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IDHAL INFRASTRUCTURE

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2089, Idhal Complex, Mullikundu,
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# STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed Residential Apartment Building (Alagu Flats) - Stilt+3 floors at Vattanam Road at Ward-G, Block-1, Ts.No:37/1,37/2,38/5,38/6 has been done by me/us based on the report of geotechnical investigation (soil test) done by Dr.SENTHAMIL KUMAR, and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We further certify that:

(i) The minimum grade of concrete is M25

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No: IS:875(relevant parts)-2015 and design of earthquake resistant structure as perIS Code No: IS:456:2000, IS:1893(part-1)

4. The building will be safe and sound when used for the purpose for which it is designed.

Structual Engineer

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Encl:Structural Design Calculation

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# STRUCTURAL DESIGN BASIS REPORT

| | | |
|---|---|---|
| **REPORT NO : SR / OCT/ 24 / 01** | **DATE : 30.10.2024** | **REV : 00** |

**LOCATION** : **ALAGU FLATS RESIDENTIAL APARTMENT PROJECT**
**DEVAKOTTAI**

**CLIENT** : **MR.A.RATHINAM**
**RATHAN ABUILDERS,**
**NO:4A, AL.VR. VALAVU,**
**DEVAKOTTAI**

**PREPARED BY** : **IDHAL INFRASTRUCTURE,**
**No.2089, Idhal Complex, Mullikundu,**
**Ram Nagar, Devakottai - 630 303,**
**email : idhalgroups@gmail.com**
**Mob No : 9944405248.**

**DISTRICT TOWN AND COUNTRY PLANNING**
**COLLECTORATE CAMPUS, SIVAGANGAI**
**SIVAGANGAI DISTRICT.**

# PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that **Thiru.A.RAMAKRISHNAN** has enrolled as **Structural Engineers Grade-I (SE)** with DISTRICT TOWN AND COUNTRY PLANNIING (D.T&CP) who has the qualification of M.E. **Structural Engineering** and experience in the relevant filed for 15 years.

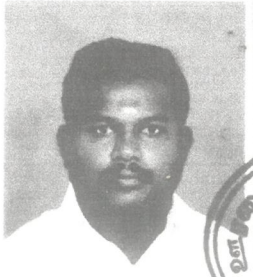
He has been given the Registration. No.SE. I / SVG .33/24 on .19 .07.2024,

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 up to . 18 .07.2029

Assistant Director
Town and Country Planning
Sivagangai District.

To
**Dr.A.RAMAKRISHNAN,M.E.** Ph.D,
No.13A, Senthil Nagar, Ramnagar,
Devakottai, Sivagangai. District.- 630302



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## 1.1 FOREWORD

### 1.1.1 –Description

Mr. A. Rathinam, Rathna Builders, No. 4A, AL. VR. Valavu, Devakottai – 630 302, intend to develop a residential building, at Devakottai.

### 1.1.2 –Objective

The objective is to provide design assumptions and philosophy adopted to analyze the structure. It covers complete structural elements design considerations for analysis of structure subjected to only gravity loads.

## 1.2 CODES, STANDARDS AND REFERENCES

### DESIGN STANDARDS:

Specific applicable clauses of the codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of the Codes and Standards will be used in designs. All design work shall be based on Indian Standards and codes with latest revision, with amendments if any, as on date.

### Structural Requirements:

The design of structural and other building services will comply with the following requirements:

- National Building Code
- The Building Regulations
- The Environmental Protection Act in liaison with the Environmental Agency.
- Fire prevention and detection in compliance with the local Fire Regulation.

### For Loads & RCC Design:

| | |
|---|---|
| IS:456 -2000(2016) | Code of Practice for plain and reinforced concrete |
| IS:3370-2021 | Code of Practice for concrete structures for the storage of liquids: (All parts) |
| IS:875 -2015 | Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts) |
| IS:5525-1969(2013) | Recommendation for detailing of reinforced concrete works |
| IS:1786-2008 | Specification for high strength deformed steel bars and wires for concrete reinforcement |
| IS:10262-2009 | Recommended guidelines for concrete mix design |

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## Foundations:

| | |
|---|---|
| IS:1080-1985(2016) | Code of Practice for design and construction of shallow foundations on soils (other than raft, ring, and shell) |
| IS:1904-1986(2015) | Code of Practice for design and construction of foundations in soils general requirement |
| IS:2950-1981(2013) | Code of Practice for design and construction of raft foundations |
| IS:8009-1976/1980 (2013/2015) | Code of Practice for calculation of settlement of foundations (All parts) |

## Miscellaneous:

| | |
|---|---|
| SP:34-1987 | Handbook of concrete reinforcement and detailing (SCIP) |
| SP:16-1999 | Design Aids for reinforced concrete to IS:456-1978 |
| IS: 432(part 2)-1995 | Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement |
| IS:3067-1995 | Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings |
| SP:7 -2005 | National Building Code of India |
| SP:24-1983 | Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete |

## Materials:

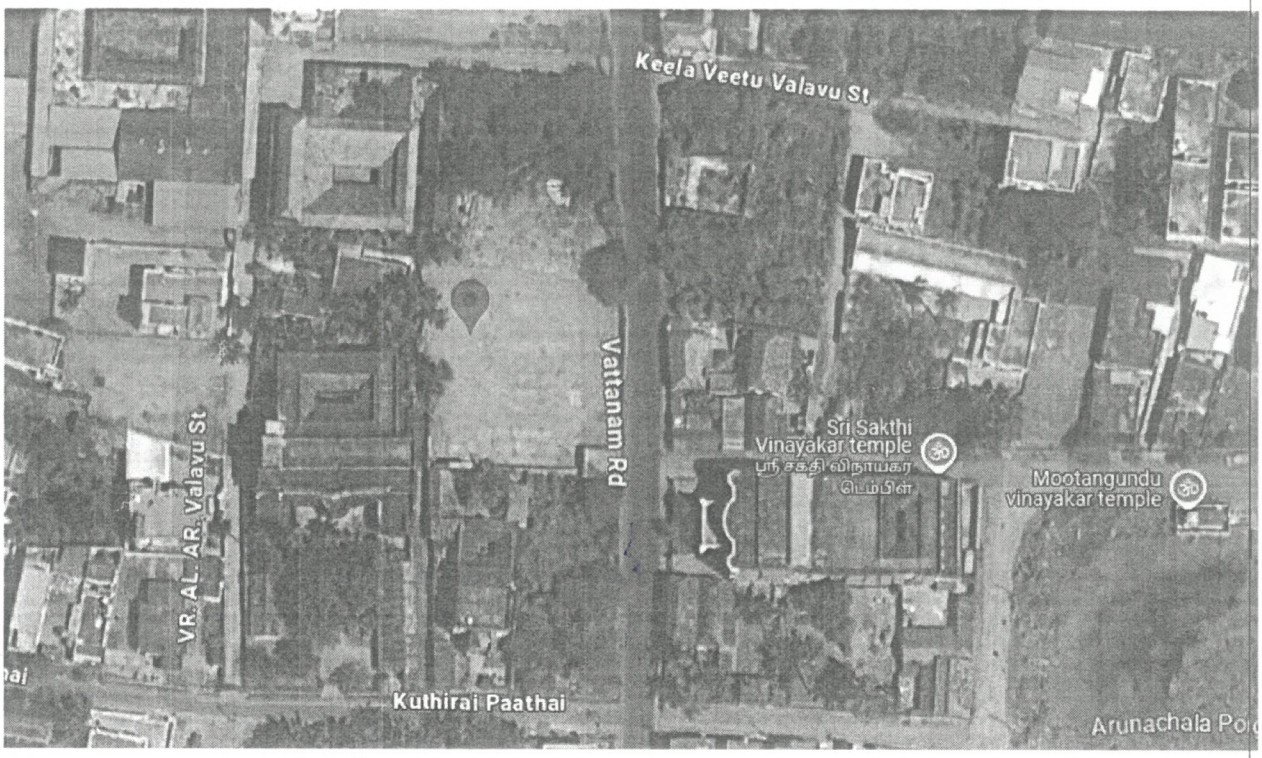
| | |
|---|---|
| IS:516– 1999 | Method of test for strength of concrete. |
| IS:269-2015 | Specification for Ordinary, rapid hardening and low heat Portland cement. |
| IS:1489-1991 | Specification for portland pozzolana cement |
| IS:4031-1991 | Method of physical tests for Portland cement. |
| IS:383-2016 | Specification for coarse and fine aggregates from natural sources for concrete. |
| IS:1199-1999 | Method of sampling and analysis of concrete. |
| IS:1566-2000 | Specification for plain hard drawn steel wire fabric for concrete reinforcement. |
| IS:4990-1998 | Specification for plywood for concrete shuttering works. |
| IS:2645-1999 | Specification for integral cement water proofing compounds. |

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## 1.3 DESCRIPTION OF STRUCTURE

### 1.3.1 –Location

DEVAKOTTAI, TAMILNADU




### 1.3.2 –Building Description.

The proposed residential building consists of a single Basement, Ground plus 4 upper floors. The usage of individual floors of tower is given below:

| Floors | Details |
|---|---|
| Ground floor | Parking |
| 1st Floor and above | Residential units |

The height of the building is 12.20m from Ground floor to Terrace level.

Total number of slabs=4 no's of slabs.

Proposed Floor Heights:

| Floor | Proposed floor to floor height |
|---|---|
| Ground floor | 3.05m |
| Upper typical floors | 3.05m |
| Total height of tower | 12.20m (Ground level to terrace level) |

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### 1.3.3 –Structural Arrangement:

- The Structural System of building comprises of Columns, RC Beams and RC Slabs construction. Floor slabs and column are considered to act as a rigid diaphragm.

| Sl. No. | Description | Tower area |
|---|---|---|
| 1 | Beam grids | Varies as per plan |
| 2 | Slab thickness | Varies and as needed by design |
| 3 | Column size | As per design |
| 4 | Beam size | As per design |

## 1.4 DESIGN APPROACH

Architectural drawing was provided by the architect.

### 1.4.1 – Design Life.

The design life of the building is assumed to be 50 years. This requirement is applicable only for concrete works and not applicable to replaceable finishing materials, water proofing membrane and thermal insulations (if any). Hence periodic maintenance / refurbishment is required for all replaceable material for longer life.

### 1.4.2 –Material Properties.

Materials specified will confirm to the latest edition of the relevant Indian Standard or other accepted standard. Specifications for materials will include sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the technical specification.

**Concrete:**

- All structural concrete shall have cube crushing strength of 25N/mm$^2$ at 28 days.
- Plain cement concrete shall have cube crushing strength of 7.5 N/mm$^2$ at 28 days.

**Concrete Mix:**

| Schedule of concrete grade for Sub-structure | | | |
|---|---|---|---|
| Floor Name | RC Footings | RC Columns | |
| Foundation | M25 | M25 | |
| **Schedule of concrete grade for Super structure** | | | |
| Floor name | RC Columns | RC Beams | RC Slabs |
| Ground floor to LMR roof | M25 | M25 | M25 |

**Reinforcing steel:**

- All reinforcement shall Confirm to IS:1786-2008 having minimum yield strength of 500N/mm$^2$. Corrosion resistant steel is not required.

### 1.4.3 –Design Loads.

**Loads:**

**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.

Density of loads considered:

- Self-weight of plain concrete : 2400kg/cum(24kN/cum)

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- Self-weight of RCC : 2500kg/cum(25kN/cum)
- AAC block masonry : 650kg/cum(6.5kN/cum)
- Soil(Dry) : 1800kg/cum(18kN/cum)
- Soil(Wet) : 2000kg/cum(20kN/cum)
- Water : 1000kg/cum(10kN/cum)
- Glass : 2800kg/cum(28kN/cum)
- Stainless steel : 7850kg/cum(78.50kN/cum)
- Masonry with plastering : 2200kg/cum(22kN/cum)
- Cinder Filling for toilets : 1000kg/cum(10kN/cum)

Super Dead Loads:

Load intensity considered:

- For all Rooms, Staircase : 150kg/sqm(1.5kN/sqm)
- For terrace : 200kg/sqm(2.0kN/sqm)
- Floor finish of 50mm thick for Residential floors : 120kg/sqm(1.2kN/sqm)
- False ceiling : 50 kg/sqm (0.5 kN/sqm) [on all floor slabs]
- Partition walls : As per actual
- Wall loads : As per actual
- External finishes : No additional finishes load
- Water proofing(membrane) : 15kg/sqm(0.15kN/sqm)

Live Loads:

The super imposed loads shall be calculated in accordance with IS:875 (Part-2) based on Occupancy Classification. For multiple occupancies of use in the building shall be referred with the other appropriate comparable occupancy classification as per Table.1 of IS:875(Part-2)-1987.

Following live loads are considered while designing the structural elements apart from the dead loads as per codes.

Residential Floors

- Residential areas : 200 kg/sqm(2.0 kN/sqm)
- Stairs : 300 kg/sqm(3.0 kN/sqm)
- Corridors/Balcony/Utility : 300 kg/sqm(3.0 kN/sqm)
- Toilets : 200 kg/sqm(2.0 kN/sqm)
- Lift machine room : 2500 kg/sqm or as per actual(25.0kN/sqm)
- Terrace : 150 kg/sqm(1.5 kN/sqm)

Actual loading due to lifts loads shall be ascertained and design live loads are suitably modified (if required) considered.

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## 1.4.4 –Durability Considerations:

Environmental conditions, Corrosion and Fire protection for concrete and structural steel.

**Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size**

*(Clauses 6.1.2, 8.2.4.1 and 9.1.2)*

| Sl No. | Exposure | Plain Concrete | | | Reinforced Concrete | | |
|---|---|---|---|---|---|---|---|
| | | Minimum Cement Content kg/m³ | Maximum Free Water-Cement Ratio | Minimum Grade of Concrete | Minimum Cement Content kg/m³ | Maximum Free Water-Cement Ratio | Minimum Grade of Concrete |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| i) | Mild | 220 | 0.60 | – | 300 | 0.55 | M 20 |
| iii) | Moderate | 240 | 0.60 | M 15 | 300 | 0.50 | M 25 |
| iii) | Severe | 250 | 0.50 | M 20 | 320 | 0.45 | M 30 |
| iv) | Very severe | 260 | 0.45 | M 20 | 340 | 0.45 | M 35 |
| v) | Extreme | 280 | 0.40 | M 25 | 360 | 0.40 | M 40 |

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

- Environment : Mild/Moderate
- Exposure conditions : Mild for super structure (concrete surfaces protected against weather or aggressive conditions) and Moderate for substructure(Concrete surfaces sheltered from severe rain or freezing whilst wet Environment)

Minimum grade of concrete : Moderate exposure–M25

- Nominal cover to reinforcement : For Moderate exposure condition, nominal cover should not be less than 30mm.

## 1.4.5 –Fire Rating:

| *Fire Resistance h* | *Minimum Beam Width b* | *Rib Width of Slabs $b_w$* | *Minimum Thickness of Floors D* | *Column Dimension (b or D)* | | | *Minimum Wall Thickness* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Fully Exposed | 50% Exposed | One Face Exposed | $p<0.4\%$ | $0.4\%\leq p\leq 1\%$ | $p>1\%$ |
| | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| 0.5 | 200 | 125 | 75 | 150 | 125 | 100 | 150 | 100 | 100 |
| 1 | 200 | 125 | 95 | 200 | 160 | 120 | 150 | 120 | 100 |
| 1.5 | 200 | 125 | 110 | 250 | 200 | 140 | 175 | 140 | 100 |
| 2 | 200 | 125 | 125 | 300 | 200 | 160 | – | 160 | 100 |
| 3 | 240 | 150 | 150 | 400 | 300 | 200 | – | 200 | 150 |
| 4 | 280 | 175 | 170 | 450 | 350 | 240 | – | 240 | 180 |

NOTES

1 These minimum dimensions relate specifically to the covers given in Table 16A.

2 $p$ is the percentage of steel reinforcement.

FIG. 1 MINIMUM DIMENSIONS OF REINFORCED CONCRETE MEMBERS FOR FIRE RESISTANCE

- Thickness of the structural elements as per Fig.1, clause 21.2of IS 456-2000.
- Nominal coversfor2hr.fire resistance as per table-15,16&16A clause 26.4 of IS456-2000:

| RC Beams | | RC Slabs | | RC Columns |
|---|---|---|---|---|
| Simply supported | Continuous | Simply supported | Continuous | |
| mm | mm | mm | mm | mm |
| 40 | 30 | 35 | 25 | 40 |

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## 1.5 ANALYSIS METHODOLOGY:

This structure has a physical interface with almost all the disciplines like geotechnical works, MEP services,landscape etc.

The structure proposed is of cast in-situ concrete construction with columns suitably placed.

As per codal requirement, one analysis model would be prepared which is as detailed below:

**Analysis model** – Analysis model with serviceability limit state condition and to be used for the design of all structural elements.

The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, core walls and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants.

Assumptions:

- The structure is idealized as 3D space frame and analyzed using Etabs software package for vertical loads.
- The structure is analyzed for specific loads like dead load, live load and for the load combinations as given in the relevant codes.
- The foundation is represented in analysis model using fixed end conditions.

### 1.5.2 Static Analysis:

The following Static loads cases are considered in the analysis.

DL -Dead Load which includes self-weight of the structure.

SDL-Super Imposed Dead Load, including load due to finishes, wall loads, Soil filling loads etc.

LL -Live Load.



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## 1.6 LOAD COMBINATIONS:

Load combinations used for Strength and Serviceability are tabulated below:

| Load Combination | Limit State of Collapse | | Limit State of Serviceability | |
|---|---|---|---|---|
| | *DL+SDL* | *LL* | *DL+SDL* | *LL* |
| DL+LL | 1.5 | 1.5 | 1 | 1 |

The various loads are combined in accordance with the stipulations in IS: 875 (Part 5)-1987; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned may be adopted.

*This value is to be considered when stability against overturning and stress reversal is critical

Where,

DL-Dead Load.

LL-Live Load.

## 1.7 DESIGN METHODOLOGY:

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS:456-2000.
- Forces and moments from the 3D analysis output for the worst combinations are used for the design of the structure.
- The foundations are designed for critical load combination.
- The structure is analyzed for specific loads like dead load, live load, and for the load combinations as given in the relevant codes.
- The slab is analyzed as two-way and one-way slabs.
- The design of special members like water tanks will be done in accordance with the relevant IS Codes.
- Design of structural steel members are done using elastic method as per IS: 800 with relevant allowable stresses.

## 1.8 ACCEPTANCE CRITERIA:

### 1.8.1 Deflection Limits:

For Reinforced concrete works:

Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.

- Limiting value for long term deflection is considered as span/250 and for the long-term deflection after erection of partitions & finishes is considered as span/350 or 20mm whichever less as per IS456–2000.

### 1.8.2 Cracking Limits:

Limiting values of crack width as per clause 35.3 of IS:456-2000 is followed in the design.

- In general, for slabs and beams, the crack width is limited to 0.3mm.
- For basement retaining wall and water retaining structures, crack width is limited to 0.2mm.
- For STP, the crack width is limited to0.1mm.

### 1.8.3 Permissible Drift Limits:

- Short term deflection for RC elements=Span/250
- Long term deflection for RC elements =Span/350

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### 1.8.4 Soil Data:

Foundations are designed based on Geo Technical investigation report and will dissipate all the vertical and horizontal loads safely to the soil below. In case of lateral forces increase in allowable bearing pressure for footing proportioning shall be done in accordance with the relevant IS codes.

Safe Bearing Capacity of the soil is 250kN/$m^2$ from Natural Ground level considered as per the report.

## 1.9 DETAILING REQUIREMENTS:

- All columns including beams are detailed as per normal detailing requirement.
- Detailing for all structural members shall be in accordance with IS: 456&SP: 34.

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**MATERIALS OF CONSTRUCTION**

| | | |
|---|---|---|
| Grade of concrete $f_{ck}$ = | 25 | N/mm$^2$ |
| Grade of steel $f_y$ = | 500 | N/mm$^2$ |
| Unit wt of soil = | 18 | KN/m$^3$ |

**CHECK FOR GROSS BEARING PRESSURE**

| | | | |
|---|---|---|---|
| Safe NET bearing pressure = | **250** | KN/m$^2$ | |
| Safe gross bearing pr. = | **312.10** | KN/m$^2$ | (net pr. + depth of foot * soil unit wt) |
| Axial load from output (P1) = | 560 | KN | |
| Moment about Z axis ($M_z$) = | 5 | KN-m | |
| Moment about X axis ($M_x$) = | 0 | KN-m | |
| Depth of top of foot. from ground = | **3** | m | |
| Unit wt of soil = | 18 | KN/m$^3$ | |
| Weight of soil retained above foot = | **138.51** | KN | |
| P = (P1+soil+foot self wt) = | **728.89** | KN | |
| Maximum bearing pressure = | **276.13** | KN/m$^2$ | } |
| Minimum bearing pressure = | **263.78** | **KN/m$^2$** | } |

**Hence footing is safe against max gross bearing pr.**

**DESIGN FORCES**

| | | |
|---|---|---|
| Axial load:($P_u$) = | 840 | **KN** |
| Moment about Z axis ($M_{uz}$) = | **7.5** | **KN-m** |
| Moment about X axis ($M_{ux}$) = | **0** | **KN-m** |
| Maximum effective soil pressure $p_{e\,max}$ | | |
| ( Pu/Area+ Muz/Zz + Mux/Zx) = | **320.37** | **KN/m$^2$** |
| Minimum effective soil pressure $p_{e\,min}$ | | |
| ( Pu/Area - Muz/Zz - Mux/Zx) = | **301.85** | **KN/m$^2$** |

Design of footing is done using above maximum effective soil pressure

**MOMENT AT FACE OF THE PEDESTAL**

Mu about X1 X1 = ( pe max x length$^2$/2)= **44.15** KN-m per meter

Mulimit = **518.88** KN-m per meter

The section is singly reinforced

| | | | |
|---|---|---|---|
| Hence, Ast = | **260.518** | mm$^2$ | |
| Min Ast = | **540.000** | mm$^2$ | (0.12 % for slab, cl 26.5.2.1) |
| Spacing required = | **145.44** | mm | (considering max of above two calculated values of Ast) |
| Spacing provided = | 125 | mm | |
| pt provided = | **0.16** | % | |
| pt required = | **0.14** | % | |
| provide a maximum s | **0.16** | % | |

Hence provide 10 mm dia bar @ 125 mm c/c parellel to length of footing ( || to Z)

Mu about N1 N1 = ( pe max x length$^2$/2)= **90.10** KN-m per meter

The section is singly reinforced

| | | | |
|---|---|---|---|
| Calc. Ast = | **539.388** | mm$^2$ | |
| Min Ast = | **540** | mm$^2$ | (0.12 % for slab, cl 26.5.2.1) |
| Spacing = | **145.44** | mm | (considering max of above two calculated values of Ast) |
| Spacing provided = | 125 | mm | |
| pt provided = | **0.16** | % | |
| pt required = | **0.14** | % | |
| provide a maximum s | **0.16** | % | |

Hence provide 10 mm dia bar @ 125 mm c/c parellel to breadth of footing ( || to X)

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# DESIGN OF BI-AXIAL ISOLATED RCC FOOTING (IS 456, 2000)

| | | |
|---|---|---|
| Building Name | DVK APARTMENTS | |
| Footing Number: | F2 | |
| Node number | 167 | |

**COLUMN**

| | | |
|---|---|---|
| WIDTH (Breadth) = | 300 | mm |
| DEPTH (Length) = | 450 | mm |
| Axial load from output (P1) = | 560 | KN |
| Moment about Z axis ($M_z$) = | 5 | KN-m |
| Moment about X axis ($M_x$) = | 0 | KN-m |
| Safe bearing pressure = | 250 | KN/m$^2$ |

AREA= 2.464 mm$^2$

1 x2 -0.15 x -2.464

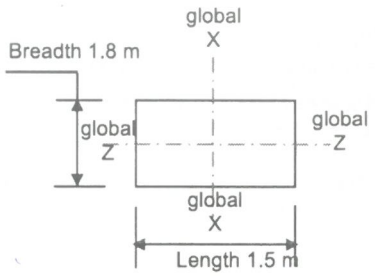
| | | | |
|---|---|---|---|
| Required length of the footing | | L | 1.646504 |
| Required width of the footing | | w | -1.4965 |
| Depth required | 113.125609 | | |
| Over All Depth | 168.125609 | | |

**PEDASTAL**

| | | |
|---|---|---|
| Offset to be provided in each side (breadth) = | 0 | mm |
| Offset to be provided in each side (length) = | 0 | mm |
| Depth of Pedestal (d) = | 0 | mm |
| Breath = | 300 | mm |
| Length = | 450 | mm |

**FOOTING**

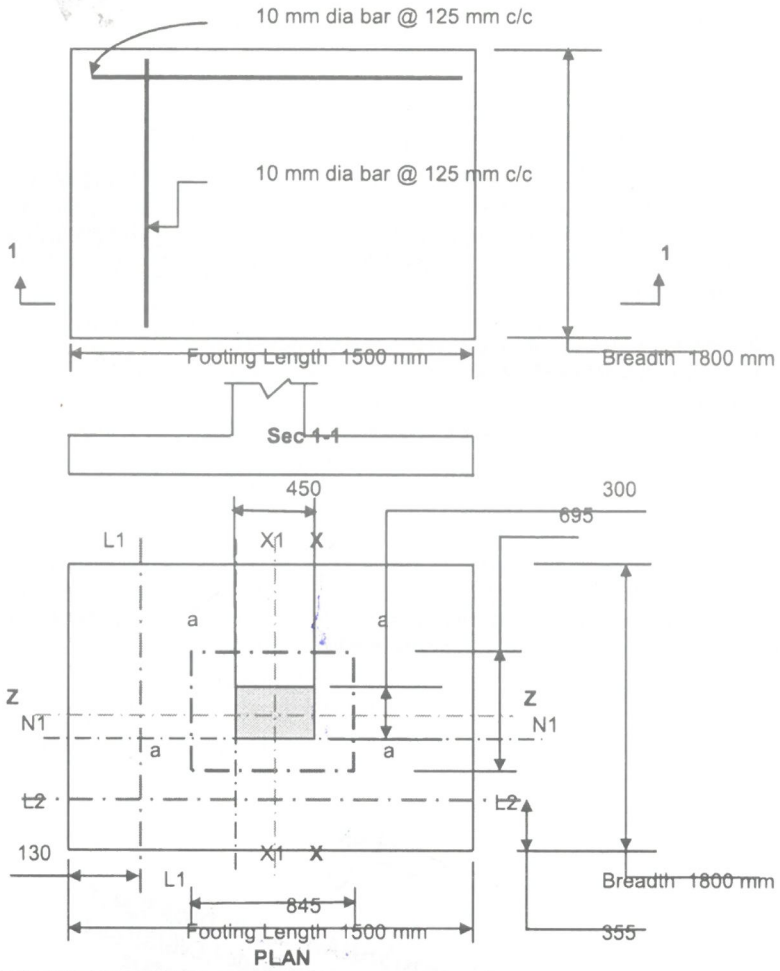
| | | |
|---|---|---|
| Revised Footing length (L, dim. ) = | 1.5 | m |
| Revised Footing Breadth (W, ) = | 1.8 | m |
| Depth of footing (D) = | 450 | mm |
| Clear cover of footing = | 50 | mm |
| Main bar dia of footing = | 10 | mm |
| Effective depth of footing at Face of The Column= | **395** | mm |
| Effective depth of footing at Edge = | **395** | mm |
| Selfweight of the footing = | **30.38** | KN |
| Area of Footing(A) = | **2.70** | m$^2$ |
| Sect mod of foot about Z axis (Zz) = | **0.81** | m$^3$ |
| Sec mod of foot about X axis (Zx) = | **0.68** | m$^3$ |



Footing Dimensions

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Arrangement of bottom reinforcement as per above design is shown below




PLAN

**CHECK FOR ONE WAY SHEAR AT FACE OF PEDESTAL :**

**One way shear at critical section L1- L1**

Distance of critical sec. from edge of footing = **0.13** m

Shear force Vs =pe max x 0.13 x 1m width of footing = **41.648** KN

Shear stress $\tau_v$ = Vs/bd = **0.105** N/mm²

$\tau_c$ = **0.30** N/mm²

**tv < tc hence O.K.**

**One way shear at critical section L2- L2**

Distance of critical sec. from edge of footing = **0.355** m

Shear force Vs =pe max x 0.355 x 1m width of footing = **113.731** KN

Shear stress $\tau_v$ = Vs/bd **0.288** N/mm²

$\tau_c$ = **0.30** N/mm²

**tv < tc hence O.K.**


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**CHECK FOR TWO WAY SHEAR**

Ref. cl 34.2.4 and cl.31.6.3 of IS 456 : 2000

Allowable shear stress $\tau_{v\ allowable}$ = $k_s \tau_c$

$k_s$ = ( 0.5 + bc) = **1.166666667** >1

Hence, $k_s$= **1**

$\tau_c = 0.25\ (fck)^{0.5}$ = **1.25** N/mm$^2$

$\tau_{v\ allowable} = k_s \times \tau_c$ = **1.25** N/mm$^2$

Shear force Vs = 320.37 ( 1.5 x 1.8 - 0.845 x 0.695) = **676.85** KN

Length of critical section = 2 x ( 845 + 695) = **3080** mm

Area of the critical section (length of critical sec x eff. d ) = **1216600** mm$^2$

Hence shear stress $\tau_v$ = **0.556** N/mm$^2$

**tv < allowable hence O.K.**

**CHECK FOR TWO WAY SHEAR FROM FACE OF THE COLUMN**

Ref. cl 34.2.4 and cl.31.6.3 of IS 456 : 2000

Allowable shear stress $\tau_{v\ allowable}$ = $k_s \tau_c$

$k_s$ = ( 0.5 + bc) = **1.166666667** >1

Hence, $k_s$= **1**

$\tau_c = 0.25\ (fck)^{0.5}$ = **1.25** N/mm$^2$

$\tau_{v\ allowable} = k_s \times \tau_c$ = **1.25** N/mm$^2$

Shear force Vs = 320.37 ( 1.5 x 1.8 - 0.695 x 0.845) = **676.85** KN

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Hence shear stress $\tau_v$ = **0.556** N/mm$^2$

**tv < allowable hence O.K.**

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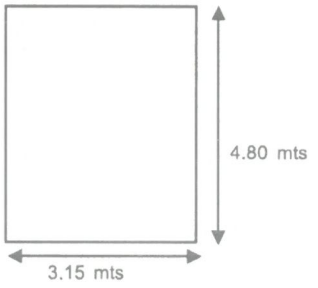
## DESIGN OF TYPICAL SLAB

PROJECT: DVK APARTMENTS

**DESIGN OF TWO WAY SLAB** — **PANEL INSIDE GRID G,K & 1,2**

| | | | |
|---|---|---|---|
| Short span | S= | 3.15 | mts |
| Long span | L= | 4.80 | mts |
| Assumed slab thickness | t= | 0.125 | mts |
| Grade of concrete | fck= | 25 | N/mm^2 |
| Grade of reinforcement | fy= | 550 | N/mm^2 |

greater than 'min. eff depth reqd'. Hence ok




***Type of panel*** — Two long edges discontinuous

***Loads***

| | | | | |
|---|---|---|---|---|
| Self weight of slab | w1= | 3.13 | kN/m^2 | |
| Floor finish | w2= | 1.50 | kN/m^2 | |
| Live load | w3= | 2.00 | kN/m^2 | TOTAL |
| Miscellaneous | w4= | 0.00 | kN/m^2 | 6.63 kN/m^2 |

| | | | |
|---|---|---|---|
| Ratio of long span to short span | R= | 1.55 | |
| Design Load with load factor of 1.5 | Wu= | 9.94 | kN/m^2 |

***Design***

| | Coeff | BM | k | pt | Ast | Dia | Spacing | d |
|---|---|---|---|---|---|---|---|---|
| Short span direction | | | | | | | | |
| Negative moment at continuous edge | 0 | 0.00 | 0.00 | 0.00 | 150.00 | 8 | 335 | 96 |
| Positive moment at midspan | 0.071 | 7.00 | 0.76 | 0.16 | 158.17 | 8 | 318 | 96 |
| Long span direction | | | | | | | | |
| Negative moment at continuous edge | 0.045 | 4.44 | 0.57 | 0.12 | 150.00 | 8 | 335 | 88 |
| Positive moment at midspan | 0.035 | 3.45 | 0.45 | 0.10 | 150.00 | 8 | 335 | 88 |

| | | | | |
|---|---|---|---|---|
| Minimum effective depth reqd | dre= | 45.05 | mm | |
| Clear cover to any reinforcement | c= | 25 | mm | |
| Minimum effective depth provided | dpr= | 88 | mm | greater than 'min. eff depth reqd'. Hence ok |
| Minimum reinforcement | Amin= | 150 | mm^2 | |

***Deflection check***

| | | | | | | |
|---|---|---|---|---|---|---|
| Reinf provided at midspan along short direction | 251.33 | mm^2 | Dia | 8 | at | 200 mm |
| Stress in reinforcement | fs= | 200.76 | N/mm^2 | | | |
| Percentage of reinforcement provided | pt= | 0.2618 | % | | | |
| Modification factor as per fig 4 of IS:456-2000 | MF= | 1.9698 | | | | |

| | | |
|---|---|---|
| Type of slab for deflection check | Simply supported | |
| Basic span to effective depth ratio | 20 | |
| Minimum effective depth reqd from deflection criteria | 79.96 | mm |
| Effective depth provided | 96 | mm greater than 'min. eff depth reqd'. Hence ok |


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BEAM ALONG GRID 2 BETWEEN GRIDS A TO G(AT FIRST FLOOR)

## ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Envelope)

**Beam Element Details**

| Level | Element | Unique Name | Section ID | Length (mm) | LLRF |
|---|---|---|---|---|---|
| FIRST FLOOR SLAB | B212 | 20 | B-200X450-M25 | 6400.8 | 1 |

**Section Properties**

| b (mm) | h (mm) | $b_f$ (mm) | $d_s$ (mm) | $d_{ct}$ (mm) | $d_{cb}$ (mm) |
|---|---|---|---|---|---|
| 200 | 450 | 200 | 0 | 40 | 40 |

**Material Properties**

| $E_c$ (MPa) | $f_{ck}$ (MPa) | Lt.Wt Factor (Unitless) | $f_y$ (MPa) | $f_{ys}$ (MPa) |
|---|---|---|---|---|
| 25000 | 25 | 1 | 500 | 415 |

**Design Code Parameters**

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 1.5 | 1.15 |

**Flexural Reinforcement for Major Axis Moment, $M_{u3}$**

| | End-I Rebar Area mm² | End-I Rebar % | Middle Rebar Area mm² | Middle Rebar % | End-J Rebar Area mm² | End-J Rebar % |
|---|---|---|---|---|---|---|
| Top (+2 Axis) | 427 | 0.47 | 0 | 0 | 426 | 0.47 |
| Bot (-2 Axis) | 175 | 0.19 | 636 | 0.71 | 237 | 0.26 |

**Flexural Design Moment, $M_{u3}$ and Axial Force, $P_u$**

| | Station Loc mm | Design $M_u$ kN-m | Design $P_u$ kN | Combo Name |
|---|---|---|---|---|
| Top (+2 Axis) End-I | 115 | -68.1137 | 0 | 1.5(DL+SDL+LL) |
| Top (+2 Axis) Middle | 4622.8 | 0 | 0 | 1.5(DL+SDL+LL) |
| Top (+2 Axis) End-J | 6285.8 | -67.9391 | 0 | 1.5(DL+SDL+LL) |
| Bot (-2 Axis) End-I | 1422.4 | 29.8535 | 0 | 1.5(DL+SDL+LL) |
| Bot (-2 Axis) Middle | 3200.4 | 95.5368 | 0 | 1.5(DL+SDL+LL) |
| Bot (-2 Axis) End-J | 4978.4 | 39.8364 | 0 | 1.5(DL+SDL+LL) |

**Shear Reinforcement for Major Shear, $V_{u2}$**

| End-I Rebar $A_{sv}/s$ mm²/m | Middle Rebar $A_{sv}/s$ mm²/m | End-J Rebar $A_{sv}/s$ mm²/m |
|---|---|---|
| 271.85 | 221.69 | 381.29 |

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COLUMN AT GRID G-2 (STILT TO FIRST FLOOR)

## ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Envelope)

**Column Element Details (Envelope)**

| Level | Element | Unique Name | Section ID | Length (mm) | LLRF | Type |
|---|---|---|---|---|---|---|
| FIRST FLOOR SLAB | C19 | 550 | C-230X450-M25 | 3050 | 0.9 | Ordinary Frame |

**Section Properties**

| b (mm) | h (mm) | dc (mm) | Cover (Torsion) (mm) |
|---|---|---|---|
| 230 | 450 | 56 | 30 |

**Material Properties**

| $E_c$ (MPa) | $f_{ck}$ (MPa) | Lt.Wt Factor (Unitless) | $f_y$ (MPa) | $f_{ys}$ (MPa) |
|---|---|---|---|---|
| 25000 | 25 | 1 | 500 | 415 |

**Design Code Parameters**

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 1.5 | 1.15 |

**Longitudinal Reinforcement Design for $P_u$ - $M_{u2}$ - $M_{u3}$ Interaction**

| Column End | Rebar Area mm² | Rebar % |
|---|---|---|
| Top | 828 | 0.8 |
| Bottom | 828 | 0.8 |

**Design Axial Force & Biaxial Moment for $P_u$ - $M_{u2}$ - $M_{u3}$ Interaction**

| Column End | Design $P_u$ kN | Design $M_{u2}$ kN-m | Design $M_{u3}$ kN-m | Station Loc mm | Controlling Combo |
|---|---|---|---|---|---|
| Top | 987.2314 | 20.898 | -33.7855 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 997.3226 | -19.9465 | 23.2747 | 0 | 1.5(DL+SDL+LL) |

**Shear Reinforcement for Major Shear, $V_{u2}$**

| Column End | Rebar $A_{sv}/s$ mm²/m | Design $V_{u2}$ kN | Station Loc mm | Controlling Combo |
|---|---|---|---|---|
| Top | 254.94 | 21.823 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 254.94 | 21.823 | 0 | 1.5(DL+SDL+LL) |

**Shear Reinforcement for Minor Shear, $V_{u3}$**

| Column End | Rebar $A_{sv}/s$ mm²/m | Design $V_{u3}$ kN | Station Loc mm | Controlling Combo |
|---|---|---|---|---|
| Top | 498.8 | 12.4722 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 498.8 | 12.4722 | 0 | 1.5(DL+SDL+LL) |

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COLUMN AT GRID G-2 (STILT TO FIRST FLOOR)

## ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Envelope)

**Column Element Details (Envelope)**

| Level | Element | Unique Name | Section ID | Length (mm) | LLRF | Type |
|---|---|---|---|---|---|---|
| FIRST FLOOR SLAB | C20 | 552 | C-450X230-M25 | 3050 | 0.7 | Ordinary Frame |

**Section Properties**

| b (mm) | h (mm) | dc (mm) | Cover (Torsion) (mm) |
|---|---|---|---|
| 450 | 230 | 56 | 30 |

**Material Properties**

| $E_c$ (MPa) | $f_{ck}$ (MPa) | Lt.Wt Factor (Unitless) | $f_y$ (MPa) | $f_{ys}$ (MPa) |
|---|---|---|---|---|
| 25000 | 25 | 1 | 500 | 415 |

**Design Code Parameters**

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 1.5 | 1.15 |

**Longitudinal Reinforcement Design for $P_u$ - $M_{u2}$ - $M_{u3}$ Interaction**

| Column End | Rebar Area mm² | Rebar % |
|---|---|---|
| Top | 1371 | 1.33 |
| Bottom | 1443 | 1.39 |

**Design Axial Force & Biaxial Moment for $P_u$ - $M_{u2}$ - $M_{u3}$ Interaction**

| Column End | Design $P_u$ kN | Design $M_{u2}$ kN-m | Design $M_{u3}$ kN-m | Station Loc mm | Controlling Combo |
|---|---|---|---|---|---|
| Top | 1313.2361 | 2.8164 | -26.2647 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 1323.3274 | -8.2176 | 26.4665 | 0 | 1.5(DL+SDL+LL) |

**Shear Reinforcement for Major Shear, $V_{u2}$**

| Column End | Rebar $A_{sv}$/s mm²/m | Design $V_{u2}$ kN | Station Loc mm | Controlling Combo |
|---|---|---|---|---|
| Top | 498.8 | 7.0284 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 498.8 | 7.0284 | 0 | 1.5(DL+SDL+LL) |

**Shear Reinforcement for Minor Shear, $V_{u3}$**

| Column End | Rebar $A_{sv}$/s mm²/m | Design $V_{u3}$ kN | Station Loc mm | Controlling Combo |
|---|---|---|---|---|
| Top | 254.94 | 4.3641 | 2600 | 1.5(DL+SDL+LL) |
| Bottom | 254.94 | 4.3641 | 0 | 1.5(DL+SDL+LL) |

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BEAM ALONG GRID 2 BETWEEN GRIDS A TO G(AT FIRST FLOOR)

**Design Shear Force for Major Shear, $V_{u2}$**

| End-I Design $V_u$ kN | End-I Station Loc mm | Middle Design $V_u$ kN | Middle Station Loc mm | End-J Design $V_u$ kN | End-J Station Loc mm |
|---|---|---|---|---|---|
| 69.4199 | 590.9 | 44.052 | 4622.8 | 82.2257 | 5809.9 |
| 1.5(DL+SDL+LL) | | 1.5(DL+SDL+LL) | | 1.5(DL+SDL+LL) | |

**Torsion Reinforcement**

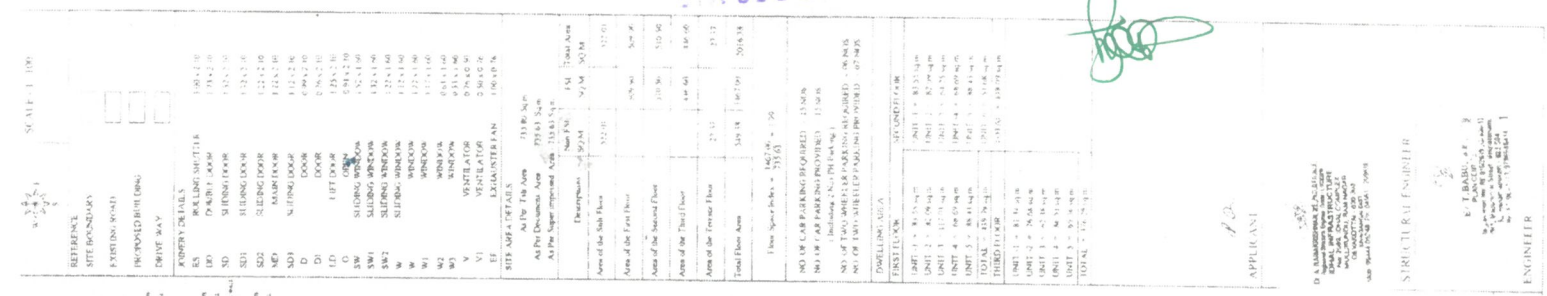
| Shear Rebar $A_{svt}$ /s mm²/m |
|---|
| 0 |

**Design Torsion Force**

| Design $T_u$ kN-m | Station Loc mm | Design $T_u$ kN-m | Station Loc mm |
|---|---|---|---|
| 0.0888 | 6285.8 | 0.0888 | 6285.8 |
| 1.5(DL+SDL+LL) | | 1.5(DL+SDL+LL) | |

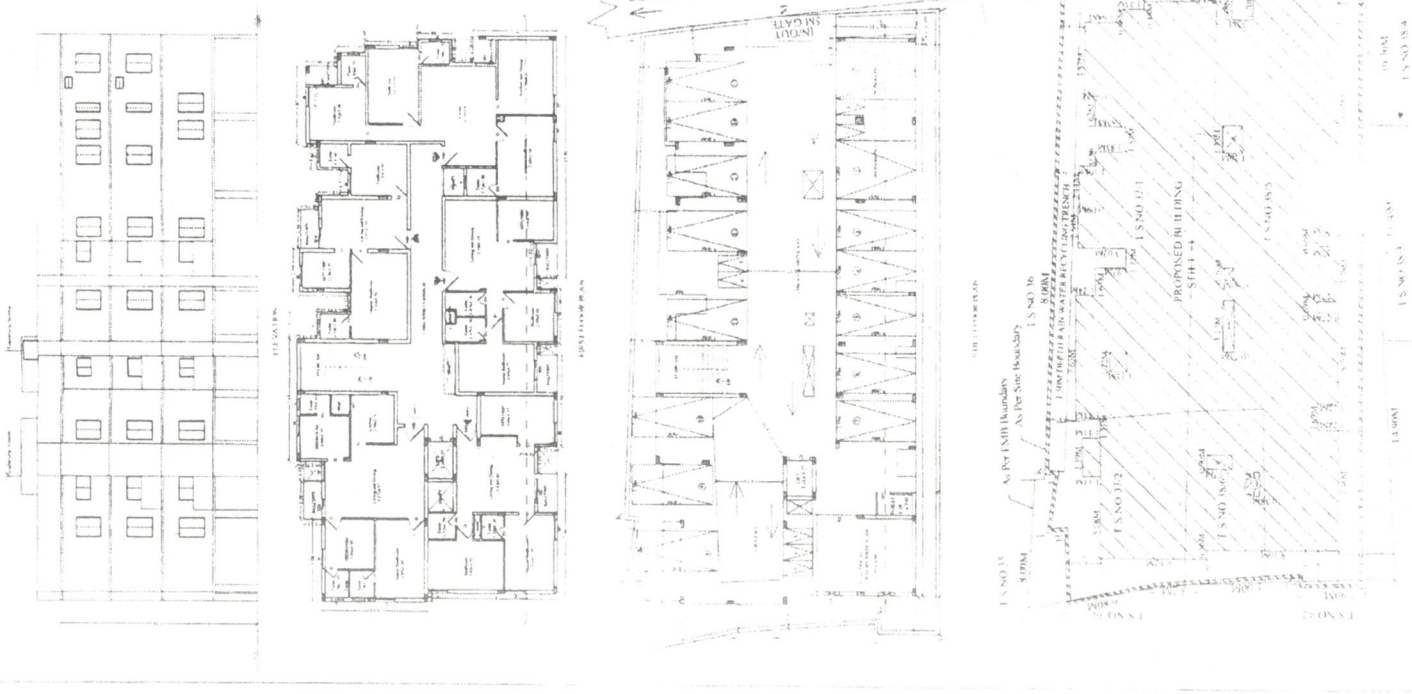
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