STRUCTURAL DESIGN BRIEF REPORT

M/s CASAGRAND

PROPOSED RESIDENTIAL VILLAS AT THAIYUR B VILLAGE, THIRUPORUR TALUK, CHENGALPATTU DISTRICT.

QUADOMETRY
DESIGN | ENGINEERING

#610, 17th B Cross Rd, Indiranagar II Stage, hoysala Nagar, Indiranagar, Bengaluru -560038

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1. INTRODUCTION

Quadometry Engineering Pvt. Ltd. has been appointed as Structural Consultants by **M/s CASAGRAND CHENNAI** to develop structural schemes and design for proposed low rise residential development at Thaiyur B Village, Thiruporur Taluk, Chengalpattu District.
The objectives of these reports are stated as follows:

- Define the engineering strategy and parameters in relation to the building structure and Architectural concept.
- Identify and record all input requirements, Analysis and design criteria.
- Develop structural scheme compatible with Architectural vision, services requirements and client's needs.
- Prepare structural design that will aim to actual structural durability and integrity.
- Desirable structural performance under characteristic services load.
- Fast-track construction and cost effectiveness

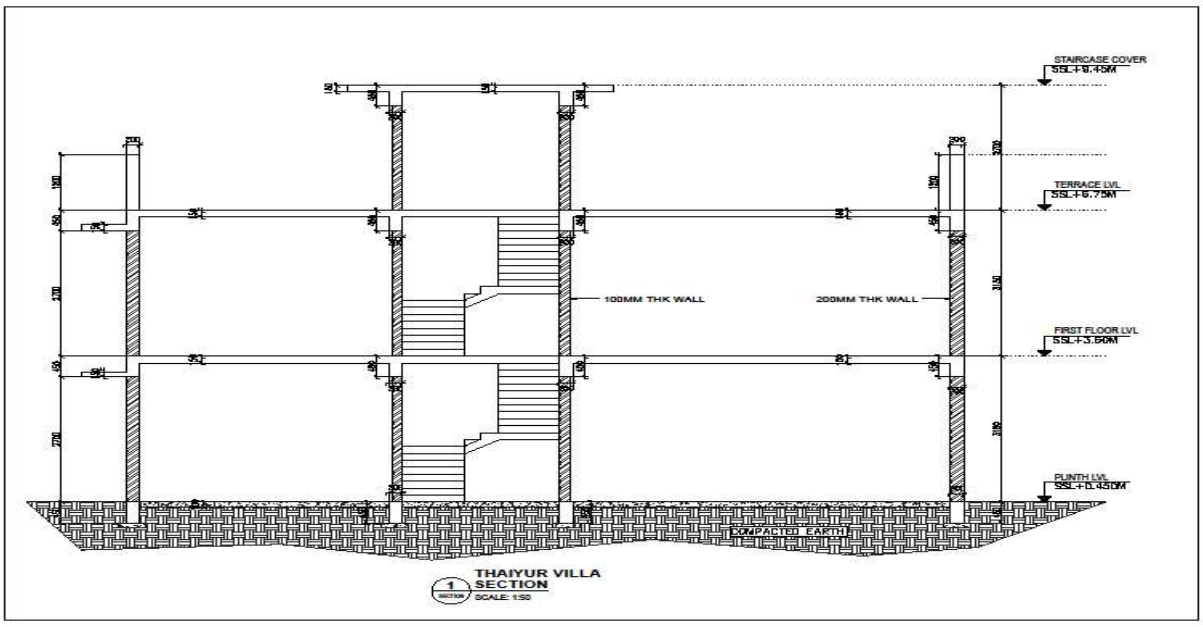
2. PROJECT DESCRIPTION

The proposed residential development consists of villa along with one Ground Floor, First floor, & Terrace Floor. This design basis caters for the Structural Design of Villa building.

Villa will have Ground floor, First floor & terrace. Height of the Blocks is approx. 9.0m from ground level.

Dimensions of Villa are approx. 16.6m x 7.72m with following floor heights

Ground Floor	:	3.15 m
First Floor	:	3.15 m
Terrace Floor	:	1.2m



3. CONSTRUCTION TYPE

SUBSTRUCTURE

There will not be any basement. The buildings will be supported on set of Isolated footing for Column.

SUPERSTRUCTURE

The superstructure will be constructed in conventional RCC slab system with beams, & columns. Concrete will be poured in a RCC slab on erection of formwork and fabrication of reinforcement.

4. STRUCTURAL SYSTEM

4.1 FOUNDATION

Based on the proposed structure and sub soil conditions, Geotechnical investigations report recommends Isolated foundation system. As per Soil report the footings will be designed for allowable Bearing Capacity, For Isolated Footing 125 kN/sq.m at depth of 1m below natural ground level.

Table-4.1 Recommended Allowable Safe Bearing Pressures

Sl.No.	Depth of Foundation below E.G.L. (m)	Allowable Safe Bearing Pressure (kPa)	Elastic Settlement (mm)
		Size of Foundation (m)	Size of Foundation (m)
		1.0	1.0
1	1.00	125	2.56
2	1.25	150	3.08
3	1.50	200	3.89
4	2.00	250	4.86

4.2 SUPERSTRUCTURE

- The proposed structural system for this project is a RC Beams & Column and RC Slabs.
- RC Columns are spaced according to the framing plans based on the architectural requirement in order to transfer the loads from the Super Structure to the Foundation System.
- The structure with villa is analysed using industry standard software ETABS.
- Beams and columns are assigned as frame elements and Slabs are assigned with shell elements wherever required.
- The slab has been considered as a rigid diaphragm at the respective floor levels to transfer the lateral forces to vertical members.
- Appropriate load and its combinations, as per relevant clauses in the latest IS codes for most unfavourable effects are chosen for design.

5. STRUCTURAL DESIGN STANDARDS AND CODES CONSIDERED

Specific applicable 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.

Loads

IS 875(Part 1): 1987:	Dead Loads Unit Weight of Building Material and Stored Material
IS 875(Part 2): 1987:	Imposed Loads
IS 875(Part 3): 2015:	Wind Loads
IS 875(Part 4): 1987:	Snow Loads
IS 875(Part 5): 1987:	Special loads and load combinations
IS 1893:2016:	Criteria for earthquake resistance design of structures.
IS: 13920-2016:	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces

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 foundation in soils general requirements.
IS 2950:1981(2013):	Code of Practice for design and construction of raft foundations
IS 2974:1998(2015/13):	Code of Practice for design and construction of machine

foundations (All parts).

IS 8009:1976/1980(2013/15): Code of Practice for calculations of foundations (All parts).

RCC:

IS 456:2000:	Code of Practice for plain and reinforced concrete
IS 458:1988:	Specification for precast concrete pipes
IS 3370:2009:	Code of Practice for concrete structures for the storage of liquids
IS 4326:2013:	Code of Practice for earthquake resistant design and construction of buildings.
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.
IS 1893(Part-1) 2016:	Criteria for earthquake resistant design of structures (General provision and buildings).
IS 13920:2016:	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
IS 1343:2012:	Prestressed Concrete

Structural steel:

IS 800:2007	Code of Practice for general construction in steel.
IS 806:1968(2013):	Code of Practice for use of steel tubes in general building construction
IS 808:1989:	Dimension for Hot rolled steel beam, column channel and angle section.
IS 816:1998:	Code of Practice for use of metal arc welding for general construction in mild steel.
IS 1161:1998:	Steel tubes for Structural Purpose.
IS 4000:1998:	High strength bolts in Steel Structures- Code of Practice
IS:7215 -1995	Tolerances for fabrication of steel structures.

6. DESIGN LOADS

6.1 Dead Loads

Dead load shall include weight of all structural and Architectural components. Self-weight of the materials shall be calculated based on unit weights given in IS: 875.
Floor finish of 50 to 75 mm thickness

Self-weight of Plain concrete	:	2400 kg/cu.m (24 kN/cu.m)
Self-weight of RCC	:	2500 kg/cu.m (25 kN/cu.m)
Solid block masonry	:	2000 kg/cu.m (20 kN/cu.m)
Light weight block masonry	:	800 kg/cu.m (8 kN/cu.m)

(with additional 20mm thick plastering on external surface and 14mm plastering on internal) wall surfaces

Soil (Dry)	:	1800 kg/cu.m (18 kN/cu.m)
Soil (Wet)	:	2000 kg/cu.m (20 kN/cu.m)
Water	:	1000 kg/cu.m (10 kN/cu.m)
Glass	:	2800 kg/cu.m (28 kN/cu.m)
Masonry with plastering solid block	:	2000 kg/cu.m (22 kN/cu.m)
Masonry with plastering light block	:	1000 kg/cu.m (10 kN/cu.m)
Filling for sunken portion	:	1200 kg/cu.m (12 kN/cu.m) (Wherever filling is required)
Waterproofing	:	As per actuals
Landscape loads	:	300/450/600 soil filling/finishes as per landscape details
OHT loads above the terraces	:	As per actuals (Shall be referred from MEP dwgs).
Wall loads	:	As per actuals
Storage rooms	:	750 kg/sq.m (7.5 kN/sq.m)

6.2 Wall Load

• External Walls: 200 mm thick Block Masonry

• Internal Walls: 200/100 mm thick Block Masonry

• Around toilets: 100mm thick Block Masonry

Wall height in m	Wall thickness in mm	kN/m for solid weight cement block
3.15	200	12.6
3.15	100	6.3
Parapet/ Railing ht 1200mm	200	4.8

For 200 thk wall of height 3.15m Block Masonry,

load calculation = 0.2*3.15*20=12.6 KN/m.

- Toilet Sinking (General) 300 mm = 3.3 KN/m2
- Balcony 300 mm = 3.3KN/m2
- Filling material for Sunken Slabs Concrete

6.3 Live Loads

Loads for the building shall be taken as follows as per IS: 875 (Part II),

Corridors, passages, lobbies and Staircase	:	3.0 kN/sq.m
Living	:	2.0 kN/sq.m
Bedroom	:	2.0 kN/sq.m
Bath and toilet rooms	:	2.0 kN/sq.m
Terrace / Balcony	:	3.0 kN/sq.m

Wind loads have been derived on basis of IS: 875 (Part 3) 2015

Basic wind speed considered Vb	:	50 m/s (for CHENNAI)
Building classification/ topography data		
Risk coefficient, k1	:	1 Table 1, IS 875 (Part 3)
Topography factor, k3	:	1
Terrain Category	:	2 Cl 6.3.2.1, IS 875 (Part 3)

Terrain and Height Multiplier (k2) will be calculated separately for the building as per Table 2 of IS 875 (Part 3):2015

Importance factor for cyclonic region(k4)	:	1 Cl 6.3.4, IS 875 (Part 3)

6.4 Wind pressure calculation (Cl. 7.2, IS 875 (Part 3) 2015)

Pz	:	0.6Vz2
Vz	:	k1 x k2 x k3 x k4 x Vb
Pd	:	Kd x Ka x Kc x Pz

Where Kd : wind directionality factor

Ka : area averaging factor

Kc : combination factor

6.5 Seismic Loads

Seismic design and detailing shall be in accordance with IS 1893 (Part 1):2016 and IS 13920:2016 respectively. Thaiyur(Chennai) falls under Zone III as categorized in IS: 1893-2016. All shear walls will be ordinary walls and has to resist 100% of lateral shear.

Seismic Force is considered in all three directions in accordance with IS 1893 (Part 1):2016.

The seismic design parameters are as follows:

Z : 0.16 (as per Table 3 IS 1893:2016)

I : 1.0 (Building as per Table 8 of IS 1893:2016)

Damping : 5% (as per Cl 7.2.4 of IS 1893:2016)

Soil type II : (for Medium or Stiff soils as per Cl 6.4.2 of IS 1893:2016)

R : 3.0 (Refer Table 9; RC building with ordinary RC structural walls)

Design Lateral Force: (as per Cl.7.2, IS 1893:2016)

Base shear (V_B) = Ah x W

Where W : Seismic weight of structure as per Cl. 7.4

Ah : Design Horizontal Seismic Coefficient as per Cl. 6.4.2 Time period calculation for Static Base Shear:

T :

they are not so connected.

b) Buildings with RC structural walls:

$$T_a = \frac{0.075h^{0.75}}{\sqrt{A_w}} \geq \frac{0.09h}{\sqrt{d}}$$

where A_w is total effective area (m^2) of walls in the first storey of the building given by:

$$A_w = \sum_{i=1}^{N_w}\left[A_{wi}\left\{0.2+\left(\frac{L_{wi}}{h}\right)^2\right\}\right]$$

where

Where h: Height of building above footing level

Minimum design Lateral Force

Building will be designed for minimum lateral force for 0.7 % of total seismic weight as per Cl.7.2.2 of IS 1893:2016 (Table 7 for Seismic Zone III). For isolated and combined footings with tie beams, SBC will be increased by 25% in earthquake condition for Rock or Hard soils, in accordance with Table 1, Sl. No. (i) of IS 1893 Part 1.

6.6 Primary Loads and Load Combination

DL : Dead Load

LL : Live Load

WLX : Wind Load in + ve X-Direction

WLY : Wind Load in + ve Y-Direction

EQx : Seismic Load in X-Direction

EQy : Seismic Load in y-Direction

TL max : Maximum Temperature load

TL min : Minimum Temperature load

Load combinations Used for Strength, Serviceability are tabulated below:

Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL+SDL	*LL*	*WL/EL/TL*	*DL+SDL*	*LL*	*WL/EL/TL*
DL + LL	1.5	1.5	—	1	1	—
DL + WL	1.5 or 0.9*	—	1.5	1	—	1
DL + EL	1.5 or 0.9*	—	1.5	1	—	1
DL + TL	1.5	—	1.5	1	—	1
DL+LL+WL	1.2	1.2	1.2	1	0.8	1
DL+LL+EL	1.2	1.2	1.2	1	0.8	1
DL+LL+TL	1.2	1.2	1.2	1	0.8	1
DL+WL+TL	1.2	—	1.2	1	—	1
DL+EL+TL	1.2	—	1.2	1	—	1
DL+LL+EL+TL	1.2	1.2	1.2	1	1	1

DL - Dead Load; LL - Live Load; TL - Temperature Load; WL - Wind Load; EL - Earthquake Load

Vertical earthquake effect is not considered for the design of structural elements. Wind load and earthquake loads are considered for both x & y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS: 18932016 / Clause 7.3.3 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination.

7. FIRE RESISITANCE OF ELEMENTS

All structural members will be designed for two-hour fire rating. The requirements for fire resistance will be met by adopting the minimum structural dimensions and clear cover to reinforcement. Minimum dimension of structural element and Nominal cover to reinforcements will be provided as given IS: 456-2000.

8. ENVIRONMENTAL EXPOSURE

The site is situated in Thaiyur, which receives moderate rainfall. However, "Moderate" exposure is considered for the Substructure in view of the site situated in valley region, there will be seasonal surface run off water. The minimum nominal cover to the reinforcement will be 35 mm & 50mm for the structural elements like Retaining wall and footing respectively which are in contact with soil. Also, for UG tank and STP walls which are in contact with water, minimum cover shall be 35mm. The members in the Superstructure exposed to weather will be designed for "Moderate" exposure condition. All members in the Super structure within the building will be designed for 'Mild' exposure condition as defined in IS 456-2000, Table 16.

9. COVER TO REINFORCEMENT

Minimum clear cover to any reinforcement shall be provided based on the fire requirements and exposure condition whichever is more.

10. MATERIALS

10.1 Concrete

Minimum grade for structural concrete shall be of grade M25. The minimum cement content in concrete for substructure as well as superstructure shall be 350kg/m3 and the maximum free water-cement ratio shall be 0.50. Reinforcements High strength deformed steel bar, produced by the thermo-mechanical treatment (TMT) process, of grades Fe 550 having elongation more than 14.5 percent as per IS 13920:2016 and conforming to other requirements of IS 1786: 2008 will be used for the reinforcement.

10.3 Structural Steel

All structural steel used for construction shall conform to IS: 2062 with fy= 310 Mpa.

11. ANALYSIS OF STRUCTURE

The analysis will be based on Stiffness matrix method and using the engineering software ETABS 19 version. This is a tried and time tested 3D Structural analysis tool, which includes analysis of plane frames, space frames using truss, beam and shell elements. Generally, all the structures will be idealized as 3D – frames, using line element for column & beams and Shell elements for slabs, shear walls. The structures shall be analysed for individual load cases as described in 6.6 above. Analysis for governing load combinations shall be performed and the

performance of the structures in various states of Collapse and Serviceability will be checked accordingly. Manual analysis shall be done for retaining walls, slabs, staircases, water tank etc. The raft and combined footings will be modelled and analysed using software SAFE.

12. DESIGN OF STRUCTURE

The design of the RC and steel structures will be based on the Limit State Method as per IS: 456-2000 and IS: 800-2007 respectively. For liquid retaining concrete structures, the design is based on the Limit State Method, conforming to IS 3370-2009.

The design of RC Columns and beams, footings, slab, staircases and junctions of the structures shall be made using spread sheets developed in-house and/or manual calculations and/or using ETABS software.

13. ACCEPTANCE OF CRITERIA

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 IS 456 – 2000.

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.

Permissible Drift Limits:

Lateral drift = Height/500(For Wind Loads)

Lateral drift = Height/1000 (at Roof) (For Seismic loads as per Note 4 of Table 9 of IS 1893:2016)

Inter Storey drift = 0.004 x storey height (as per IS 1893:2016)

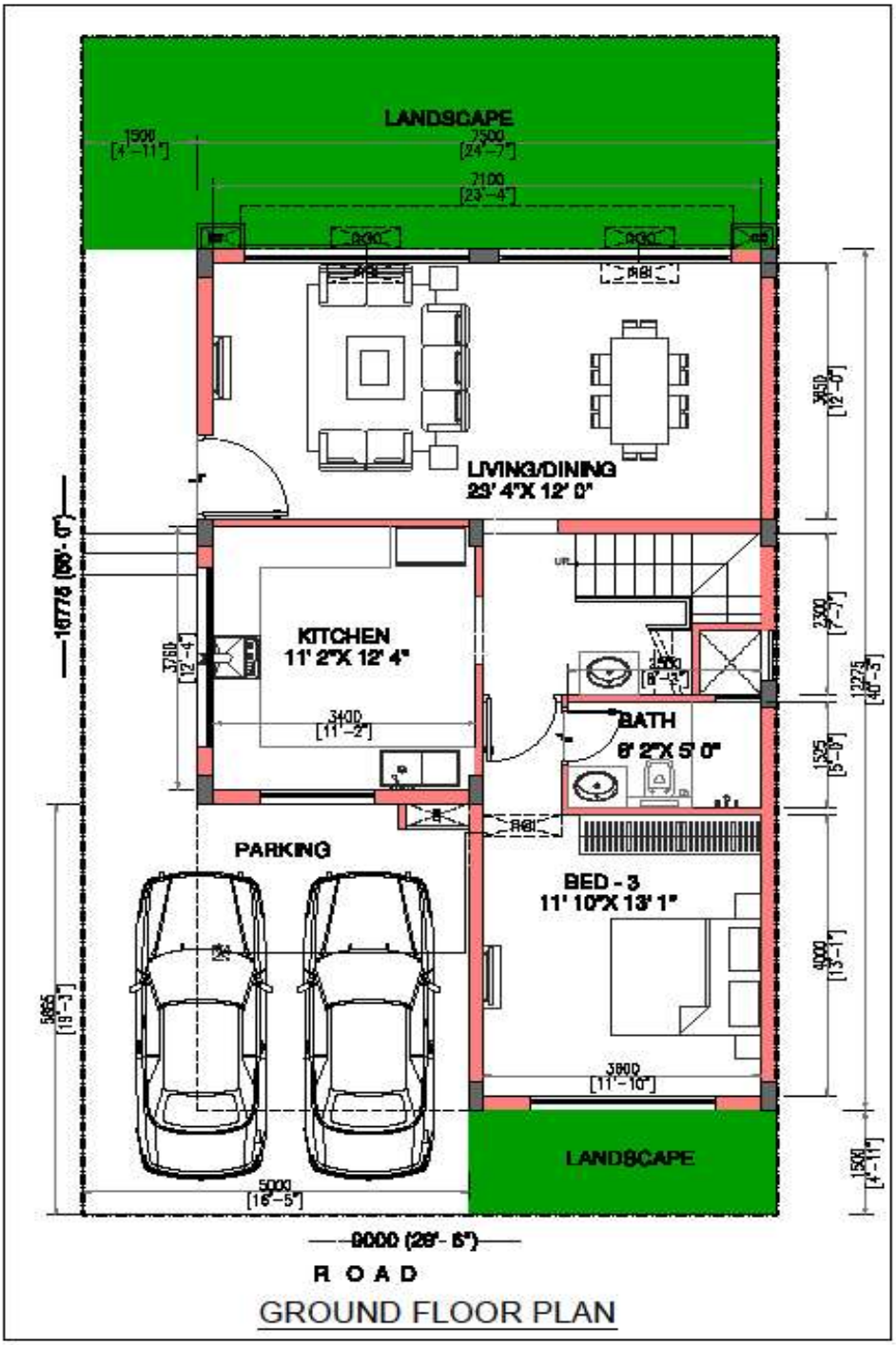
14. WATERPROOFING

The following Water-Proofing methodology is adopted for various members,

1. Bottom of Foundation, Rafts, Lift pits and Tanks: Self Adhesive HDPE membrane or equivalent.
2. Retaining walls: Sam-Shield XL with protection boards.
3. Podium w/o landscape: Brush bond/Spray apply Polyurethane.
4. Planters/STP/UG (Internal): Brush bond/Spray apply Polyurea.
5. Toilets/Balconies: Dr. fixit - fast flex.
6. Terrace: Brickbat Coba with crystalline mortar or Polyurethane.

ANNEXURE FRAMING PLANS

FLOOR FRAMING LAYOUT



GROUND FLOOR PLAN

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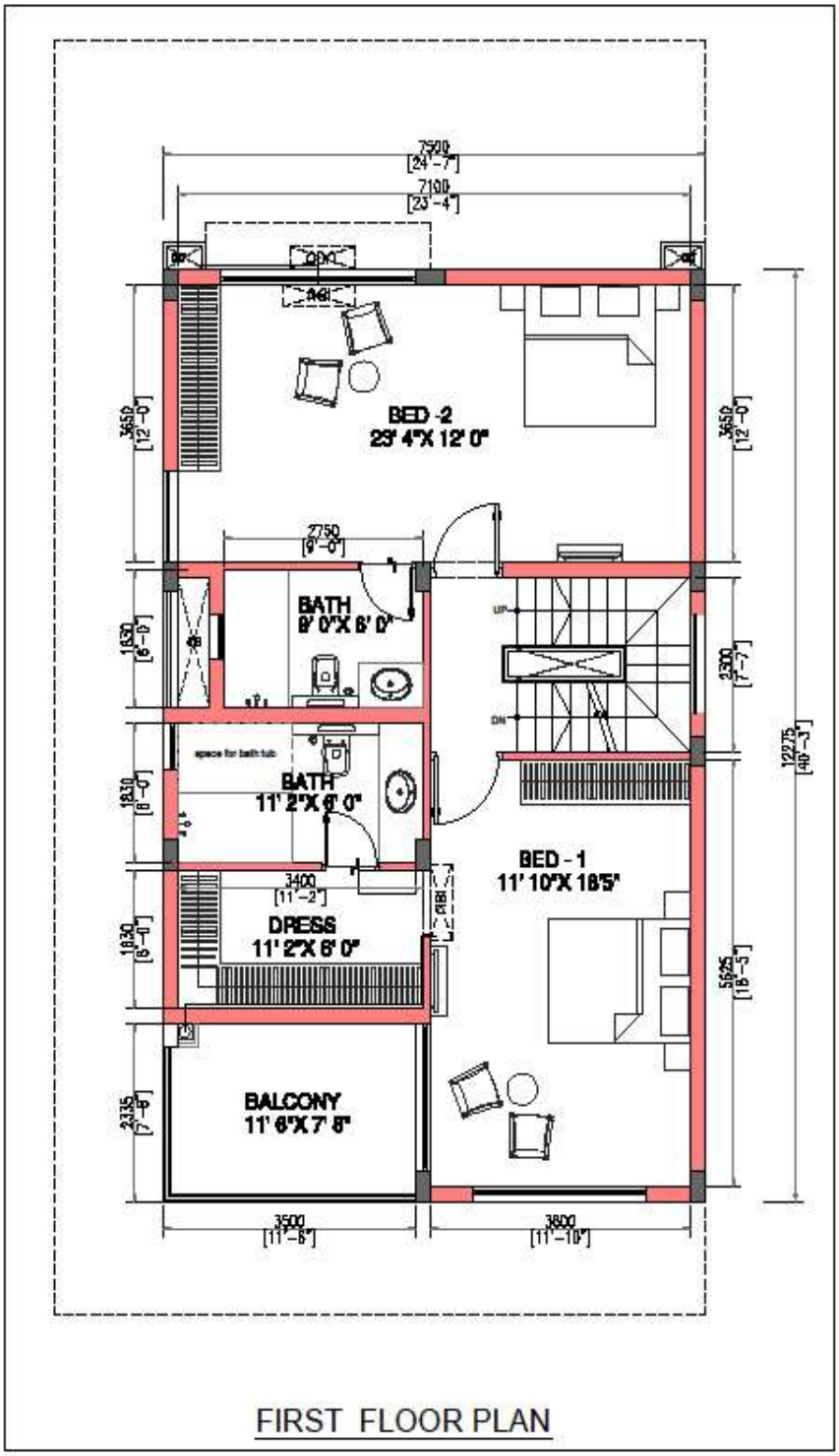
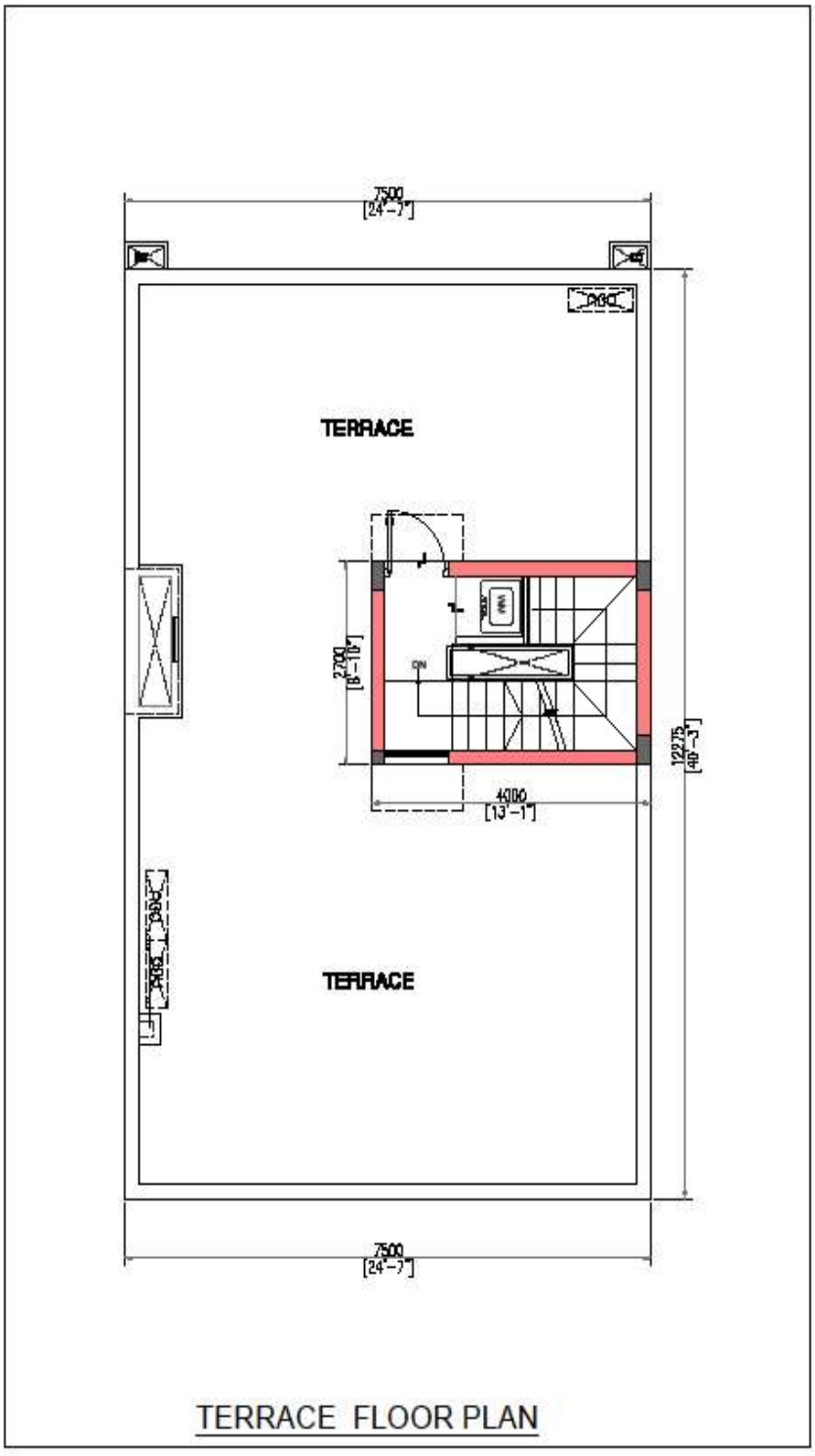
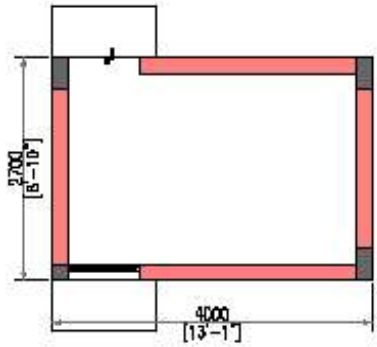


FIRST FLOOR PLAN



TERRACE FLOOR PLAN



STAIRCASE COVER PLAN