Design And Analysis Of Residential Building C+G+7 Using Staad.Pro

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Abstract : *The project comprises the development of plans, elevations, and sectional view of a Residential Reinforced Concrete building of ground floor, using Auto-cad 2008. Structural loads (Gravitational loads only), Dead and Live loads are only considered for the design of structure, and the loads considered are as per IS: 875 – Part-I & II. The analysis and design of the building skeletal fame is performed by using STAAD Pro V8i package for factored (Limit state of strength) combination(s). The structural displacements in vertical and horizontal directions of the building are permitted to the limitations as per IS: 456 – 2000, for un-factored (Limit state of serviceability) combination(s). Structural elements like Slab(s) and Footing(s) are designed manually using MS Excel. The reinforcement details are furnished according to the Codal provisions and presented in this report.*

I. INTRODUCTION

Behavior of the Structure:

The building and other structure are composed of horizontal and vertical structural elements that resist lateral forces. The horizontal elements, diaphragms and horizontal bracings are used to distribute the lateral forces to vertical elements. The vertical elements that are used to transfer lateral forces to the ground are shear wall, braced frames and moment resisting frames. The structure must include complete lateral and vertical force resisting systems, capable of providing adequate energy dissipation capacity to withstand the design ground motions within the prescribed limits, deformations and strength demand.

Motivation:

Day to day variations in the designing of the structures we were motivated to deal with this project. As civil engineering is much concerned with different designs to meet the necessity of human life, we took this project.

Problem definition:

As the land is con sized to meet the demands of all the growing population the adoption of multi storied had grown up to meet their demands. As it is cost effective. Many of RC building constructed recent times have special feature of the ground is left open for the purpose of parking, i.e. columns in the ground story do not have any partition walls of either masonry or RC between them.

Objectives of project:

Carrying out a complete design of the main structural elements of a multi – storied building including slabs, beams, columns and footing. Getting real life experience with the engineering practices.

Structure should be so arranged that it can transmit dead, wind and imposed loads in a direct manner to the foundations. The general arrangement should ensure a robust and stable structure that will not collapse progressively under the effects of misuse or accidental damage to any one element.

Limitations of project:

- Depending on the site area the number of floors is limited.
- Designing is completely based on IRC codes.
- Once the structure is designed completely minor changes are accepted in site with cost consideration.

- If once the structure is designed for one purpose it cannot be used for other purpose if the load acting on it is increased than the designed.

2. STEEL REINFORCEMENT

Steel bars are essentially used in the tension zone of flexural members of concrete to resist the tensile stresses as concrete is weak in tension and in compression members to increase the load carrying capacity.

Steel is used as reinforcement to take up the tensile stresses in RCC construction the following reasons,

- Its tensile strength is high
- It can develop good bond with concrete
- Its coefficient of expansion is nearly same as for concrete
- It is easily available

3. FUNCTIONS OF REINFORCEMENT IN RCC

The reinforcement in RCC serves the following different types of functions,

- To resist the bending tension in flexural members like slabs, beams and walls of water tanks etc.
- To increase the load carrying capacity of compression members like columns
- To resist diagonal tension due to shear.
- To resist the effects of secondary stresses like temperature etc.
- To reduce the shrinkage of concrete.
- To resist spiral cracking due to torsion
- To prevent the development of wide cracks in concrete due to tensile strain.

TYPES OF REINFORCEMENT

Reinforcing steel consists of bars usually circular in cross section. The following four types of steel reinforcement are generally used in reinforced concrete construction.

- Mild steel and medium tensile steel bars conforming to IS 432 (part I)
- High yield strength deformed steel bars (HYSD bars) conforming to IS 1566
- Steel wire fabric conforming to IS 1566
- Structural steel conforming to Grade A of IS 2062

All reinforcement shall be free from loose mill scale, loose rust, oil, mud, and any other substances which reduces bond between steel and concrete. The grades of steel normally used for reinforcement are Fe 250, Fe 415, and Fe 500. Fe refers to ferrous metal and the number following it refers to specified yield strength in N/mm2

4. MODEL GENERATION

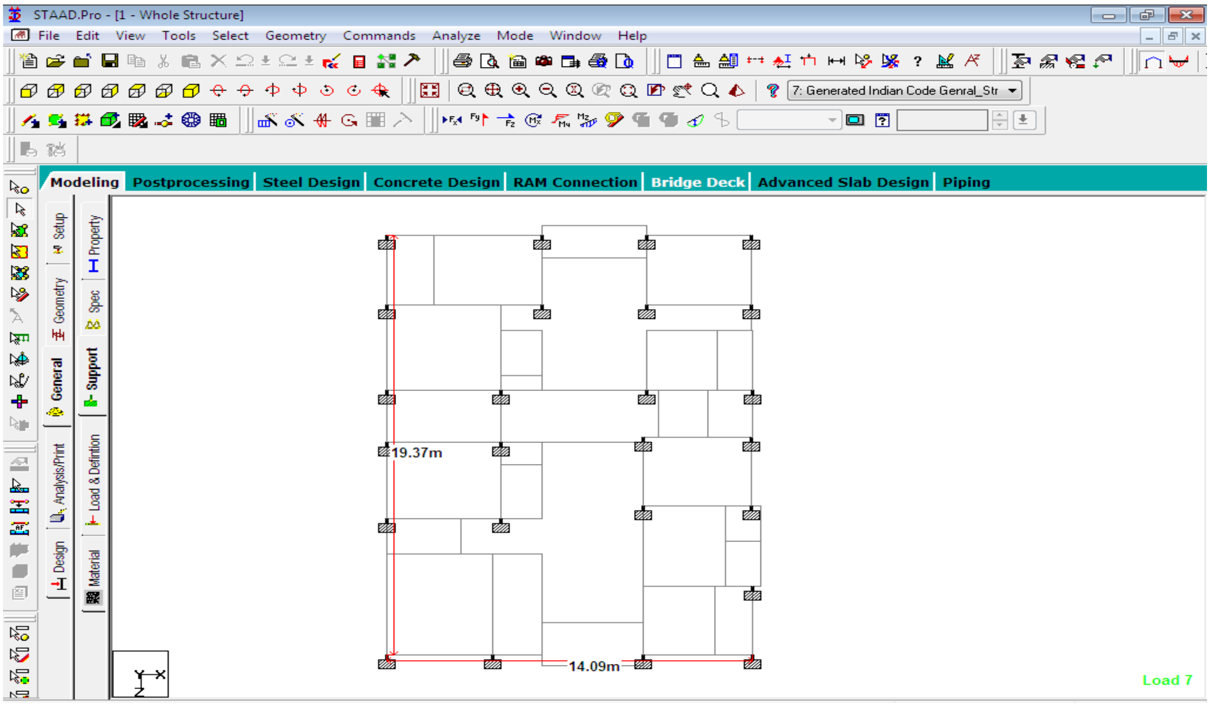
STATEMENT OF THE PROJECT:

SAILENT FEATURES:

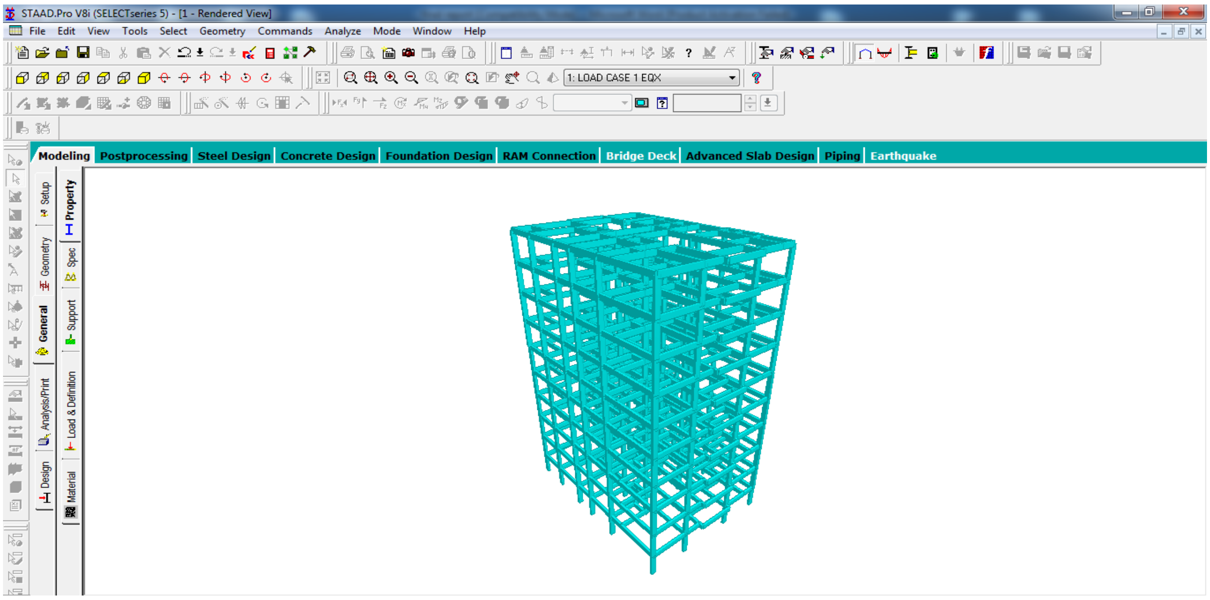
Utility of Building : Residential
No. Of Floors : C+ G+7 floors
Shape of Building : Rectangular
Type of Construction : R.C.C framed structure
Type of Walls : Brick walls 115 and 230mm
Geometric details
Length of the building: 14.09 m
Width of the building : 19.37 m
Floor height : 3.0m
Founding depth : 2.5 m (From N.G.L)

Materials:
Concrete : M25
Steel grade : Fe415

5. PLAN OF THE STRUCTURE



3D RENDERING



ISOMETRIC VIEW OF BUILDING

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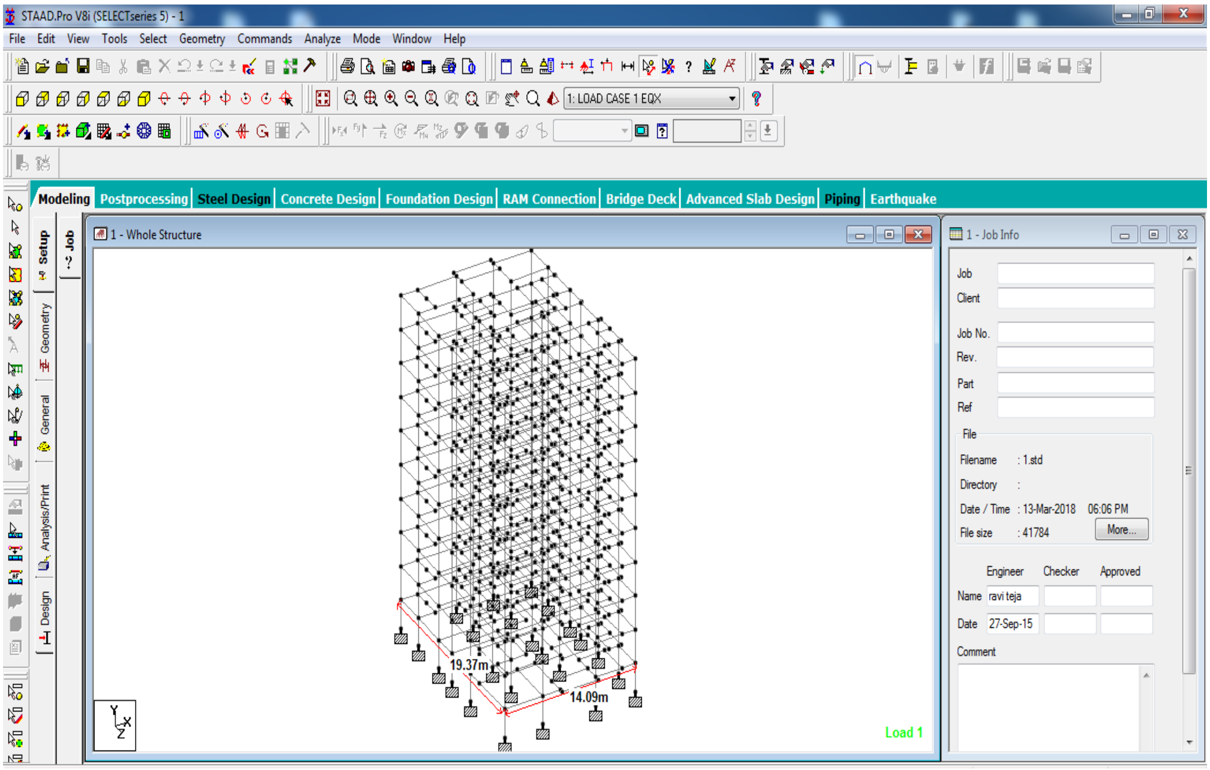


MATERIAL PROPERTIES

Material	Property	Value	Units	Remarks
Concrete, M25	Density	25	kN/ m3	IS : 875 Part - 1
	Characteristic Strength	25	N/ mm2	IS: 456 :2000
	Modulus of Elasticity	25000	N/ mm2	IS:456 :2000
Reinforcing Steel	Density	78.5	kN/ m3	IS : 875 Part - 1
	Characteristic Strength	415	N/ mm2	IS:800 - 2007
	Modulus of Elasticity	200000	N/ mm2	IS:800 - 2007

6. ANALYSIS OF C+ G+7 BUILDING IS 1893:2002 CODAL PROVISIONS LOADS

The reinforced concrete structures are designed to resist the following types of loads.

Dead load

Dead loads are permanent or stationary loads which are transferred to the structure throughout their life span. Dead loads mainly cause due to self-weight of structural members, permanent partitions, fixed equipment's and fittings. These loads shall be calculated by estimating the quantity of each material and them multiplying it with the unit weight. The unit weights of various materials used in building construction are given in the code IS 875 (part -1) -1987. The unit weight of commonly used building materials are given below:

RC PROPERY:

Column Size: 300x420 mm

Beam Size: 300x450 mm

Table: Unit weight of common building materials

s.no.	Material	Unit weight KN/m3
1	Plain concrete	24
2	Reinforced concrete	25
3	Brick masonry, cement plaster	20
4	Stone masonry	24
5	Wood	8
6	Steel	78.5
7	Floor finish	0.6-1.2

Load calculations

Self - weight of Slab load:
Floor loads for 120mm thick slab
Thickness of slab -120mm
Unit weight of reinforced concrete - 25.00kn/m3
= 0.12 x 1x 25
= 3.0 KN/m2

Dead load of slab = 3.0kn/m2
Floor finishes = 1.50kn/ m2
= 3.0 x 1. 5
= 4.5KN/m2
Roof Finishing: 1.0 KN/Sq.m
Total load of slab = 8.5kn/ m2
Self-weight of Beam Load:
Beam Size- 300x450mm
Unit weight of reinforced concrete - 25.00kn/m3
= 0.3 x 0.45 x 25
= 3.375Kn/m3
Wall loads
External Wall
230mm thick wall for 3.0 heights
Thickness of wall 'b' - 0.23m
Height of walls 'h' – 2.7mm
Unit weight of brick masonry γ - 19.2kN/m3
= 0.23 x 2.7 x 19.2
Total load h*b* γ = - 11.9 kN/m3
Internal or Partition Walls
150mm thick wall for height 3.0m
Thickness of wall 'b' - 0.12m
Height of walls 'h' - 2.7m
Unit weight of brick masonry 'γ' - 19.2kN/m3
= 0.12 x2.7x 19.2
Total load h*b* γ = -5.912 kN/m3
Parapet & Balcony wall load
Thickness of wall 'b' - 0.115m
Parapet wall 'h' - 1.00m
Unit weight of brick masonry 'γ' - 19.20kn/m3
= 0.115 x 1 x 19.2
Total load h*b* γ = 2.208 kn/m3

Live loads (or) imposed loads:

These are the loads that changes with time. Live loads or imposed loads include loads due to the people occupying the floor, weight of movable partitions, weight of furniture and materials. The live loads to be taken in design of buildings have been given in IS: 875 (part-2) -1987. Some of the common live loads used in the design of buildings are given below:
Live loads are either movable or moving loads without any acceleration or impact. There are assumed to be produced by the intended use or occupancy of the building including weights of movable partitions or furniture etc. The floor slabs have to be designed to carry either uniformly distributed loads or concentrated loads whichever produce greater stresses in the part under consideration.
Since it is unlikely that any one particular time all floors will not be simultaneously carrying maximum loading, the code permits some reduction in imposed loads in designing columns, load bearing walls, piers supports and foundations.
Live load as per Code IS: 875 (Part-2)

Patient rooms
4.000kn/ m2
Stair case, corridor
3.000kn/ m2
Terrace, portico
2.000kn/ m2

Live loads on floors (IS 875, part-2)

S.no.	Type of floor	Minimum live load KN/m^2
1	Floors in dwelling houses, tenants, hospital wards, hostels.	2.0
2	Office floor other than entrance halls, floors of light	2.5-4.0 (2.5 when separate storage work rooms facility is provided, other wise 4.0
3	Floors of banking halls, office entrance halls and reading rooms	3.0
4	Shops, educational buildings, assembly buildings, restaurants	4.0
5	Office floors for storage, assembly floor space without fixed seating, public rooms in hotels, dance halls and waiting halls	5.0
6	Ware houses, shops and factories • Light weight loads • Medium weight loads • Heavy weight loads	 5.0 7.5 10.0
7	Garages (light –handling vehicles of weight<25 KN) Garages (heavy-vehicles of weight >25 KN)	4.0 7.5
8	Stairs, landings, balconies and corridors for floors mentioned in 1, but not liable to overcrowding stairs, landings and corridors for floors mentioned in 1, but liable to overcrowding and for all other floors	3.0 5.0
9	Flat slabs, sloped roofs • Access provided • Access not provided	 1.5 0.75

Wind loads:

The horizontal load caused by the wind is called as wind loads. It depends up on the velocity of wind and shape and size of the building. Complete details of calculating wind loads on structures are given in IS 875(part -3)-1987.

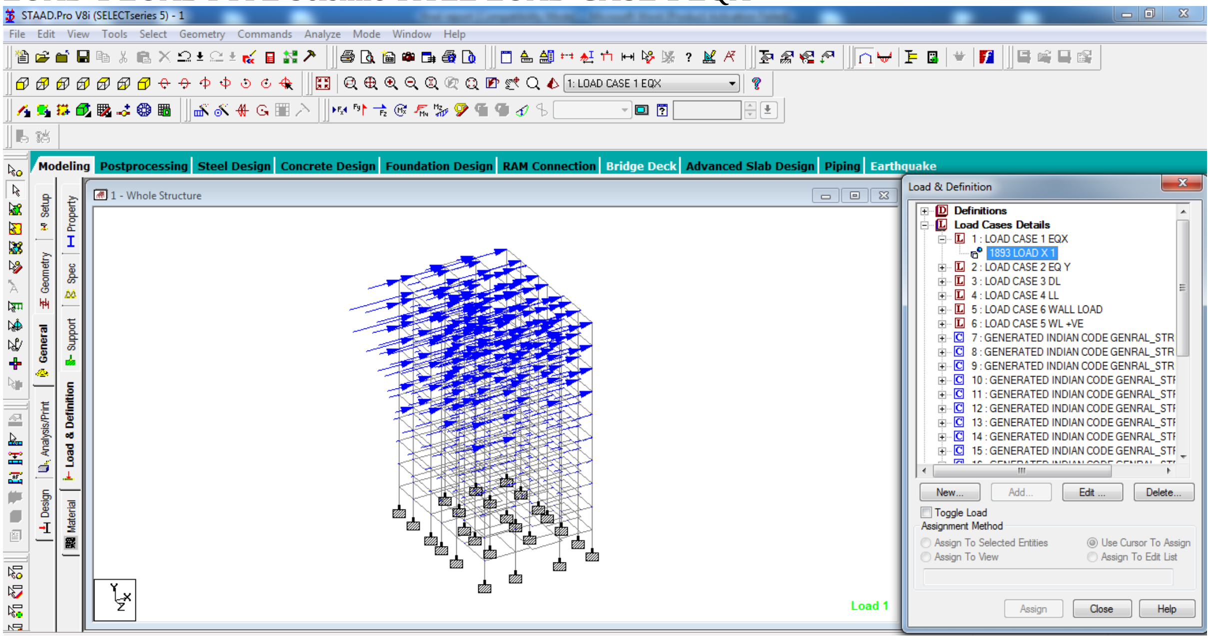
Wind load is primarily horizontal load caused by the movement of air relative to earth. Wind load is required to be considered in design especially when the heath of the building exceeds two times the dimensions transverse to the exposed wind surface. For low rise building say up to four to five storeys, the wind load is not critical because the moment of resistance provided by the continuity of floor system to column connection and walls provided between columns are sufficient to accommodate the effect of these forces. Further in limit state method the factor for design load is reduced to 1.2 (DL+LL+WL) when wind is considered as against the factor of 1.5(DL+LL) when wind is not considered. IS 1893 (part 3) code book is to be used for design purpose.

Design Wind Speed Vz = Vb x K1 x K2 x K3
Where
Vb- Design Wind speed
K1- Probability factor
K2 – Terrain factor
K3- Topography Factor
Exposure factor is -1.0 (As per code)

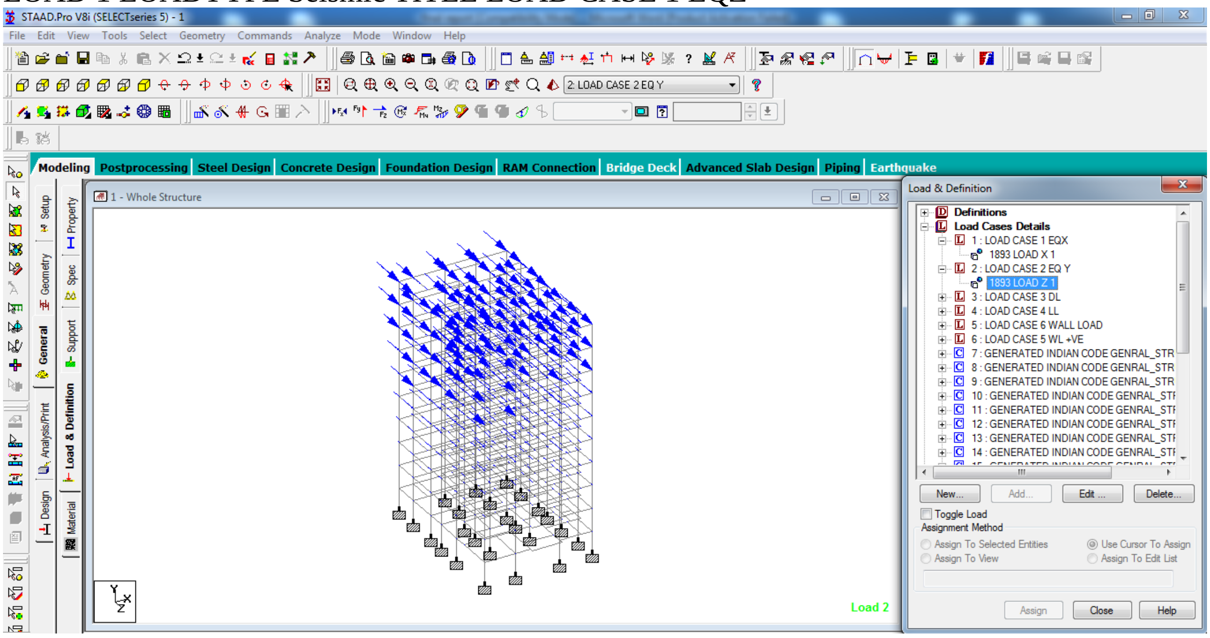
7. ANALYSIS RESULTS

ANALYSIS OF STRUCTURAL FRAME

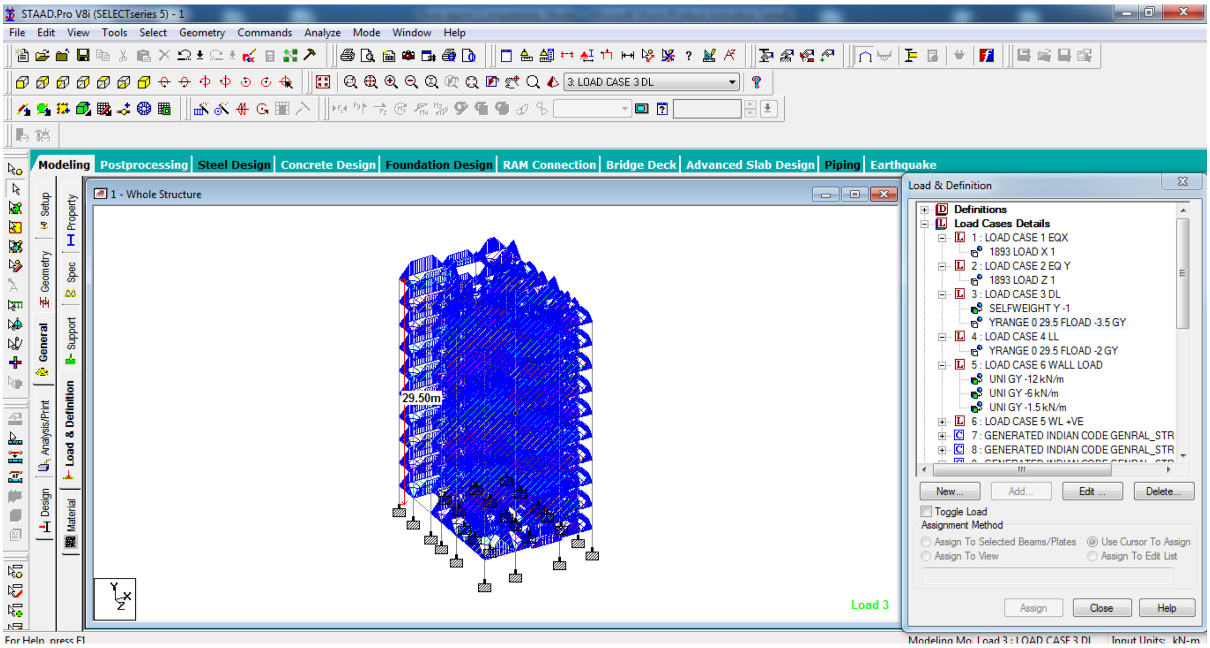
LOAD 1 LOADTYPE Seismic TITLE LOAD CASE 1 EQX



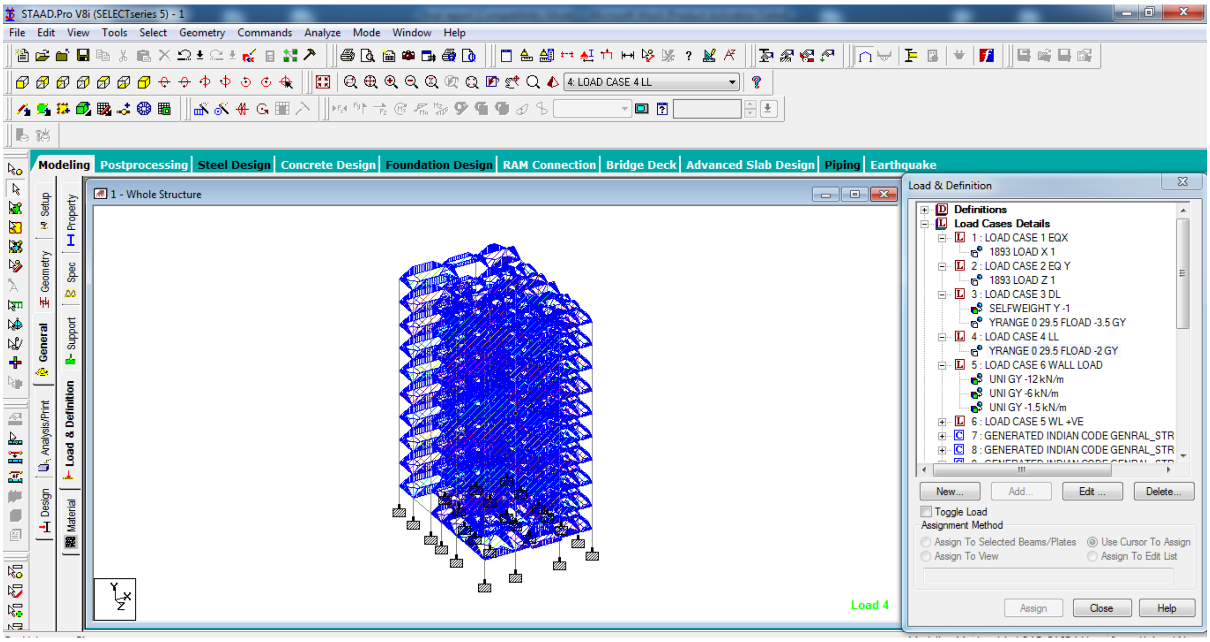
LOAD 1 LOADTYPE Seismic TITLE LOAD CASE 1 EQZ



LOAD 3 LOADTYPE Dead TITLE LOAD CASE 3 DL



LOAD 4 LOADTYPE Live TITLE LOAD CASE 4 LL



LOAD 5 LOADTYPE Roof Live TITLE LOAD CASE 6 WALL LOAD

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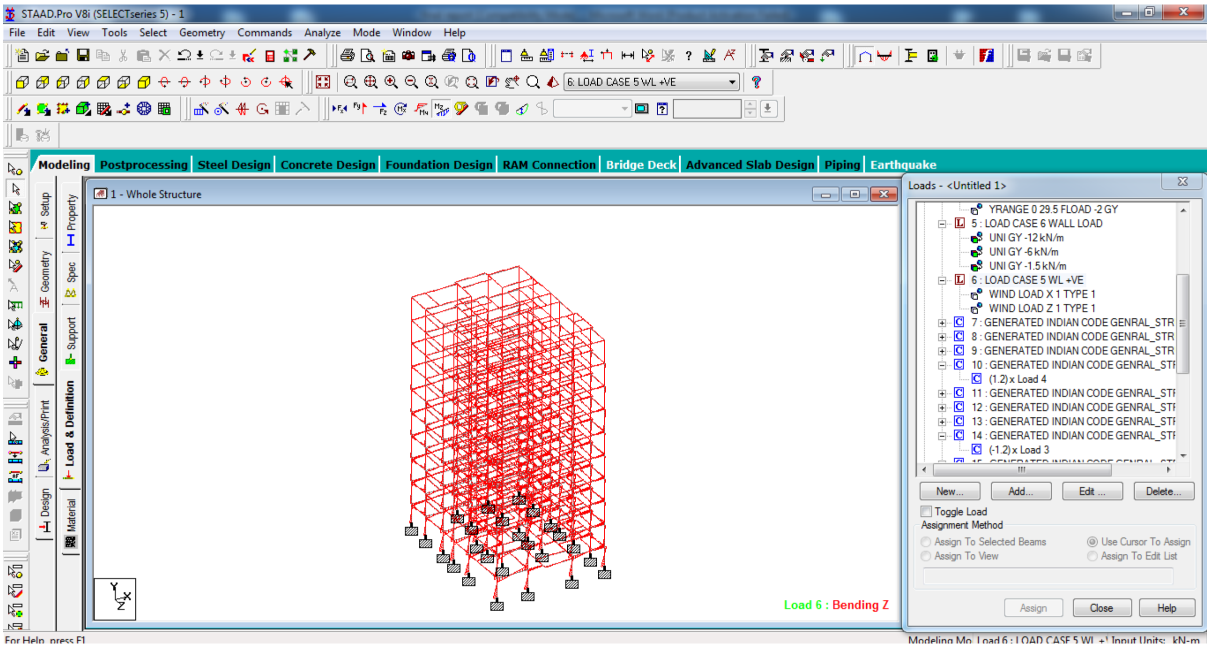
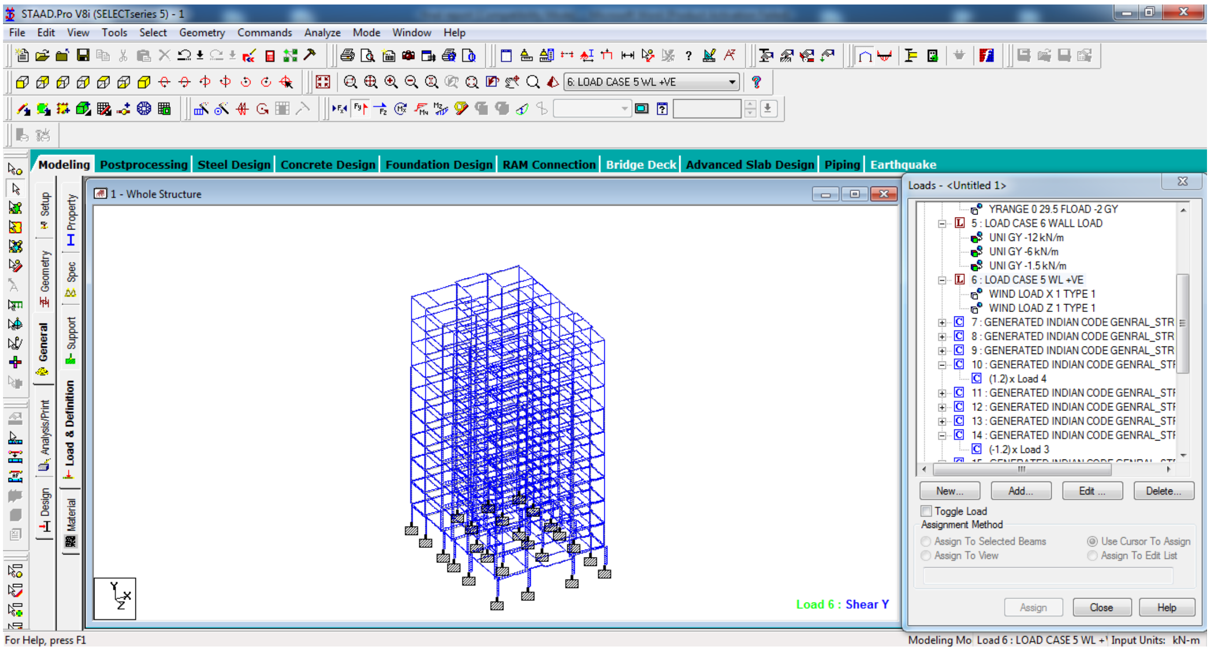
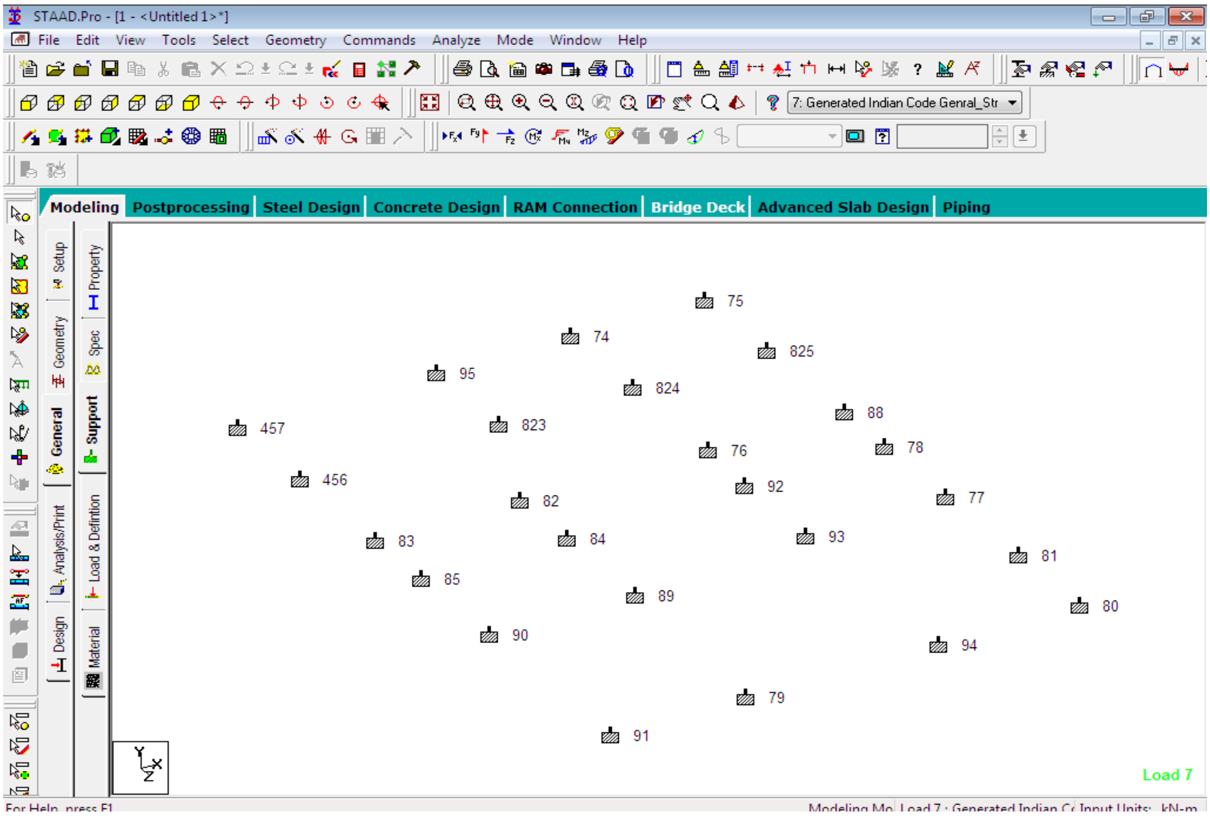


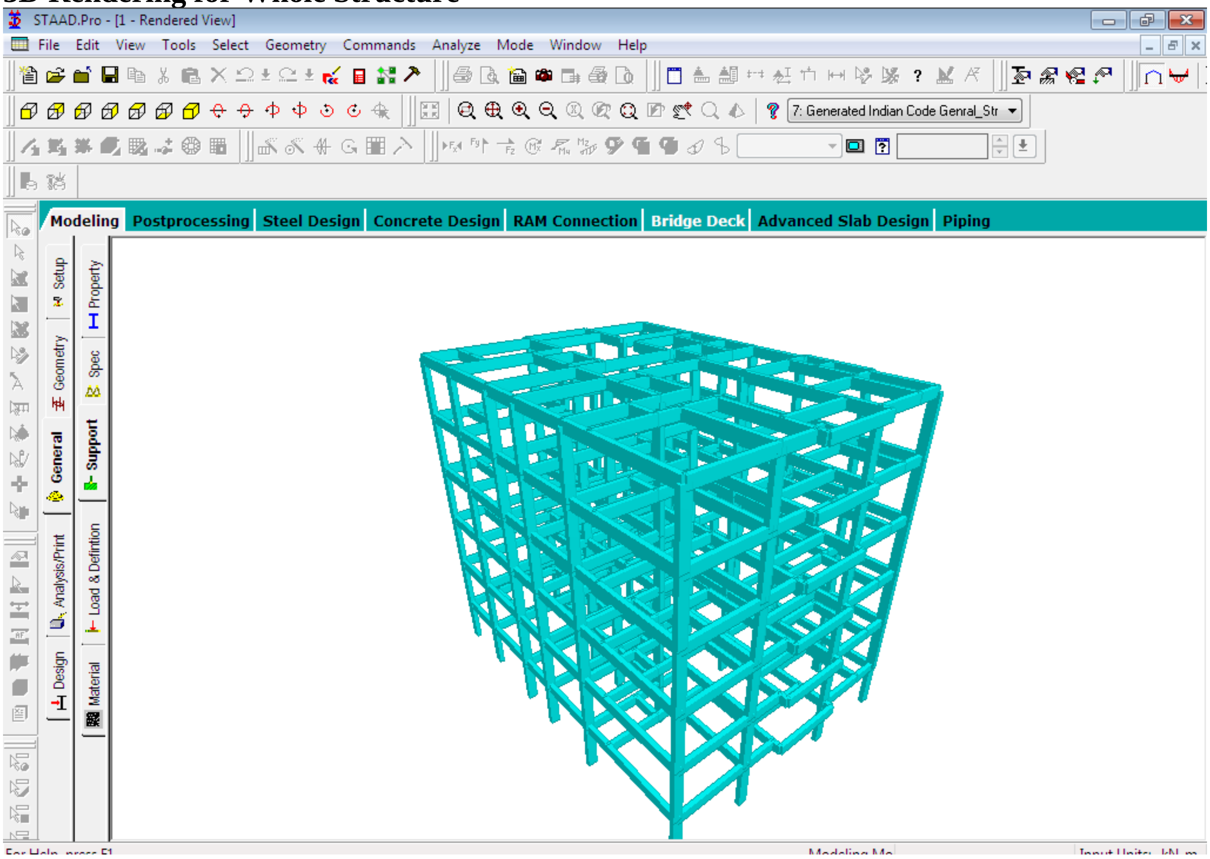
Shear force Moment for Whole structure



Support Reaction for Whole Strucutre



3D Rendering for Whole Structure



8. Conclusions

STAAD PRO has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed as per IS: 456(2000). Beams are designed for flexure, shear and torsion.

Design for Flexure:

Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging (creating tensile stress at the top face) moments are calculated for all active load cases at each of the above-mentioned sections. Each of these sections are designed to resist both of these critical sagging and hogging moments. Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried.

Design for Shear:

Shear reinforcement is calculated to resist both shear forces and torsional moments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

Beam Design Output:

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design:

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

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