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STRUCTURAL DESIGN REPORT

PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT + 3 FLOORS RESIDENTIAL BUILDING WITH 15 DWELLING UNITS (HEIGHT 12.00 M) AT PLOT NO:11, SRI BALAJI AVENUE, AYNAMBAKKAM CHENNAI.

STRUCTURAL CONSULTANT:

B&W STRUCTURAL DESIGN CONSULTANTS

181/64, GANDHI ROAD, (NEAR CENTRAL BANK OF INDIA).

VELACHERY.

CHENNAI-600042.

For SRI HARI HOMES

S.Vijay
Proprietor

PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT + 3 FLOORS RESIDENTIAL BUILDING WITH 15 DWELLING UNITS (HEIGHT 12.00 M) AT PLOT NO:11, SRI BALAJI AVENUE, AYNAMBAKKAM CHENNAI.

1. INTRODUCTION

The Structure is a Residential building. It is designed as RCC building supported on Pile Foundation at 18m depth from Existing Ground Level.

2. STRUCTURAL SYSTEM

The structural system adopted is as below.

- The entire structure is designed as R.C. Framed Beam-Slab Structure with Beams Framing in to Columns.
- The Foundation System considered for the Structure is an Pile Foundation at 18m depth from Existing Ground Level and Pile Capacity is taken as 1138KN.

3. MATERIAL SPECIFICATIONS

3.1. CONCRETE AND REINFORCEMENT

1. Concrete Grades: **M25**

(Minimum cement content-460kg/m3, water cement ratio – 0.45).

2. TMT High:max **Fe 500**Grade for all R.C. members

Yield Strength Bars (For efficient usage of Rebar (for all rebar) Consumption in Concrete).

4. ENVIRONMENTAL CONDITIONS, CORROSION AND FIRE PROTECTION FOR CONCRETE.

Environment – Severe

Exposure conditions – Concrete exposed to rain

Fire protection – Thickness of the structural elements shall be governed by fire rating (2hrsFire rating considered in the Design)

Nominal concrete cover to reinforcement – Exposure conditions and fire rating covers for 2 hr. fire resistance

Nominal Cover to reinforcement

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(As per IS 456:2000 , TABLE 16A) For 2 hr. fire resistance

Beams	-	25 mm
Slabs	-	20 mm
Columns	-	40mm
Foundation	-	50mm
pile and pile cap	-	75mm
RC wall	-	50 mm
waist slab	-	25 mm

5. STRUCTURAL ANALYSIS & DESIGN

- The entire Structure is analyzed using Software STAAD PRO-V8i Structural Analysis Package.
- In the 3D Model, Loads are applied and Analyzed for various Load Combinations. The results of all Load Combinations are reviewed and Members are designed for Maximum Forces arrived.
- The 3D Model Comprises Column-Beam Frame with Slabs contributing loads to the Frame and the effect of Slab stiffness has been ignored in the analysis.

Ultimate load combination

* * * WITH LOAD FACTOR * * *

1. LOAD COMB 1 1.5*DL + 1.5*L.L
2. LOAD COMB 2 1.0*DL + 1.0*L.L

A. Dead loads:

Dead Load shall include weight of all Structural and Architectural components.

Self-weight of the materials shall be calculated on the basis of unit weights given in IS: 875 PART I-1987.

1. Unit weight of concrete - 25 kN /m^3
2. Unit weight of steel - 78.5 kN /m^3
3. Floor finish considered - 1.5kN /m^2
5. Unit weight of Solid block -20kN/m

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B. Live loads:

Following Live Loads are considered while designing the Structural Elements Apart from the Dead Loads as per codes.

1. Living, Kitchen and bed room floor slab	:	3KN / Sq. m
2. Toilet	:	2 KN / Sq. m
3. Corridor, staircase and passage	:	3 KN/ Sq.m

C. Additional Floor Provision & Equipment Load

In the Design intent. Loads arising due to Provision for additional Floors to be built in Future has not been considered. If any equipment has been proposed to be mounted on terrace, then the load details based on vendor inputs will be considered.

7. LOADING INTENSITIES ON SLABS:

1. REDENTIAL BUILDING FLOOR SLAB:

Self-wt. of the slab = 0.15m x 25 KN/m3	= 3.75 KN/m^2
Floor finishes	= 1 KN/m^2
False ceiling	= 0.5 KN/m^2
Total load	= 5.25 KN/m^2

2. RESIDENTIAL BUILDING TOILET FLOOR SLAB:

Self-wt. of the slab = 0.15m x 25 KN/m3	= 3.75 KN/m^2
Soil filling = 0.23*18	= 4.14 KN/m^2
Total load	= 7.89 KN/m^2

3. Member load:

Grade beam	= (4.8m -0.38m) x 0.23m x 20 KN/ m^3	= 20 KN/m
Ground floor beam	= (3.5m -0.38m) x 0.23m x 20 KN/ m^3	= 14 KN/m
Parapet wall	= 0.9m x 0.23m x 20 KN/ m^3	= 4 KN/m

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PILE CAP DESIGN CALCULATIONS

Design Code	:	IS Code	
Pilecap No	:	PC1	
Column No	:	C1	(300mm X 600mm)
Member Ref. No	:	47	
Concrete Grade	:	M25	
Steel Grade	:	Fe500	
Clear Cover	:	50	mm
Top of pile-cap below ground	:	0	M
Density of Soil	=	18	KN/cuM
Founding Depth	=	0.20	M
Pile Capacity in compression	=	700	KN
Pile Capacity in tension	=	75	KN
Pile Capacity Reduction	=	0	%
Pile Overloading	=	10	%
Pile Group Overloading	=	10	%
Pile Capacity Increase for EQ	=	25	%
Pile Capacity Increase for Wind	=	25	%
Live Load Reduction	=	0	%
Consider Capacity Design	:	No	
Consider Overburden Pressure	:	Yes	
No. of Piles	=	2	
Pile Diameter	=	600	mm
Pile Spacing	=	2.5	x Ø
Pilecap Size	=	2400X900	mm
Pilecap Depth	=	750	mm
Soil Wt. + Pile-cap Wt.	=	40.5	KN

For design, moments along shorter direction of pile cap has been ignored

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Check for Maximum Load on One Pile:

Critical Analysis Load Combination : 3

Critical Load Combination	:	[1] : (LOAD 1: DL) +(LOAD 2: LL)	
Pcomb	=	1168.72	KN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1209.22	KN
Mx	=	-1.49	KNM
My	=	3.55	KNM
P	=	Ptotal/ No. of Piles	
	=	604.61	KN
Pmx	=	1	KN
Pmy	=	0	KN
Maximum load on pile	=	605.61	KN
Allowable load on pile	=	700 X 1	
	=	770	KN

Check for Maximum Load on Pile Group:

Critical Analysis Load Combination	:	3	
Critical Load Combination	:	[1] : (LOAD 1: DL) +(LOAD 2: LL)	
Pcomb	=	1168.72	KN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1209.22	KN
Mx	=	-1.49	KNM
My	=	3.55	KNM
Maximum load on pile group	=	1209.22	KN
Allowable load on pile group	=	2 x 700 x 1.1	
	=	1540	KN

Check for Uplift Load on Pile:

No uplift in any pile

Design for Bending:

Bottom Steel Along Column-D

Critical Analysis Load Combination	:	4	
Critical Load Combination	:	[4] : 1.5 (LOAD 1: DL) +1.5 (LOAD 2: LL)	
Pcomb	=	1753.08	KN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1813.83	KN
Mx	=	-2.24	KNM
My	=	5.32	KNM

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Ppile	=	Max Load on pile	
	=	908.4083	KN
Deff	=	690	mm
Beff	=	900	mm
DfCol	=	0.45	M
BMux	=	Ppile X DfCol	
	=	408.78	KNM
PtReq	=	0.23	%
AstReq (BM)	=	1587	Sqmm/M
AstPrv	=	T12 @ 150 c/c	
	=	1608	Sqmm/M

Top Steel Along Column-D

D	=	750	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Steel X D X 1000	
	=	0.06% X 750 X 1000	
	=	450	Sqmm/M
AstPrv	=	T12 @ 150 c/c	
	=	462	Sqmm/M

Bottom Steel Along Column-B

AstReq (BM)	=	0.2 x (D/2) x B/100	
	=	0.2 x 375 x 900/100	
	=	675	Sqmm/M
AstPrv	=	T12 @ 150 c/c	
	=	683	Sqmm/M

Top Steel Along Column-B

D	=	750	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Steel X D X 1000	
	=	0.06% X 750 X 1000	
	=	450	Sqmm/M
AstPrv	=	T12 @ 150 c/c	
	=	462	Sqmm/M

Design for One Way Shear:

Along Column-D

Critical Analysis Load Combination : 4

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Critical Load Combination	:	[4] : 1.5 (LOAD 1: DL) +1.5 (LOAD 2: LL)	
Pcomb	=	1753.08	KN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1813.83	KN
Mx	=	-2.24	KNM
My	=	5.32	KNM
Ppile	=	Max Load on pile	
	=	908.4083	KN

Location of critical section is at d/2 from face of column

Section Location from column center	=	645	mm

Data for Piles

Pile No	Load (KN)	% covered	Shear (KN)
P1	908.41	32.5	613.18
P2	905.42	32.5	611.16

Design Shear Force (Vu)	=	Max. of (Shear due to P1, P2)	
	=	613.18	KN
Deff	=	690	mm
Beff	=	900	mm
Tv	=	Vu/(Beff x Deff)	
	=	0.99	N/Sqmm
Tc	=	0.35	N/Sqmm
Av	=	105	mm
Shear enhancement factor	=	2 X Deff / Av	
	=	13.14	mm
Enhanced shear strength (Tce)	=	4.62	N/Sqmm
Tv	<	Tce, Hence Shear Reinforcement is not required	

Along Column-B

One way shear check do not applicable for 2 pile pile-cap design

Design of Face Reinforcement:

AsfrReq	=	SFR % X D X Beffsfr	
	=	0.05 X 750 X 500 / 100	
	=	188	Sqmm
Asfr Prv	=	3 - T10	
	=	236	Sqmm

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Check for Load Transfer from Column to PileCap

Critical Analysis Load Combination	=	4	
Critical Load Combination	:	[4] : 1.5 (LOAD 1: DL) +1.5 (LOAD 2: LL)	
P	=	1753.08	KN
A2	=	0.18	sqM
A1	=	1.26	sqM
Base Area	=	1.26	sqM
A1	<	Base Area	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	2.65	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modication Factor X Column Area	
	=	4050	KN
Concrete Bearing Capacity	>	P, Hence Safe.	

COLUMN DESIGN CALCULATIONS

General Data

Column No.	:	C1	
Level	:	0m To 1.8m	
Design Code	=	IS Code	
Grade Of Concrete	=	M25	N/Sqmm
Grade Of Steel	=	Fe500	N/Sqmm
Column B	=	450	MM
Column D	=	450	MM
Clear Cover	=	40	MM
Clear Floor Height @ B	=	3000	MM
Clear Floor Height @ D	=	3000	
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

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Load Data

Analysis Reference No.	=	47
Critical Analysis Load Combination	:	4

Load Combination	=	[2] : 1.5 (LOAD 1: DL) +1.5 (LOAD 2: LL)	
Critical Location	=	Top Joint	
Pu	=	550	KN
Mux	=	-30.31	KNM
Muy	=	-10.07	KNM
Vux	=	-8.55	KN
Vuy	=	15.6	KN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	14.32	MM
Mminy	=	Pu x Minimum Eccentricity	
	=	34.83	KNM

Slenderness Check

Max Slenderness Ratio(L/B)	=	6	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / D	
	=	2.7, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / B	
	=	7.2, Column not Slender Along B	

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Calculation of Design Moment

Direction	Manalysis	Mmin	Mdesign	MsIndx	Mdesign-

					final
	A	B	C	E	F
Major Axis - Mux	30.31	---	30.31	0	30.31
Minor Axis - Muy	10.07	34.83	34.83	0	34.83

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Critical Case - Axial Load & BiAxial Bending

Pu	=	550	KN
Mux	=	30.31	KNM
Muy	=	34.83	KNM

Biaxial Bending Check

Pt Calculated	=	2.07	
Steel Provided	=	4-T16 +2-T12	
Mux1	=	306.98	KNM
Muy1	=	154.32	KNM
Puz	=	0.45 x Fck x Ac + 0.75 x Fy x Asc	
	=	3378.02	KN
Pu/Puz	=	0.52	
Alpha	=	1.53	
Interaction Ratio	=	(Mux / Mux1)^Alpha + (Muy / Muy1)^Alpha)	
	=	0.13 < 1	

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Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	4	
Critical Load Combination	=	[2] : 1.5 (LOAD 1: DL) +1.5	KN

		(LOAD 2: LL)	
Design shear force, Vuy	=	15.5958	KN
Pu	=	1741.62	
Design shear stress, Tvy	=	Vuy / (B x Deff)	N/Sqmm
	=	0.0945	N/Sqmm
Design shear strength, Tc	=	0.6493	N/Sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	2.1611	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.5	
Enhanced shear strength, Tc-e	=	0.9739	N/Sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	4	
Critical Load Combination	=	[2] : 1.5 (LOAD 1: DL) +1.5 (LOAD 2: LL)	KN
Design shear force, Vux	=	-8.5535	kN
Pu	=	550	
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.057	N/Sqmm
Design shear strength, Tc	=	0.6493	N/Sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	2.1611	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.5	
Enhanced shear strength, Tc-e	=	0.9739	
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

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Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	5	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	256	mm
Min. dimension of column	=	230	mm
Max. 300 mm	=	300	mm
Maximum B/2	=	150	
Provided spacing	=	150	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	150	---	---	150	---

BEAM DESIGN CALCULATION

Group		**: G1**
Beam No		**: B1**
Analysis Reference (Member)	4.2m	: 125
Beam Length		: 3500 mm
Breadth (B)		: 300 mm
Depth (D)		: 450 mm
Effective Depth (d)		: 395 mm
Design Code		: IS Code
Beam Type		: Regular Beam
Grade Of Concrete		: M25
Grade Of Steel		: Fe500

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Clear Cover (Cmin) : 25 mm

Es : 2x10^5 N/Sqmm

Flexure Design	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - Analysis	4	4	4	4	4	4
Critical L/C - RCDC	2	2	2	2	2	2
Mu (KNm)	4.56	23.9	1.77	48.43	0	54.01
Tu (KNm)	3.39	3.39	3.39	3.39	3.39	3.39
M_{Tu} (KNm)	4.99	4.99	4.99	4.99	4.99	4.99
Mud (KNm)	9.55	28.88	6.76	53.41	4.99	59
MuLim (KNm)	156	156	156	156	156	156
R	0.204	0.617	0.144	1.141	0.107	1.26
Ptmin (%)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%)	0.2	0.2	0.2	0.278	0.2	0.309
Pcclc (%)	0.002	0	0.016	0	0.025	0
PtPrv (%)	0.679	0.679	0.679	0.87	0.679	0.87
AstCalc (Sqmm)	237	237	237	329.24	237	366.11
AstPrv (Sqmm)	804.24	804.24	804.24	1030.44	804.24	1030.44
Reinforcement	3-T12 2-T12	3-T12 2-T12	3-T12 2-T12	3-T12 2-T12	3-T12 2-T12	3-T12 2-T12

Shear Design	Left	Mid	Right
Critical L/C - Analysis	4	4	4
Critical L/C - RCDC	2	2	2
Vu (KN)	69.77	32.17	72.73
Tu (KNm)	3.39	3.39	3.39
V_{Tu} (KN)	18.08	18.08	18.08

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Vut (KN)	87.85	50.25	90.81
Tv (N/Sqmm)	0.74	0.42	0.77
Tc (N/Sqmm)	0.61	0.55	0.61
Vc (KN)	72.1	65.5	72.1
Vus=Vut-Vc (KN)	15.75	0	18.71
Asv Torsion (Sqmm)	327.085	213.898	335.988
Asv Reqd (Sqmm)	332.364	332.364	332.364
Legs	2	2	2
Stirrup Dia	8	8	8
SvCalc (mm)	165	175	165
SvPrv (mm)	165	175	165
Asv Torsion Prv (Sqmm)	609.33	574.51	609.33
Asv Total Prv (Sqmm)	609.33	574.51	609.33

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 296 mm

Spc2 = 300 mm

For Torsion

(X1 = 260, Y1 = 410)

Spc3 = X1 = 260 mm

Spc4=(X1+Y1)/4 = 167.5 mm

SFR Design

Beam Width = 300 mm

Beam Depth = 450 mm

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Web Depth = 450 <= 750 mm

Side Face Reinforcement
Not Required.

SLAB DESIGN CALCULATIONS

Level	=	4.2m	
Design Code	=	IS Code	
Grade Of Concrete	=	M25	N/Sqmm
Grade Of Steel	=	Fe500	N/Sqmm
Clear Cover	=	20.000	mm
Long Span, Ly	=	4.195	M
Short Span, Lx	=	3.765	M
Imposed Load	=	1.000	KN/Sqm
Live Load	=	2.000	KN/Sqm
Slab Thickness	=	150.000	mm
Effective Depth Along LX, Deffx	=	125.000	mm
Effective Depth Along LY, Deffy	=	125.000	mm
Self Weight	=	5.000	KN/Sqm
Total Load, TL	=	14.000	KN/Sqm
Span	=	2-Way	
Panel Type	=	Two Adjacent Edge continuous	

Design Moments:

Short Span Positive Moment At Midspan -

Moment Coefficient	=	0.043	
BM	=	20.382	KNM
Mu = 1.5 X BM	=	30.573	KNM
Area Of Steel Required (Mu)	=	422.079	Sqmm/M
Steel Provided	=	**T8 @ 150 c/c**	
	=	931.000	Sqmm/M

Short Span Negative Moment At Continuous Support -

Moment	=	0.058	

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Coefficient			
BM	=	27.176	KNM
Mu = 1.5 X BM	=	40.764	KNM
Area Of Steel Required (Mu)	=	573.231	Sqmm/M
Steel Provided	=	**T10@ 150 c/c**	
	=	931.000	Sqmm/M

Long Span Positive Moment At Midspan -

Moment Coefficient	=	0.028	
BM	=	12.951	KNM
Mu = 1.5 X BM	=	19.427	KNM
Area Of Steel Required (Mu)	=	280.233	Sqmm/M
Steel Provided	=	**T10@ 150 c/c**	
	=	1131.000	Sqmm/M

Long Span Negative Moment At Continuous Support -

Moment Coefficient	=	0.037	
BM	=	17.269	KNM
Mu = 1.5 X BM	=	25.903	KNM
Area Of Steel Required (Mu)	=	378.325	Sqmm/M
Steel Provided	=	**T10@ 150 c/c**	
	=	1131.000	Sqmm/M

Distribution Steel @ 0.12% -

Area Of Steel Required	=	210.000	Sqmm
Steel Provided	=	**T10@ 150 c/c**	
	=	931.000	Sqmm/M

Shear Check :

Along Short Span

Shear Coefficient(Lx), SF1	=	0.447	
V = SF1 x TL x Lx	=	36.316	KN
Vu = 1.5 X V	=	54.474	KN
Shear Stress, Tv	=	0.311	N/Sqmm
Nominal Shear Stress, Tc	=	0.410	N/Sqmm

For SRI HARI HOMES

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Modification Factor 'K'	=	1.200	
K x Tc	=	0.492	
	>	0.311	Slab Is Safe In Shear

Along Long Span

Shear Coefficient(Ly), SF2	=	0.360	
V = SF2 x TL x Lx	=	29.232	KN
Vu = 1.5 X V	=	43.848	KN
Shear Stress, Tv	=	0.266	N/Sqmm
Nominal Shear Stress, Tc	=	0.342	N/Sqmm
Modification Factor 'K'	=	1.200	
K x Tc	=	0.411	
	>	0.266	Slab Is Safe In Shear

Deflection Check:

Basic Span To Depth Ratio	=	26	
Span Correction Factor	=	1.000	
Tensile Steel Factor	=	2.198	
Compression Steel Factor	=	1.000	
Flange Correction Factor	=	1.000	
Max Span To Depth Ratio	=	26.00 x 1.00 x 2.20 x 1.00 x 1.00	
	=	57.142	
Lx/d	=	33.143	
	<	57.142	Slab Is Safe In Deflection

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