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**T. Bharanidharan** M.E, AMIE.
+91 9791 7766 85
Registered Civil & Structural Engineer
Chartered Engineer

KURAL ASSOCIATES
Perception to Execution

# STRUCTURAL STABILITY CERTIFICATE

SITE ADDRESS:- PROPOSED CONSTRUCTION OF STILT FLOOR + 4 FLOORS + 5TH FLOOR (PART) (HEIGHT – 18.30M) RESIDENTIAL BUILDING WITH 15 DWELLING UNITS AVAILING PREMIUM FSI AT PLOT NO.15 & 16A, DOOR NO.15 & 16, PASUMPON MUTHURAMALINGAM STREET, RAJAJI COLONY, SALIGRAMAM, CHENNAI 600093, COMPRISED IN OLD S.NO.101/1A (PT) AND T.S.NO.3/2, BLOCK NO.34 OF SALIGRAMAM VILLAGE, WITHIN THE LIMIT OF GREATER CHENNAI CORPORATION.

The Residential Building referred to above is a framed structure with **S+5 upper floor**. The structural design and drawing for the building are being prepared by us conforming to the relevant bureau of Indian Standards viz. IS 456:2000 for plain and reinforced concrete, IS 875(part-II)- 1987 for imposed loads and IS 1893:2002(part-1) for seismic force.

We certify that the building when constructed according to our structural designs and drawings will be **structurally safe and sound** taking earthquake effects in account and fit for occupation. No more future vertical expansion will be allowed except staircase & lift headroom.

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
KURAL ASSOCIATES
No.3/1517,Mugalivakkam Main Road,
Madhanandapuram,Porur,Chennai-600125.
Mob:9791776685 / Tel No:044-79670563

3/1517, Mugalivakkam Main Road, Madhanandhapuram, Porur, Chennai - 600 125.
kuralassociates.engineers@gmail.com

044 79670563 | /kuralassociates

CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

# PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru. T. BHARANITHARAN** has enrolled as **Registered Structural Engineer Grade-II (SE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Structural Engg.)** and experience in the relevant field for **8 years**.

He has been given the Registration No.**SE/GR-II/2019/04/036 Renewed** on **01.04.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **31.03.2029**.




**(A. MEGANATHAN)**
**Superintendent**

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
KURAL ASSOCIATES
No.3/1517,Mugalivakkam Main Road,
Madhanandapuram,Porur,Chennai-600125.
Mob:9791776685 / Tel No:044-79670563

PROPOSED CONSTRUCTION OF STILT FLOOR + 4 FLOORS + 5TH FLOOR (PART) (HEIGHT – 18.30M) RESIDENTIAL BUILDING WITH 15 DWELLING UNITS AVAILING PREMIUM FSI AT PLOT NO.15 & 16A, DOOR NO.15 & 16, PASUMPON MUTHURAMALINGAM STREET, RAJAJI COLONY, SALIGRAMAM, CHENNAI 600093, COMPRISED IN OLD S.NO.101/1A (PT) AND T.S.NO.3/2, BLOCK NO.34 OF SALIGRAMAM VILLAGE, WITHIN THE LIMIT OF GREATER CHENNAI CORPORATION.

## Structural design brief

Introduction

The proposed residential building is a framed structure with stilt and five upper floors. The building is analyzed and designed conforming to loading standards IS: 875 (part II) and to seismic force as per IS 1893: 2002, the revised India code for earth quake resistant design of structures.

A. Load considered in the design

| | |
|---|---|
| Live load on roof | 1.5 KN/$M^2$ |
| Live load on floor | 2 KN/$M^2$ |
| Weathering course on roof | 2KN/$M^2$ |
| Floor finish | 1 KN/$M^2$ |
| Light partition | 1 KN/$M^2$ |
| Unit weight of brickwork | 20 KN/$M^3$ |
| Unit weight of concrete | 25 KN/$M^3$ |

B. Design details

| | |
|---|---|
| Design method | LIMIT STATE DESIGN |
| Codes & special publication used | IS 456: 2000, IS 1893:2002(PART I), SP 16, IS 875(PART II) |
| Concrete grade | M25 |
| Steel grade | FE 415 |

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
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C. Foundation Details

| | |
|---|---|
| Type of foundation | Pile foundation |
| Allowable capacity as per soil test report | 160 tons for 750mm dia piles |
| Depth of foundation | 29m below NGL |
| Diameter of main bars in footings | 20mm, 20mm, 16mm, 12mm |

D. Slab Details

| | |
|---|---|
| Type of slab | Two way slab |
| Thickness of the slab provided | 125mm |
| Steel cover to slab | 25mm |
| Diameter of main bars used | 10mm, 8mm |

E. Beam Details

| | |
|---|---|
| Size of the beam provided | 230 x 450mm, 230 x 600mm, 230 x 380mm |
| Bottom steel cover to beam | 25mm |
| Diameter of main bars used | 25mm, 20mm, 16mm, 12mm |
| Stirrups used | 2 legged stirrups 8mm dia |

F. Column Details

| | |
|---|---|
| Size of the columns provided | 300mmx600mm |
| Steel cover to column | 40mm |
| Diameter of main bars used | 25mm, 20mm, 16mm |
| Binder diameter | 8mm |

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1. LOADINGS

A. Dead and live loads

Gravity load on roof :6.125 KN/$m^2$ (weathering course + slab)

Gravity load on floors :5.125 KN/$m^2$ (floor finish + light partition + slab)

Live load on roof :1.5 KN/$m^2$

Live load on floor :2 KN/$m^2$

B. Wind loads

Wind loads for design of structures shall be based on the design wind speeds arrived on the basis of IS: 875 (PART III)

The parameters for calculation of design wind speed as per IS: 875 (PART III) are as follows:

Basic wind speed ($v_b$) : 50m/sec

Height :15m

From table 1, IS 875 (part 3), for mean probable design life of structure as 50 yrs and wind speed of 50m/sec, risk coefficient, $K_1$ :10

From table 2, terrain category 2 and class A for a height of 15m and plan dimensions 13.34 x 33.34, terrain, height, structure size factor, $K_2$ : 1.02

Topography factor, $K_3$ :1.0

Design wind speed ( $V_z$ ) :Vb x K1 X K2 X K3

Design wind pressure ($P_z$): 0.6 $Vz^2$

:0.6 x $51^2$ :1560.6N/$m^2$

: 1.5606 KN/$m^2$

C. Determination of earthquake parameters and loadings

Zone factor, Z for Chennai seismic ZONE III: 0.16, (table 2, clause 6.4.2)

I, Importance factor : 1, (form table 6)

R, Response reduction factor : 3 for OMRF (ordinary moment resisting frame, table 7)

Fundamental natural period along X direction,

$T_x$ : 0.09 x h / $\sqrt{d_x}$ : 0.09 x 12 / $\sqrt{6.79}$

T.BHARANIDHARAN.M.E.,C.Eng.
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: 0.041 (clause 7.62)

The soil at the site is soft $S_a/g$ : 2.5 as $0.1 \leq T \leq 0.67$

Fundamental natural period along Z direction,

$T_z$ : 0.09 x h / √ dz : 0.09 x 12 / √21.07

: 0.235 (clause 7.6.2)

The soil at the site is soft $S_a/g$ : 2.5 as $0.1 \leq T \leq 0.67$

Design horizontal seismic coefficient

$A_h$ : Z I $S_a$/ 2Rg (clause 6.4.2)

: 0.16 x 1 x 2.5/ 2 x 3:0.0667

Seismic weight of the building : Total gravity load + 0.25 superimposed load

W: 8194 + (0.25 x 1178)

W: 8489.0 kN

Design seismic base shear

$V_B$ : $A_h$W ( caluse 7.5.3)

0.0667 x 8489 : 566.2KN

Shear per column : 566.2 / 13 : 42.78KN

## 2. LOAD CALACULATION FOR MAXIMUM LOADED COLUMN

| | | |
|---|---|---|
| Loading area for the column | :3 x 4.6 | :13.8m² |
| Gravity load reaction from the roof | :6.125 x 13.8 | : 84.52Kn |
| Self weight of the beam | :0.30 x 0.9 x 7.6 x 25 | |

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| | |
|---|---|
| | :51.3KN |
| Weight of the parapet wall | :1 x 0.23 x 20 x 7.6 |
| | :34.96KN |
| Total gravity load | :170.72KN |
| Gravity load reaction from the floor | :5.125 x 13.8 : 70.725KN |
| Self weight of the beam | :0.30 x 0.9 x 25 x 7.6 |
| | :51.3KN |
| Weight of 230mm wall | :0.23 x 2.1 x 20 x 7.6 |
| | :73.4KN |
| Weight of toilet filling | :0.25 x 20 x 3.2 :16KN |
| Weight of 115mm wall | :0.115 x 20 x 2.4 x 3.9 |
| | :21.53KN |
| Total gravity load | :232.83 KN |
| Self weight of the column | :0.3 x 0.6 x 25 x 20.74 |
| | :93.38KN |
| Total gravity load at the foundation | :170.72 + (232.8 x 5 )+ 93.38 |
| Level, KN | :1428.1 KN |
| Total superimposed load at the foundation | :(30.6 + (40.79x 4)) x 0.7) |
| Level, KN | :164.18 KN |
| Total load | :1592.28 KN |

The loads for the other column are calculated in a similar way.

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No.3/1517,Mugalivakkam Main Road,
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## 3.COLUMN DESIGN

Column size

| | | | |
|---|---|---|---|
| B | 300mm | fck | 25 |
| D | 600mm | fy | 415 |
| Cover | 40mm | Effect. Length ratio 0.65 IS 456:200 | |
| Ground floor height,L | | 3000mm $L_{eff1}$ | 0.65 X L 950 pg 9 |
| First floor height,L | | 3000mm $L_{eff2}$ | 0.65 X L 1950 |

Check for slenderness

| | | | |
|---|---|---|---|
| $L_{eff1}/D$ | 3.25 | $L_{eff1}/b$ | 6.50 |
| $L_{eff2}/D$ | 3.25 | $L_{eff2}/b$ | 6.50 |

All columns are short about both axis

Size of column and check $e_{min}$

$e_{min}$ :$L_{eff}/500 + D/30$ 18.90

Hence adopt 20mm eccentricity. 0.02 x 1592.43 : 31.84KN

Design axial load, $P_u$ : 1592.28 KN

Design moment, $M_x$ : $M_{min}$: 31.84 KNm

Designing the column as axially loaded column with uniaxial moment

Calculation of area of steel

| | | | |
|---|---|---|---|
| Cover | 40mm | | |
| Design axial load, pu: | 1592.28 KN | | |
| Design moment, Mx: | Pu x emin | 31.84 KN | |
| D | 600mm | fck | 25 |
| b | 300mm | fy | 415 |
| cover | 40mm | | |

diameter of rod assumed 25mm

d' : 40 + 25/2 :52.5mm

d'/D : 52.5/600 :0.0875mm

$Mz/fckbD^2$ : 31.84 x 1.5 x $10^6$/25 x 300x x 600 x 600

:0.0176

$p_u$/fck bD :1592.28 x 1.5 x $10^3$/25 x 300 x 600

:0.53

From SP 16 chart 45

T.BHARANIDHARAN.M.E.,C.Eng.
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p/fck : 0.03

Ast : 0.03 x 25 x 300 x 600/100 : 1350 $mm^2$

However 10 Nos of Y16 (2010.62$mm^2$) rods are provided.

Also binders Y8 @ 150mm are provided.

## 4. DESIGN OF FOUNDATION

BORED PILE 500 mm DIA

LOAD 160 t ( Stilt + 5 = 5 floors)

Earthquake load =10%
wind load =10% =30%
self weight =10%

160 + 48 = 208 t

Load on each pile = 208/3 = 69.3 t

Depth = 16.5 m ( Rock formation ) pile – 50 cm dia

L/D=1650/50 = 33>12 (long column )

Reduction Co- efficient Cr= 1.75 – (1650/48 x 50)

=1.75 –( 165 / 240)

=1.75 – 0.68

=0.67

Concrete safe stress = 0.67 x 400 =268 N / $cm^2$

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Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
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Steel safe stress = 0.67 x 23000 = 15410 N / $cm^2$

268 x [1963 – At] + [14375 x At] = 700000

490750 – 250 At + 14375 At = 700000

14125 At =14.81 $cm^2$

12 x π/4 $d^2$ = 1481

$d^2$ = ( 1481 x 4)/(3.14 x 12)

d = 12.5 mm say 12 mm

provide 3 NOS 16mm & 3 NOS 12mm

CHECK FOR EARTH QUAKE FORCES:

Check the critical column and its foundation to earth quack forces as per IS 1893

Use seismic co-efficient method as per clause 3.4.2-3(a)

$\alpha_h$ = β I ($\alpha_b$)

($\alpha_h$) = Horizontal seismic co-efficient

$\alpha_b$ = basic horizontal seismic co-efficient as per seismic zone (Chennai) – zone III = 0.04

β = A co-efficient depent up on soil foundation as per table – 3 =1.

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REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
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I = A co-efficient depent up on soil as per table – 4. = 1.20

$(\alpha_h)$ = 0.048

Total load on column = 160 ton.

Size of pile = 500 mm dia.

Safe bearing capacity of soil = 84T/m²

HΣ = horizontal force component of earth quake.

$= (\alpha_h) \times w$

$= 0.048 \times 100$

= 4.8 Ton.

Column size = 300 mm x 450 mm

Effective depth = 40 cm

Shear stress = HΣ / bjd

$= 4800 / (30 \times 0.87 \times 50)$

$= 3.678 \text{ kg / cm}^2 < 8\text{kg / cm}^2$

Hence the column is safe against earth quake.

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$H_V$ = vertical component of earth quake force as per clause 3.4.5 of IS 1893

$H_V = (\alpha_h) / 2 = 0.024$

Vertical component force due to seismic (P1) = HV x P

= 0.024 X 160 = 3.84 Ton

Total load on footing = P + P1 = 160 + 3.84 = 163.84 Ton.

Size of pile = 500 mm dia

Stress on soil = P/A

=163.84 / (500 mm dia)

= 9.8 ton / $m^2$< 10.0 ton / $m^2$

Which is safe

However it is proposed to provide bored piles 500 mm dia @ 16.5 m depth (as per enclosed drawing)

## 5. DESIGN OF PILTH BEAM

Assuming a plinth beam of size 230mm x 380mm

Self weight of the plinth beam:0.23 x 0.380 x 25 : 2.185 KN/m

Weight of the 230mm wall :0.23 x 2.4 x 20 :11.04KN/M

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
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Total load on plinth beam :2.185 + 11.04 :13.225KN/M

Maximum moment for a span of 5m :13.225 x 1.5 x $5^2$/16: 30.99KN/m

$Mu/bd^2$ : 30.99 x $10^6$ / 230 x $330^2$ :1.24

From table 3 of SP 1 6 $P_t$= 0.3658, Ast : 0.3658 x 230 x 350/100

: 294.469$mm^2$

Top and bottom steel of 3 NOS, of Y12 is provided. Area of steel provide

:339$mm^2$

## 6. DESIGN OF FLOOR BEAM

Self weight of the beam :0.23 x 0.45 x 25 : 2.6N/m

Weight of the 230mm wall :0.23 x 2.1 x 20 : 9.66KN/m

Span

Reaction from slab : 2.6 x 2 : 5.2 KN/m

Total factored load : 1.5(5.2 + 9.66 + 6.3): 31.75 KN/m

Maximum moment at support : 432.02 KN/m

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
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$Mu/bd^2$ : 432.02 x $10^6$/230 x $450^2$ : 1.72, from table 3 of SP 16 Pt : 0.566

Ast : 0.566 x 230 x 450/100 : 1551.97$mm^2$

Ast provided : 4 Y16 (804.2$MM^2$)

Maximum moment at mid-span : 432.02KN/m

$Mu/bd^2$ : 432.02 x $10^6$ / 230 x $450^2$ : 1.72, from table 3 of SP Pt: 0.566

Ast : 0.566 x 230 x 450/100 : 585.81$mm^2$,

Ast provided: 4-Y16(804.2$MM^2$)

Maximum shear force : 239KN.for Pt : 1.4

Shear capacity of the section :τc bd : 0.72 x 230 x 450 : 74.52KN

Shear to be carried by the stirrups, Vus: 320.88 – 12.2 : 196.68KN

Vus/d : 196.68/57.5 : 3.42. provide stirrups of Y8ST2@100MM for 1m near

The supports, Y8ST2@125MM for the next 1m, Y8ST2@125mm for the next

1m and Y8ST2@230mm for the remaining span.

All the other beam are designed in a similar way.

## 7. DESIGN OF FLOOR SLAB:

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
KURAL ASSOCIATES
No.3/1517,Mugalivakkam Main Road,
Madhanandapuram,Porur,Chennai-600125.
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| | |
|---|---|
| Self weight of the slab 125mm thick | :3.125KN/$m^2$ |
| Floor finish | :1 KN/$m^2$ |
| Live load | :2 KN/$m^2$ |
| Total load | :6.125 KN/$m^2$ |

The slab has one long edge continuous

ly/lx : 4.53/3.69:1.23<2. The slab is designed as a two-way slab.

From table 26 of IS 456:2000 for ly/lx : 1.15; αx: 0.0725, αy : 0.043

Negative moment at continuous edge for shorter side Mx : αx w $l^2X$

:0.0725 X 6.125 X $3.69^2$ X 1.5:9.07KN/m

Effective depth required :$\sqrt{9.07 \times 10^6/0.138 \times 25 \times 1000}$

:51.27mm.

A slab depth of 125mm is provided.

Mu/$bd^2$ : 9.07 x $10^6$/1000 x $100^2$ : 0.907. from table 3 of SP 16 Pt: 0.2631

Ast required : 0.2631 x 1000 x 125/100: 263.1$mm^2$.

However Y8@ 150mm c/c (335$mm^2$ ) is provided along the shorter span.

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO:(RE/GR-I/19/05/166) &(SE/GR-II/19/04/036)
KURAL ASSOCIATES
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Positive moment at mid span for the longer side My : $\alpha y \, w \, l^2x$

: 0.043 x 6.125 x $3.69^2$ x 1.5 : 5.37KNm

$Mu/bd^2$: 5.37 x $10^6$ / 1000 x $100^2$ : 0.537. from table 3 of SP 16 Pt :0.15236

Ast required : 0.15236 x 1000 x 100/100 :152.36$mm^2$.

However Y8@ 150mm c/c (335$mm^2$) is provided along the longer span.

All other slab are designed in a similar way.

T.BHARANIDHARAN.M.E.,C.Eng.
Registered Civil & Structural Engineer,CMDA
REGD NO.(RE/GR-I/19/05;156) &(SE/GR-II/19/04/036)
KURAL ASSOCIATES
No.3/1517,Mugalivakkam Main Road,
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