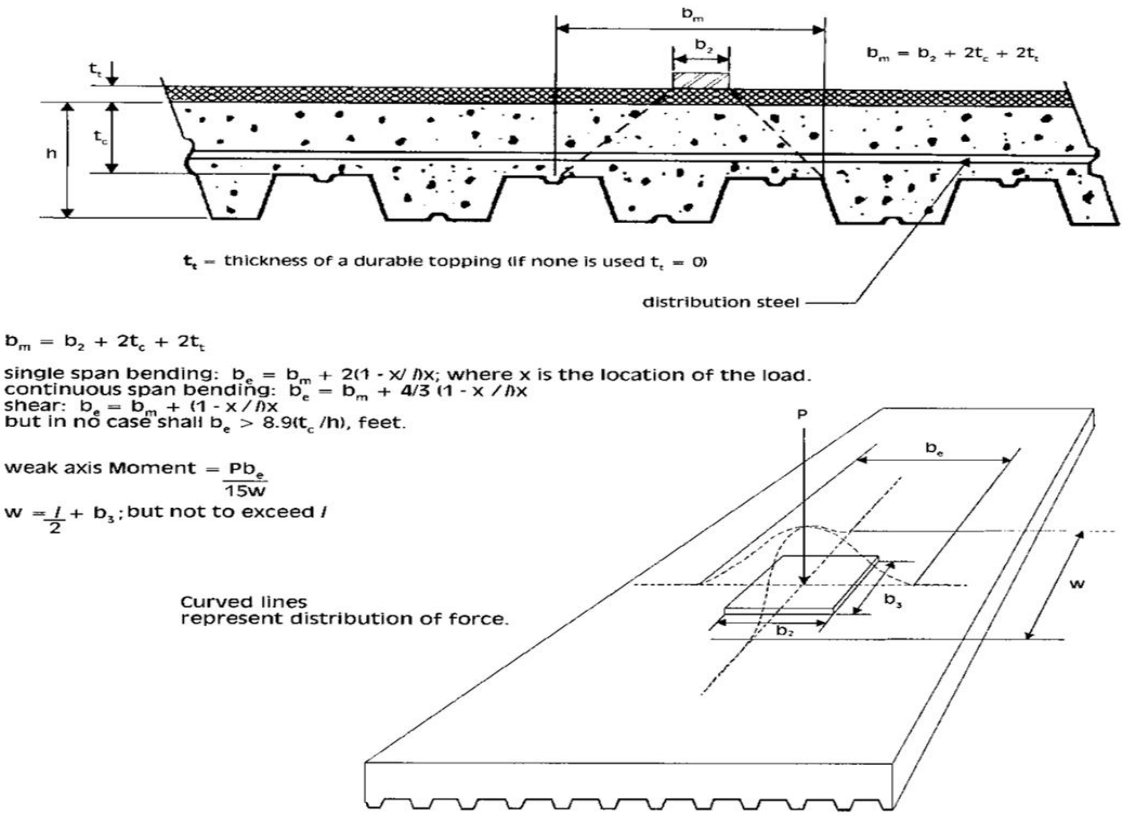
bo =	26.80	in.	bo = 2*(b2+b3+2*tc)
ϕVc =	5.40	kips	ϕVc = 2*0.85*SQRT(f'c*1000)*bo*tc/1000
Vu =	8.50	kips	Vu =1.7*P **Vu > Allow.**

Deflection for Concentrated Load:

yuc =	2.372	in.	yuc = ((12/n)*tc^2/2+(12/n)/(12/rw(avg))*hd*(tc+hd/2)+....
	---		....+Asd*(tc+hd-yd))/(tc*(12/n)+Asd+(12/n)/(12/rw(avg))*hd)
Iuc =	13.71	in.^4	Iuc = (12/n)*tc^3/12+(12/n)*tc*(yuc-tc/2)^2+Id+Asd*(h-yuc-yd)^2+....
	---		....+(12/n)/(12/rw(avg))*hd^3/12+(12/n)/(12/rw(avg))*hd*(h-hd/2-yuc)^2
Iav =	10.21	in.^4	Iav = (Icr+Iuc)/2 (average of cracked and uncracked)
Δ(P) =	0.028	in.	Δ(P) = 0.015*P*(12/be)*L^3/(Es*Iav) (Es=29000 ksi)
Δ(ratio) =	L/2334		Δ(ratio) = L*12/Δ(P)

Weak Axis Moment for Concentrated Load:

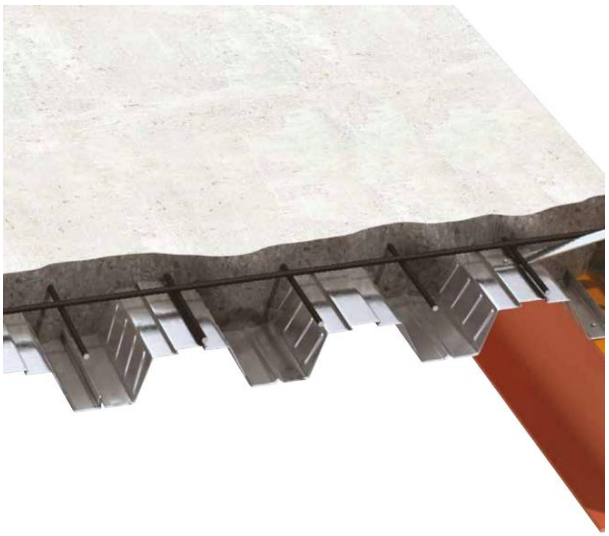
A'c =	26.40	in.^2	A'c = 12*tc
Ast(min) =	0.020	in.^2/ft.	Ast(min) = 0.00075*A'c **Ast >=Ast(min), O.K.**
x =	33.00	in.	x = (L*12)/2 (assumed for bending)
bm =	8.90	in.	bm = b2+2*t(top)+2*tc
be =	30.90	in.	be = bm+4/3*(1-x/(L*12))*x <= be(max)
w =	37.50	in.	w = (L*12)/2+b3 <= L*12
a =	0.270	in.	a = Ast*Fy/(0.85*f'c*b) where: b = 12"
ϕMnw =	1.34	ft-kips/ft.	ϕMnw = (0.85*As*Fy*(d2-a/2))/12
Muw =	0.44	ft-kips/ft.	Muw = (1.6*(P*be*12/(15*w)))/12 **Muw <=Allow., O.K.**



Concentrated Load Distribution for Slab on Metal Deck

GAGE 18 STEEL DECK DETAILS :

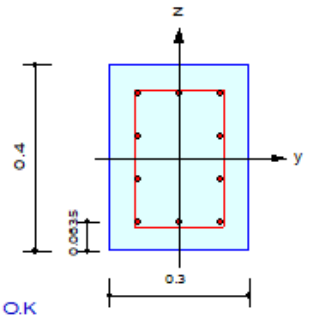
Slab = 130mm THK
Transverse Bars = 12 mm dia RSB @ 200 mm BW.
Longitudinal Bars = 16 mm dia RSB @ 200 mm BW.



ANALYSIS OF COLUMN (C-1)

1. Design Condition

Design Code	: NSCP 2015	UNIT SYSTEM : kN, m
Member Number	: 145 (PM), 135, 159 (Shear-y,z)	
Material Data	: fc = 20684.3, fy = 280000, fys = 230000 KPa	
Column Height	: 3.2 m	
Section Property	: C1 (No : 6)	
Rebar Pattern	: 10 - 4 - D20	Ast = 0.0031416 m² (pst = 0.026)

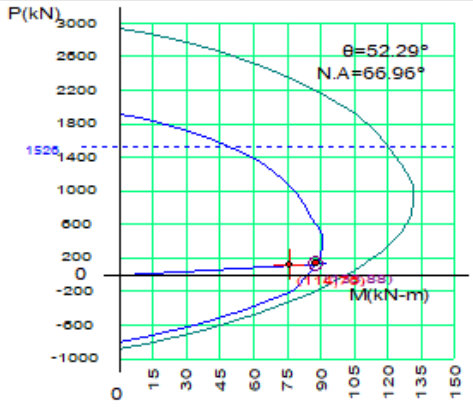


2. Axial and Moments Capacity

Load Combination : 12 (Pos : J)

Concentric Max. Axial Load	φPn-max	= 1525.79 kN	
Axial Load Ratio	Pu / φPn	= 114.414 / 133.191	= 0.859 < 1.000 ..... O.K
Moment Ratio	Mc / φMn	= 76.2333 / 88.2756	= 0.864 < 1.000 ..... O.K
	Mcy / φMny	= 45.7275 / 53.9916	= 0.847 < 1.000 ..... O.K
	Mcz / φMnz	= 60.9960 / 69.8390	= 0.873 < 1.000 ..... O.K

P-M Interaction Diagram



φPn(kN)	φMn(kN-m)
1907.24	0.00
1820.83	17.67
1633.51	40.14
1380.91	60.79
1103.65	74.91
852.90	82.30
702.68	85.41
593.13	88.70
357.33	91.24
42.41	85.86
-415.83	56.31
-739.24	10.80
-791.68	0.00

3. Shear Capacity

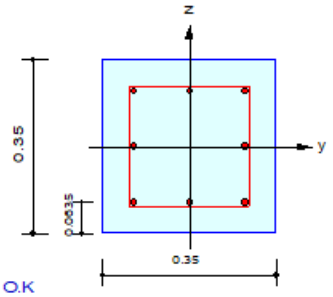
[END]	y (LCB : 13, POS : J)	z (LCB : 8, POS : J)
Applied Shear Force (Vu)	65.6495 kN	68.2861 kN
Design Shear Strength (φVc+φVs)	59.1539 + 64.0827 = 123.237 kN	61.8144 + 91.1790 = 152.993 kN
Shear Ratio	0.533 < 1.000 ..... O.K	0.446 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

[MIDDLE]	y (LCB : 13, POS : 1/2)	z (LCB : 8, POS : 1/2)
Applied Shear Force (Vu)	65.6495 kN	68.2861 kN
Design Shear Strength (φVc+φVs)	59.3277 + 64.0827 = 123.410 kN	61.9999 + 91.1790 = 153.179 kN
Shear Ratio	0.532 < 1.000 ..... O.K	0.446 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

ANALYSIS OF COLUMN (C-2)

1. Design Condition

Design Code	: NSCP 2015	UNIT SYSTEM : kN, m	
Member Number	: 82 (PM), 82, 236 (Shear-y,z)		
Material Data	: fc = 20684.3, fy = 280000, fys = 230000 KPa		
Column Height	: 3 m		
Section Property	: C2 (No : 7)		
Rebar Pattern	: 8 - 3 - D20	Ast = 0.00251328 m² (pst = 0.021)	

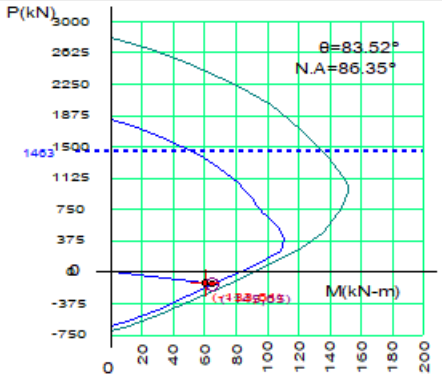


2. Axial and Moments Capacity

Load Combination : 21 (Pos : I)

Concentric Max. Axial Load	φPn-max	= 1462.91 kN	
Axial Load Ratio	Pu / φPn	= -133.04 / 144.998	= 0.918 < 1.000 ..... O.K
Moment Ratio	Mc / φMn	= 60.5531 / 65.3774	= 0.926 < 1.000 ..... O.K
	Mcy / φMny	= 6.84444 / 7.37720	= 0.928 < 1.000 ..... O.K
	Mcz / φMnz	= -60.165 / 64.9598	= 0.926 < 1.000 ..... O.K

P-M Interaction Diagram



φPn(kN)	φMn(kN-m)
1828.63	0.00
1625.05	32.48
1406.68	57.24
1186.67	74.48
981.70	86.21
805.50	93.97
699.94	97.93
644.65	101.94
554.99	106.42
384.06	110.45
95.70	92.47
-442.78	29.93
-633.35	0.00

3. Shear Capacity

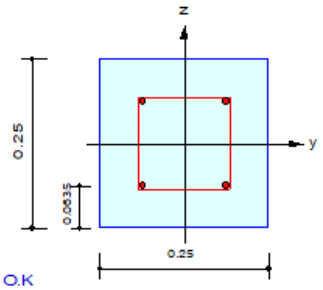
[END]	y (LCB : 13, POS : J)	z (LCB : 19, POS : J)
Applied Shear Force (Vu)	69.2114 kN	49.7310 kN
Design Shear Strength (φVc+φVs)	63.1501 + 77.6309 = 140.781 kN	47.7899 + 77.6309 = 125.421 kN
Shear Ratio	0.492 < 1.000 ..... O.K	0.397 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

[MIDDLE]	y (LCB : 13, POS : 1/2)	z (LCB : 19, POS : 1/2)
Applied Shear Force (Vu)	69.2114 kN	49.7310 kN
Design Shear Strength (φVc+φVs)	63.3228 + 77.6309 = 140.954 kN	48.3158 + 77.6309 = 125.947 kN
Shear Ratio	0.491 < 1.000 ..... O.K	0.395 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

ANALYSIS OF STIFFENER COLUMN (SC)

1. Design Condition

Design Code	: NSCP 2015	UNIT SYSTEM : kN, m
Member Number	: 231 (PM), 240, 231 (Shear-y,z)	
Material Data	: fc = 20684.3, fy = 230000, fys = 230000 KPa	
Column Height	: 3.2 m	
Section Property	: SC (No : 8)	
Rebar Pattern	: 4 - 2 - D16	Ast = 0.00080424 m² (pst = 0.013)

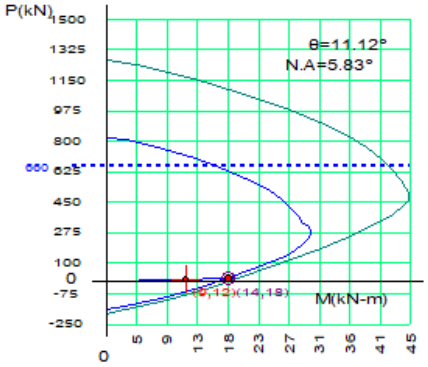


2. Axial and Moments Capacity

Load Combination : 20 (Pos : J)

Concentric Max. Axial Load	φPn-max	= 660.238 kN	
Axial Load Ratio	Pu / φPn	= 9.33468 / 14.0614	= 0.664 < 1.000 ..... O.K
Moment Ratio	Mc / φMn	= 11.8520 / 18.1001	= 0.655 < 1.000 ..... O.K
	Mcy / φMny	= 11.6071 / 17.7606	= 0.654 < 1.000 ..... O.K
	Mcz / φMnz	= 2.39703 / 3.48941	= 0.687 < 1.000 ..... O.K

P-M Interaction Diagram



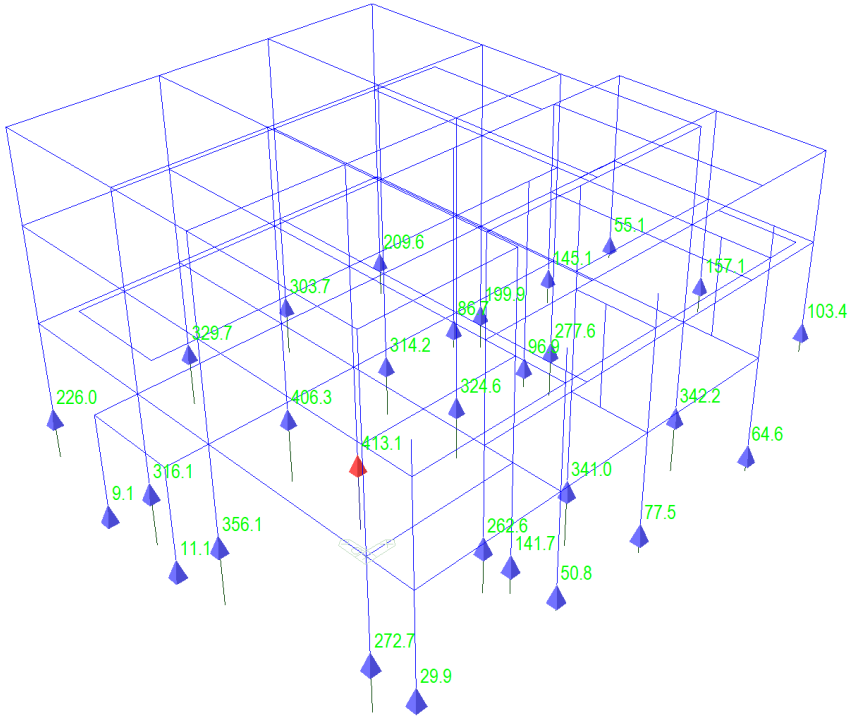
φPn(kN)	φMn(kN-m)
825.30	0.00
754.91	8.41
645.41	17.30
543.72	23.05
452.02	26.47
375.66	28.33
331.00	29.11
308.89	29.98
273.96	30.25
207.28	28.86
66.45	21.76
-97.45	8.19
-166.48	0.00

3. Shear Capacity

[END]	y (LCB : 22, POS : J)	z (LCB : 11, POS : J)
Applied Shear Force (Vu)	11.4120 kN	14.3393 kN
Design Shear Strength (φVc+φVs)	29.5405 + 50.5346 = 80.0751 kN	28.3553 + 50.5346 = 78.8899 kN
Shear Ratio	0.143 < 1.000 ..... O.K	0.182 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

[MIDDLE]	y (LCB : 22, POS : 1/2)	z (LCB : 11, POS : 1/2)
Applied Shear Force (Vu)	11.4120 kN	14.3393 kN
Design Shear Strength (φVc+φVs)	29.6007 + 50.5346 = 80.1353 kN	28.4409 + 50.5346 = 78.9755 kN
Shear Ratio	0.142 < 1.000 ..... O.K	0.182 < 1.000 ..... O.K
As-H.use	0.00157 m²/m, 2-D10 @100	0.00157 m²/m, 2-D10 @100

ANALYSIS OF FOOTING (F-1)



COLUMN-FOOTING REACTIONS

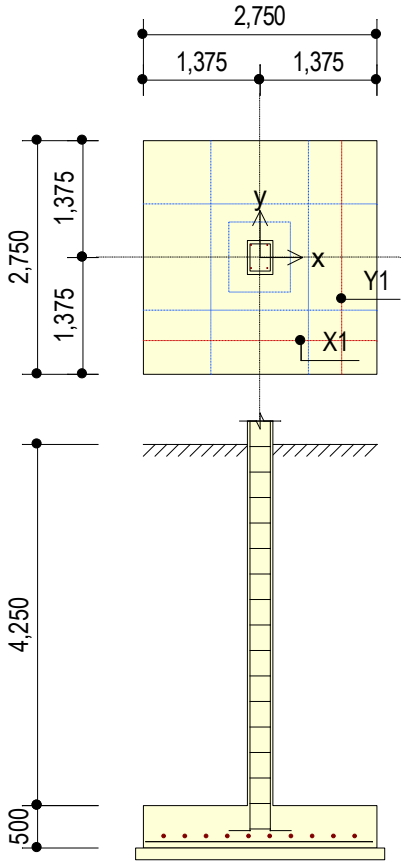
■ **MEMBER NAME : F-1**

1. General Information

(1) Design Code : ACI318M-14
(2) Code Unit : N, mm

2. Material

(1) F'_c : 20.70MPa
(2) F_y : 275MPa



3. Section

(1) Section Size

- Depth : 500mm
- Cover : 75.00mm

(2) Column Section

- Shape of Column : Rectangle
- Section : 300x400mm

4. Rebar

(1) Direction Y

- Layer 1 : D20@250 (A_s = 1,257mm²)

(2) Direction X

- Layer 1 : D20@250 (A_s = 1,257mm²)

5. Foundation

(1) Foundation Size

- L_x : 2.750m
- L_y : 2.750m
- f_e : 150kN/m²

6. Design Load

(1) Service Load

- P_s : 413kN
- M_{sx} : 0.000kN·m
- M_{sy} : 0.000kN·m

(2) Factored Load

- P_u : 413kN
- M_{ux} : 0.000kN·m
- M_{uy} : 0.000kN·m

(3) Surcharge Load

- Surface Load : 0.000KPa

- Weight Density : 18.00kN/m³
- Soil Height : 4.250m

(4) Self weight is considered.

7. Calculation Summary

(1) Overturning Moment (Service Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	914	0.000	M_{sy} / M_{rx}
Direction Y (kN·m)	0.000	914	0.000	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	1,096	0.000	M_{uy} / M_{rx}
Direction Y (kN·m)	0.000	1,096	0.000	M_{ux} / M_{ry}

(3) Bearing Capacity

Category	Value	Criteria	Ratio	Note
Compression (kN/m²)	142	150	0.950	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	662	0.000	ø = 0.750
Direction Y (kN)	0.000	630	0.000	ø = 0.750

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	1,251	1,430	0.875	ø = 0.750

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	37.71	120	0.315	ø = 0.900
Direction X, M_{uy} (kN·m)	40.99	126	0.325	ø = 0.900

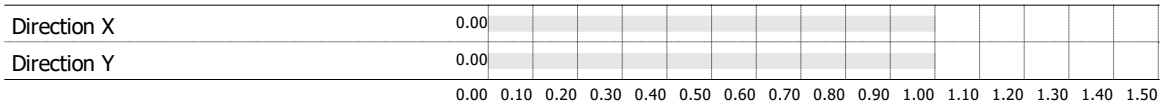
(7) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	250	314	0.796	$A_{s.req}$ = 1,000mm²
Direction X, M_{uy} (mm)	250	314	0.796	

8. Check overturning moment (Service Load)

Calculation Summary (Overturning Moment (Service Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	914	0.000	M_{sy} / M_{rx}
Direction Y (kN·m)	0.000	914	0.000	M_{sx} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x (kN·m)	R_y (kN·m)
Self Weight of Concrete	85.84	1.000	1.375	1.375	118	118
Self Weight of Soil	579	1.000	1.375	1.375	795	795
Surcharge Load	0.000	1.000	1.375	1.375	-	-
Resistance Moment	-	-	-	-	914	914

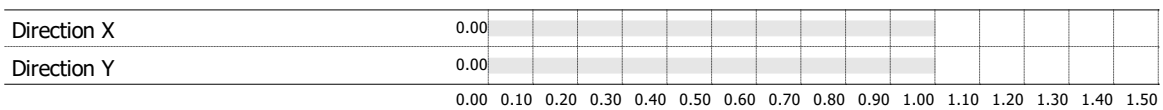
(2) Check overturning moment

Direction X (M_{sy})			Direction Y (M_{sx})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
0.000kN·m	914kN·m	0.000	0.000kN·m	914kN·m	0.000

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	1,096	0.000	M_{uy} / M_{rx}
Direction Y (kN·m)	0.000	1,096	0.000	M_{ux} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x (kN·m)	R_y (kN·m)
Self Weight of Concrete	85.84	1.200	1.375	1.375	142	142
Self Weight of Soil	579	1.200	1.375	1.375	955	955
Surcharge Load	0.000	1.600	1.375	1.375	-	-
Resistance Moment	-	-	-	-	1,096	1,096

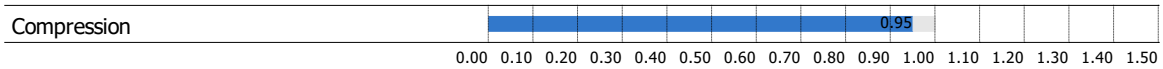
(2) Check overturning moment

Direction X (M_{uy})			Direction Y (M_{ux})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
0.000kN·m	1,096kN·m	0.000	0.000kN·m	1,096kN·m	0.000

10. Check Soil Capacity

Calculation Summary (Bearing Capacity)

Category	Value	Criteria	Ratio	Note
Compression (kN/m²)	142	150	0.950	



(1) Calculate actual soil stress

- $q_{s.top\text{-}left}$ = 142kN/m² $q_{s.top\text{-}right}$ = 142kN/m²
- $q_{s.bot\text{-}left}$ = 142kN/m² $q_{s.bot\text{-}right}$ = 142kN/m²
- $q_{s.max}$ = 142kN/m²
- $q_{s.max}$ / f_e = 0.950 → O.K

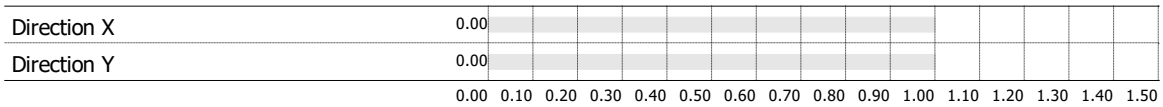
(2) Calculate factored soil stress

- $q_{u.top\text{-}left}$ = 191kN/m² $q_{u.top\text{-}right}$ = 191kN/m²
- $q_{u.bot\text{-}left}$ = 191kN/m² $q_{u.bot\text{-}right}$ = 191kN/m²
- $q_{u.max}$ = 191kN/m² $q_{u.min}$ = 191kN/m²

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	662	0.000	ø = 0.750
Direction Y (kN)	0.000	630	0.000	ø = 0.750



(1) Calculate one-way shear (Direction X)

- V_u = 0.000kN
- ø = 0.750
- øV_c = 662kN
- V_u / øV_c = 0.000 → O.K

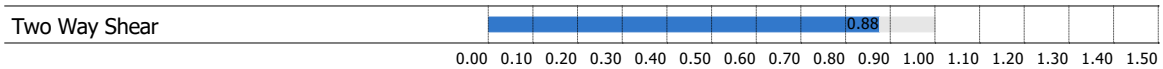
(2) Calculate one-way shear (Direction Y)

- V_u = 0.000kN
- ø = 0.750
- øV_c = 630kN
- V_u / øV_c = 0.000 → O.K

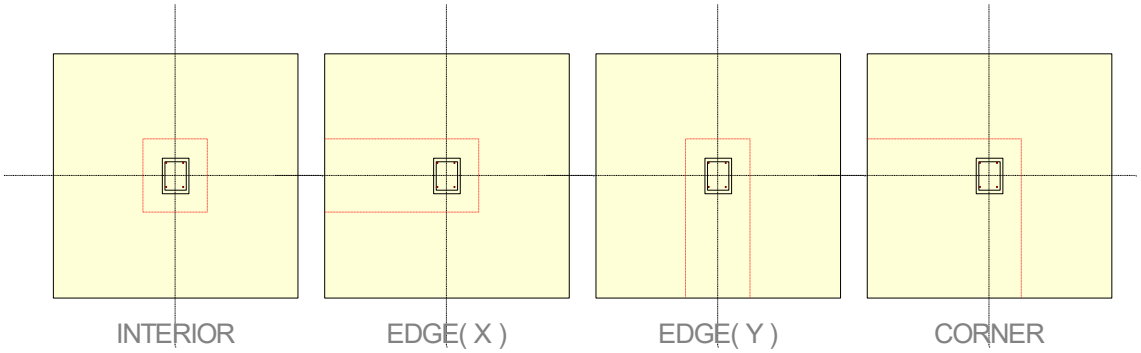
(3) Calculate two-way shear

Calculation Summary (Two Way Shear)

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	1,251	1,430	0.875	ø = 0.750



-	b_0 (mm)	V_{c1} (kN)	V_{c2} (kN)	V_{c3} (kN)	V_c (kN)	V_u (kN)	øV_c (kN)	Ratio
Interior	3,060	2,456	3,561	1,907	1,907	1,251	1,430	0.875
Edge(X)	4,280	3,435	3,293	2,667	2,667	1,093	2,000	0.547
Edge(Y)	4,280	3,435	3,293	2,667	2,667	1,120	2,000	0.560
Corner	3,515	2,821	2,402	2,190	2,190	774	1,643	0.471

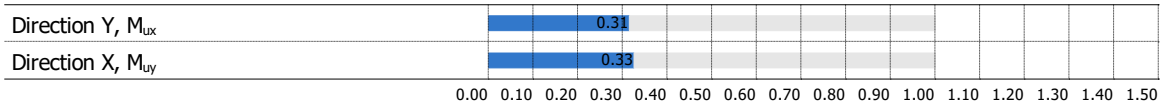


- ø = 0.750
- d = 415mm
- $V_{c1} = 0.17\left(1 + \frac{2}{\beta}\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c2} = 0.083\left(\frac{a_s\ d}{b_0} + 2\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c3} = 0.33\sqrt{f'_c}\ b_0\ d$
- V_c = min(V_{c1} , V_{c2} , V_{c3})
- V_u = 1,251kN
- $V_u / øV_c$ = 0.875 → O.K

12. Check Moment Capacity

Calculation Summary (Moment Capacity)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	37.71	120	0.315	ø = 0.900
Direction X, M_{uy} (kN·m)	40.99	126	0.325	ø = 0.900



(1) Calculate moment capacity (Direction X)

- ø = 0.900
- M_{uy} = 40.99kN·m øMny = 126kN·m
- $M_{uy} / øM_{ny}$ = 0.325 → O.K

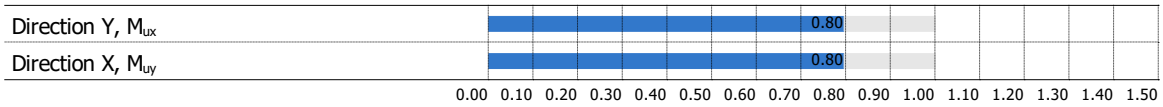
(2) Calculate moment capacity (Direction Y)

- ø = 0.900
- M_{ux} = 37.71kN·m øMnx = 120kN·m
- $M_{ux} / øM_{nx}$ = 0.315 → O.K

13. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	250	314	0.796	$A_{s.req}$ = 1,000mm²
Direction X, M_{uy} (mm)	250	314	0.796	



(1) Calculate minimum rebar area required

- $A_{s.min}$ = 0.00200D = 1,000mm²

(2) Calculate minimum rebar space required (Direction Y)

- A_s = 314mm² (D20@250)
- $s_{req.}$ = 314mm
- s_x = 250mm < $s_{req.}$ = 314mm → O.K

(3) Calculate minimum rebar space required (Direction X)

- A_s = 314mm² (D20@250)
- $s_{req.}$ = 314mm
- s_y = 250mm < $s_{req.}$ = 314mm → O.K

ANALYSIS OF FOOTING (CF-1)

■ **MEMBER NAME : CF-1**

1. General Information

(1) Design Code : ACI318M-14
(2) Code Unit : N, mm

2. Material

(1) F'_c : 20.70MPa
(2) F_y : 275MPa

3. Design Load

(1) Column 1

- P_s : 273kN
- M_{sy} : 0.000kN·m
- P_u : 273kN
- M_{uy} : 0.000kN·m

(2) Column 2

- P_s : 29.90kN
- M_{sy} : 0.000kN·m
- P_u : 29.90kN
- M_{uy} : 0.000kN·m

(3) Surcharge Load

- Surface Load : 0.000KPa
- Weight Density : 18.00kN/m³
- Soil Height : 4.250m

(4) Self weight is considered.

4. Foundation

(1) Foundation Size

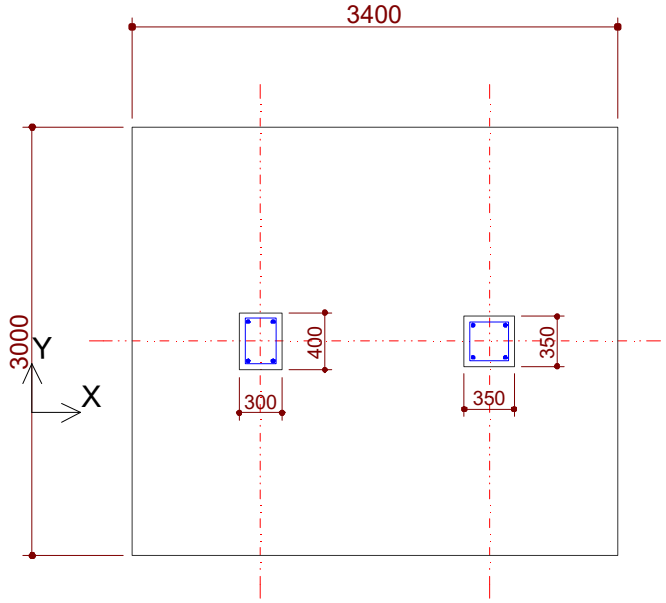
- L_x : 3.400m
- L_y : 3.000m
- Depth : 450mm
- Cover : 75.00mm

(2) Soil Bearing Capacity

- f_e : 150kN/m²

5. Column

No.	Shape	Section	Lxi
1	Rectangle	300x400mm	0.900m
2	Rectangle	350x350mm	1.600m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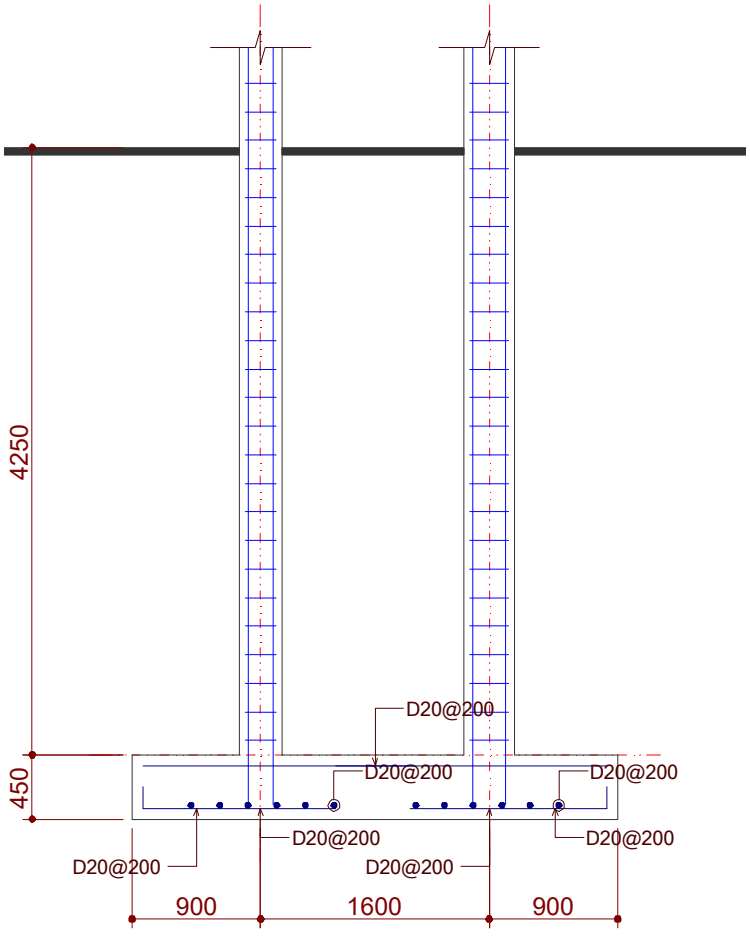
Y
X
400
350
300
350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D20@200
D20@200
D20@200
D20@200
D20@200
D20@200
900
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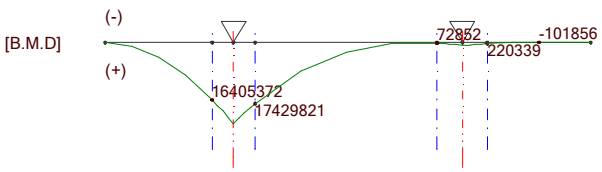
900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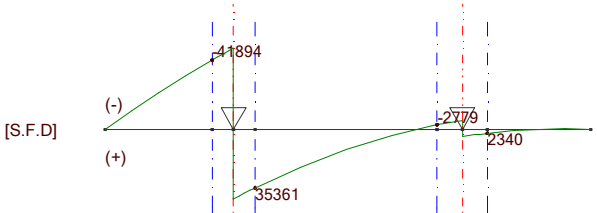

[S.F.D]
41894
(-)
(+)
2779
2340
35361

6. Rebar

(1) Direction X

- Cantilever(L) : D20@200 (A_s = 1,571mm²)
- Colm (1) : D20@200 (A_s = 1,571mm²)
- Span (1-2) : D20@200 (A_s = 1,571mm²)
- Colm (2) : D20@200 (A_s = 1,571mm²)
- Cantilever(R) : D20@200 (A_s = 1,571mm²)

(2) Direction Y

- Colm (1) : D20@200 (A_s = 1,571mm²)
- Colm (2) : D20@200 (A_s = 1,571mm²)

7. Calculation Summary

(1) Overturning Moment (Service Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	0.000	0.000	M_{sy} / M_{rx}
Direction Y (kN·m)	0.000	0.000	0.000	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	0.000	0.000	M_{uy} / M_{rx}
Direction Y (kN·m)	0.000	0.000	0.000	M_{ux} / M_{ry}

(3) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	68.63	635	0.108	ø = 0.750
Direction Y (kN)	0.000	0.000	0.000	ø = 0.750

(4) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	258	1,127	0.229	ø = 0.750

(5) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	119	129	0.921	ø = 0.900
Direction X, M_{uy} (kN·m)	17.43	137	0.127	ø = 0.900

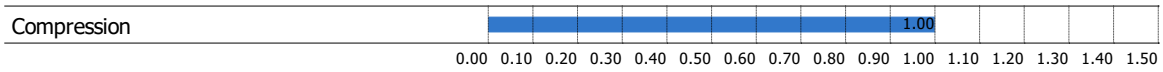
(6) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	0.000	0.000	0.000	$A_{s.req}$ = 900mm²
Direction X, M_{uy} (mm)	0.000	0.000	0.000	

8. Check Soil Capacity

Calculation Summary (Bearing Capacity)

Category	Value	Criteria	Ratio	Note
Compression (kN/m²)	150	150	1.000	



(1) Calculate actual soil stress

- $q_{s.left}$ = 150kN/m² $q_{s.right}$ = 82.78kN/m²
- $q_{s.max}$ = 150kN/m²
- $q_{s.max}$ / f_e = 1.000 → O.K

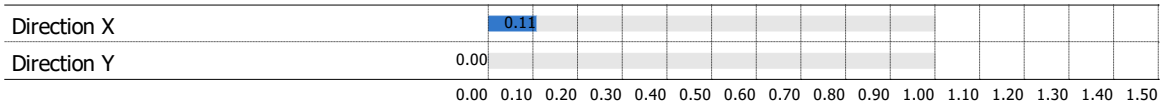
(2) Calculate factored soil stress

- $q_{u.left}$ = 63.27kN/m² $q_{u.right}$ = -3.939kN/m²
- $q_{u.max}$ = 63.27kN/m² $q_{u.min}$ = -3.939kN/m²

9. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	68.63	635	0.108	ø = 0.750
Direction Y (kN)	0.000	0.000	0.000	ø = 0.750



(1) Calculate one-way shear (Direction X)

- V_u = 68.63kN
- ø = 0.750
- $øV_c$ = 635kN
- $V_u / øV_c$ = 0.108 → O.K

(2) Calculate two-way shear

Column	Position	b_0 (mm)	V_{c1} (kN)	V_{c2} (kN)	V_{c3} (kN)	V_c (kN)	V_u (kN)	$øV_c$ (kN)	Ratio
1	Interior	2,820	1,936	2,660	1,503	1,503	258	1,127	0.229
2	Interior	2,820	2,323	2,660	1,503	1,503	15.15	1,127	0.0134

- ø = 0.750
- d = 355mm
- $V_{c1} = 0.17\left(1 + \frac{2}{\beta}\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c2} = 0.083\left(\frac{a_s\ d}{b_0} + 2\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c3} = 0.33\sqrt{f'_c}\ b_0\ d$
- V_c = min(V_{c1} , V_{c2} , V_{c3})
- V_u = 258kN
- $V_u / øV_c$ = 0.229 → O.K

10. Check Moment Capacity

(1) Calculate moment capacity (Direction X)

Position	Top/Bottom	ø	M_u (kN·m/m)	$øM_n$ (kN·m/m)	Ratio	Remark
Cantilever(L)	Bottom	0.900	16.41	137	0.120	OK
Colm (1)	Bottom	0.900	17.43	137	0.127	OK
Span (1-2)	Top	0.900	0.000	137	0.000	OK
Colm (2)	Bottom	0.900	0.220	137	0.00161	OK
Cantilever(R)	Bottom	0.900	0.220	137	0.00161	OK

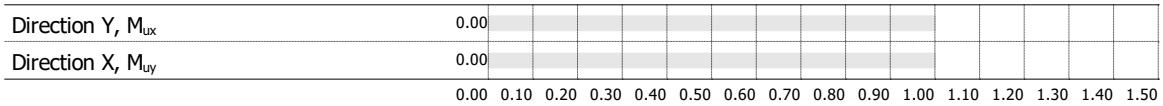
(2) Calculate moment capacity (Direction Y)

Position	Top/Bottom	ø	M_u (kN·m/m)	$øM_n$ (kN·m/m)	Ratio	Remark
Colm (1)	Bottom	0.900	119	129	0.921	OK
Colm (2)	Bottom	0.900	12.59	129	0.0973	OK

11. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	0.000	0.000	0.000	$A_{s.req}$ = 900mm²
Direction X, M_{uy} (mm)	0.000	0.000	0.000	



(1) Calculate minimum rebar area required

- $A_{s.min}$ = 0.00200D = 900mm²

(2) Calculate minimum rebar space required (Direction X)

Position	Top/Bottom	Rebar	A_s (mm²)	S_{max} (mm)	S_{req} (mm)	Remark
Cantilever(L)	Bottom	D20@200	314	450	349	OK
Colm (1)	Bottom	D20@200	314	450	349	OK
Span (1-2)	Top	D20@200	314	450	349	OK
Colm (2)	Bottom	D20@200	314	450	349	OK
Cantilever(R)	Bottom	D20@200	314	450	349	OK

(3) Calculate minimum rebar space required (Direction Y)

Position	Top/Bottom	Rebar	A_s (mm²)	S_{max} (mm)	S_{req} (mm)	Remark
Colm (1)	Bottom	D20@200	314	450	349	OK
Colm (2)	Bottom	D20@200	314	450	349	OK

ANALYSIS OF FOOTING (CF-2)

■ MEMBER NAME : CF-2

1. General Information

(1) Design Code : ACI318M-14
(2) Code Unit : N, mm

2. Material

(1) F'_c : 20.70MPa
(2) F_y : 275MPa

3. Design Load

(1) Column 1

- P_s : 404kN
- M_{sy} : 0.000kN·m
- P_u : 404kN
- M_{uy} : 0.000kN·m

(2) Column 2

- P_s : 50.80kN
- M_{sy} : 0.000kN·m
- P_u : 50.80kN
- M_{uy} : 0.000kN·m

(3) Surcharge Load

- Surface Load : 0.000KPa
- Weight Density : 18.00kN/m³
- Soil Height : 4.250m

(4) Self weight is considered.

4. Foundation

(1) Foundation Size

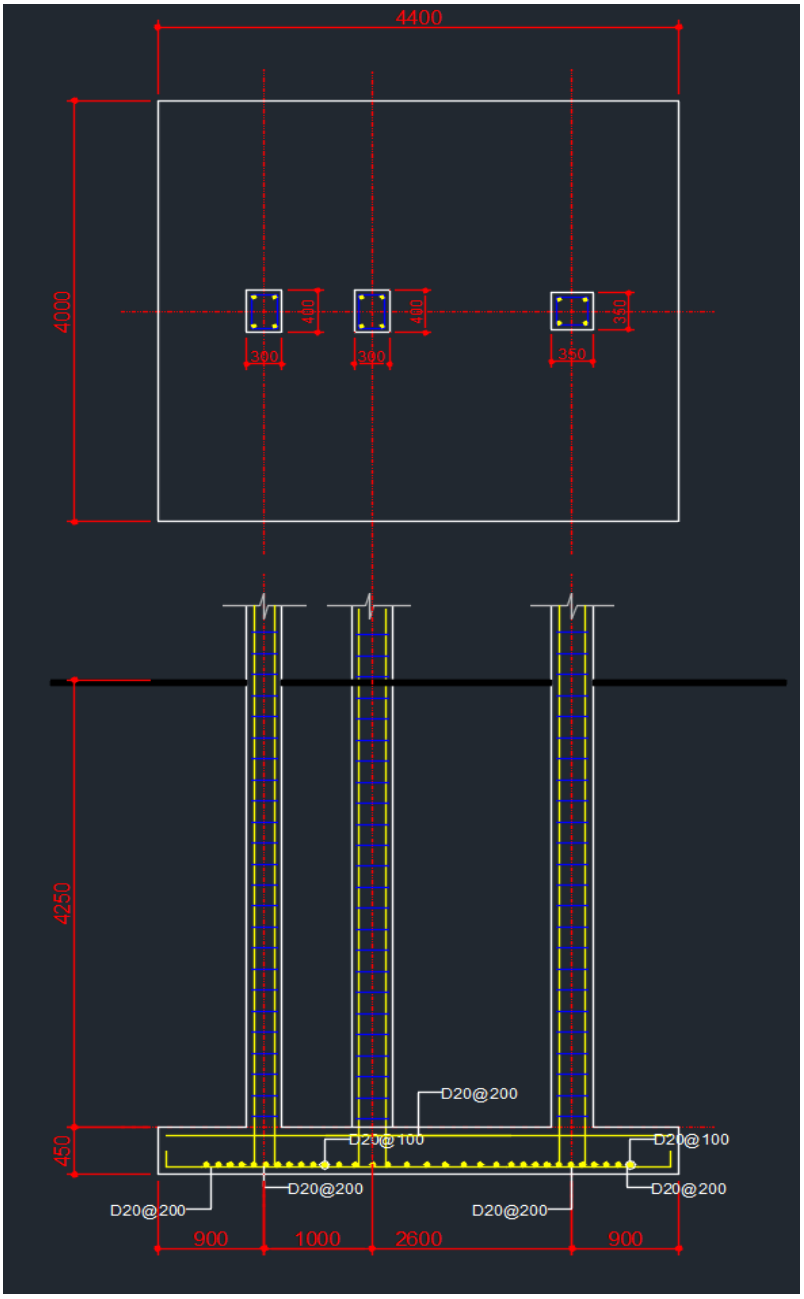
- L_x : 4.400m
- L_y : 4.000m
- Depth : 450mm
- Cover : 75.00mm

(2) Soil Bearing Capacity

- f_e : 150kN/m²

5. Column

No.	Shape	Section	Lxi
1	Rectangle	300x400mm	0.900m
2	Rectangle	350x350mm	2.600m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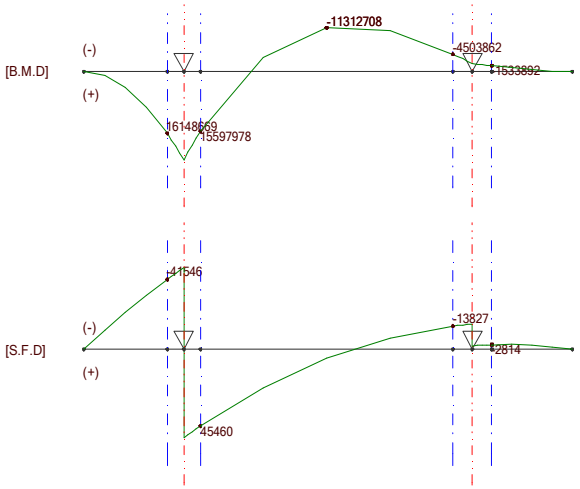
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45460

6. Rebar

(1) Direction X

- Cantilever(L) : D20@200 (A_s = 1,571mm²)
- Colm (1) : D20@200 (A_s = 1,571mm²)
- Span (1-2) : D20@200 (A_s = 1,571mm²)
- Colm (2) : D20@200 (A_s = 1,571mm²)
- Cantilever(R) : D20@200 (A_s = 1,571mm²)

(2) Direction Y

- Colm (1) : D20@100 (A_s = 3,142mm²)
- Colm (2) : D20@100 (A_s = 3,142mm²)

7. Calculation Summary

(1) Overturning Moment (Service Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	0.000	0.000	M_{sy} / M_{rx}
Direction Y (kN·m)	0.000	0.000	0.000	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	0.000	0.000	0.000	M_{uy} / M_{rx}
Direction Y (kN·m)	0.000	0.000	0.000	M_{ux} / M_{ry}

(3) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	124	847	0.146	ø = 0.750
Direction Y (kN)	0.000	0.000	0.000	ø = 0.750

(4) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	392	1,127	0.347	ø = 0.750

(5) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	254	249	0.72	ø = 0.900
Direction X, M_{uy} (kN·m)	16.15	137	0.118	ø = 0.900

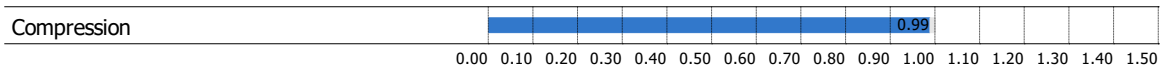
(6) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	0.000	0.000	0.000	$A_{s.req}$ = 900mm²
Direction X, M_{uy} (mm)	0.000	0.000	0.000	

8. Check Soil Capacity

Calculation Summary (Bearing Capacity)

Category	Value	Criteria	Ratio	Note
Compression (kN/m²)	148	150	0.988	



(1) Calculate actual soil stress

- $q_{s.left}$ = 148kN/m² $q_{s.right}$ = 76.97kN/m²
- $q_{s.max}$ = 148kN/m²
- $q_{s.max}$ / f_e = 0.988 → O.K

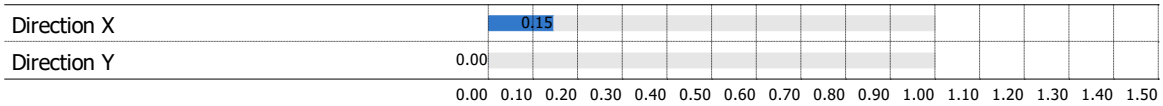
(2) Calculate factored soil stress

- $q_{u.left}$ = 61.46kN/m² $q_{u.right}$ = -9.748kN/m²
- $q_{u.max}$ = 61.46kN/m² $q_{u.min}$ = -9.748kN/m²

9. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	124	847	0.146	ø = 0.750
Direction Y (kN)	0.000	0.000	0.000	ø = 0.750



(1) Calculate one-way shear (Direction X)

- V_u = 124kN

- ø = 0.750
- øV$_c$ = 847kN
- V$_u$ / øV$_c$ = 0.146 → O.K

(2) Calculate two-way shear

Column	Position	b_0 (mm)	V_{c1} (kN)	V_{c2} (kN)	V_{c3} (kN)	V_c (kN)	V_u (kN)	øV_c (kN)	Ratio
1	Interior	2,820	1,936	2,660	1,503	1,503	392	1,127	0.347
2	Interior	2,820	2,323	2,660	1,503	1,503	37.95	1,127	0.0337

- ø = 0.750
- d = 355mm
- $V_{c1} = 0.17\left(1+\frac{2}{\beta}\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c2} = 0.083\left(\frac{a_s\ d}{b_0}+2\right)\sqrt{f'_c}\ b_0\ d$
- $V_{c3} = 0.33\sqrt{f'_c}\ b_0\ d$
- V_c = min(V_{c1} , V_{c2} , V_{c3})
- V_u = 392kN
- V_u / øV_c = 0.347 → O.K

10. Check Moment Capacity

(1) Calculate moment capacity (Direction X)

Position	Top/Bottom	ø	M_u (kN·m/m)	øM_n (kN·m/m)	Ratio	Remark
Cantilever(L)	Bottom	0.900	16.15	137	0.118	OK
Colm (1)	Bottom	0.900	16.15	137	0.118	OK
Span (1-2)	Top	0.900	-11.31	137	0.0825	OK
Colm (2)	Bottom	0.900	0.000	137	0.000	OK
Cantilever(R)	Bottom	0.900	0.000	137	0.000	OK

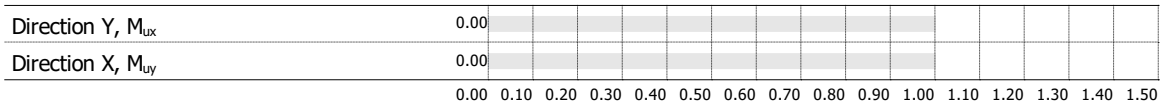
(2) Calculate moment capacity (Direction Y)

Position	Top/Bottom	ø	M_u (kN·m/m)	øM_n (kN·m/m)	Ratio	Remark
Colm (1)	Bottom	0.900	254	249	1.019	OK
Colm (2)	Bottom	0.900	30.43	249	0.122	OK

11. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	0.000	0.000	0.000	$A_{s.req}$ = 900mm²
Direction X, M_{uy} (mm)	0.000	0.000	0.000	



(1) Calculate minimum rebar area required

- $A_{s.min}$ = 0.00200D = 900mm²

(2) Calculate minimum rebar space required (Direction X)

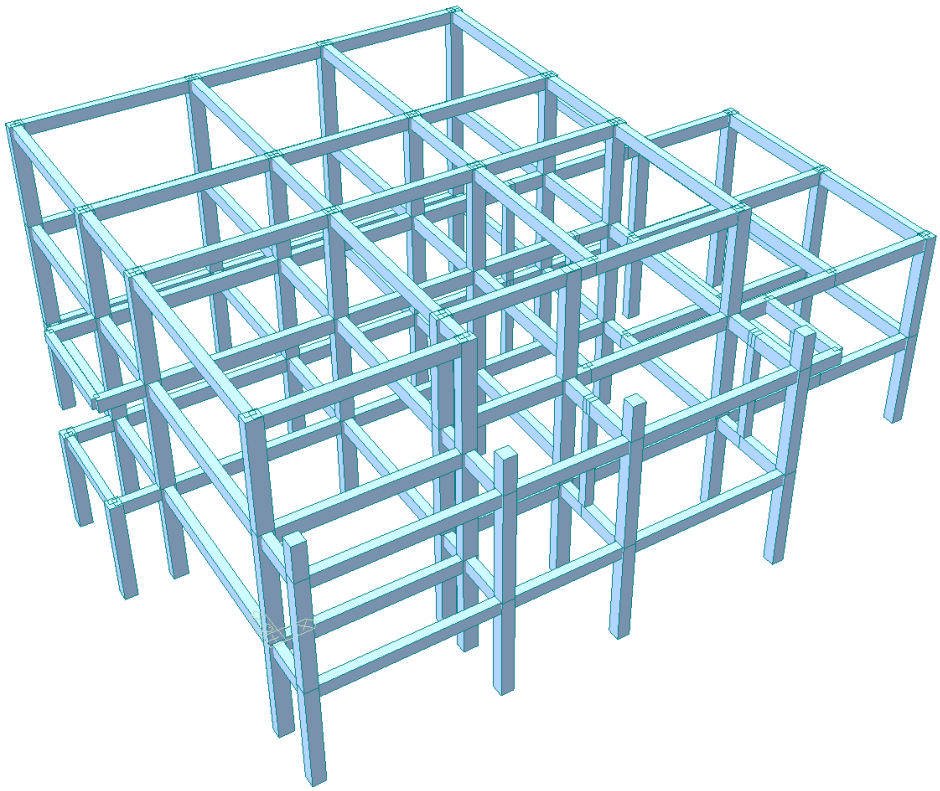
Position	Top/Bottom	Rebar	A_s (mm²)	S_{max} (mm)	S_{req} (mm)	Remark
Cantilever(L)	Bottom	D20@200	314	450	349	OK
Colm (1)	Bottom	D20@200	314	450	349	OK
Span (1-2)	Top	D20@200	314	450	349	OK
Colm (2)	Bottom	D20@200	314	450	349	OK
Cantilever(R)	Bottom	D20@200	314	450	349	OK

(3) Calculate minimum rebar space required (Direction Y)

Position	Top/Bottom	Rebar	A_s (mm²)	S_{max} (mm)	S_{req} (mm)	Remark
Colm (1)	Bottom	D20@100	314	450	349	OK
Colm (2)	Bottom	D20@100	314	450	349	OK

STRUCTURAL ANALYSIS

PROJECT TITLE : PROPOSED RESIDENTIAL BUILDING
LOCATION : GAMUTON, LANUZA SURIGAO DEL SUR
OWNER : MARIA CLAIRE D. MILITANTE



Prepared :
ENGR. JERADE REY JARY A. MONDEJAR
CIVIL ENGINEER
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PTR NO. : 9045581
ISSUED ON :01/03/2025