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DESIGN AND ANALYSIS OF RESIDENTIAL BUILDING C+G+7 USING STAAD.PRO

Mohd Imran Khan, Laiphrakpam Willaim Singh, Mohammed Abdul Gafoor, Meer Rizwan Ali, Syed Hussain Ahmed, S. Mahesh

Dept. of Civil Engineering, SVITS, Mahbubnagar, Telangana, India.

ABSRACT: 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.

INTRODUCTION

ABOUT STAAD PRO

STAAD Pro is a Structural Analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems.

STAAD Pro allows structural engineers to analyze and design virtually any type of structure through its flexible modelling environment, advanced features and fluent data collaboration.

STAAD Pro is one of the leading structural analysis and design software which supports more than 100 steel, concrete and timber design codes and has the largest worldwide user base.

It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or a buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

In recent years it has become part of integrated structural analysis and design solutions mainly using an exposed API called Open STAAD to access and drive the program using an VB macro system included in the application or other by including Open STAAD functionality in applications that themselves include suitable programmable macro systems. Additionally, STAAD Pro is added direct links to applications such as RAM Connection and STAAD Foundation to provide engineers working with those applications which handle design post processing not handled by STAAD Pro itself. Another form of integration supported by STAAD Pro is the analysis schema of the CIM steel Integration Standard, version 2 commonly known as CIS/2 and used by a number modelling and analysis applications.

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

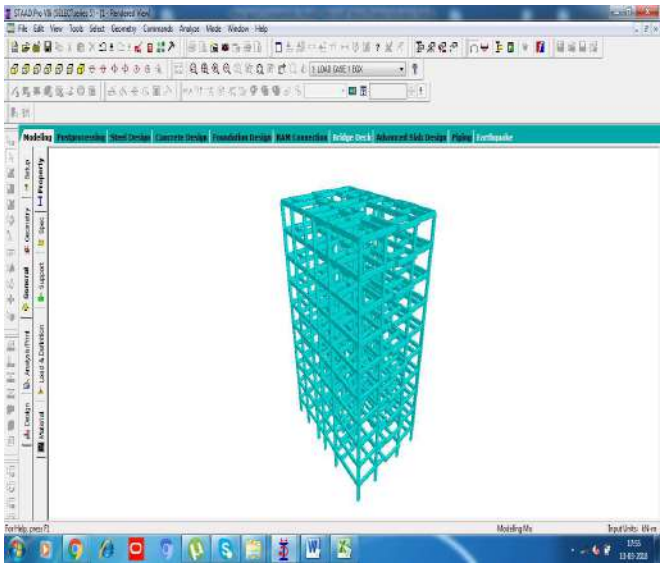
Floor height : 3.0m

Founding depth : 2.5 m (From N.G.L)

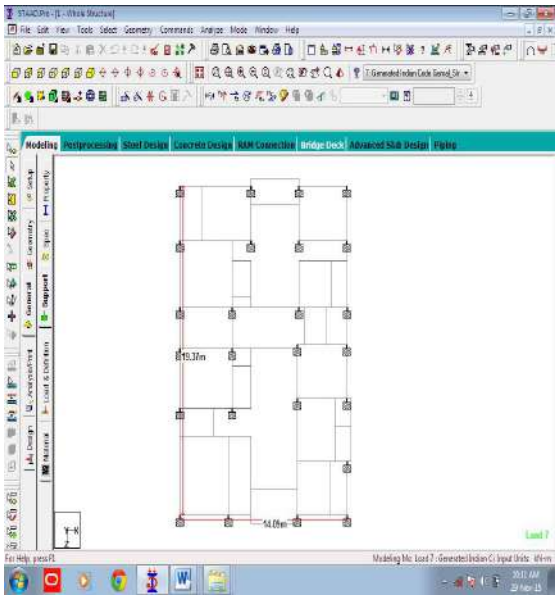
Materials:

Concrete : M25

Steel grade : Fe415

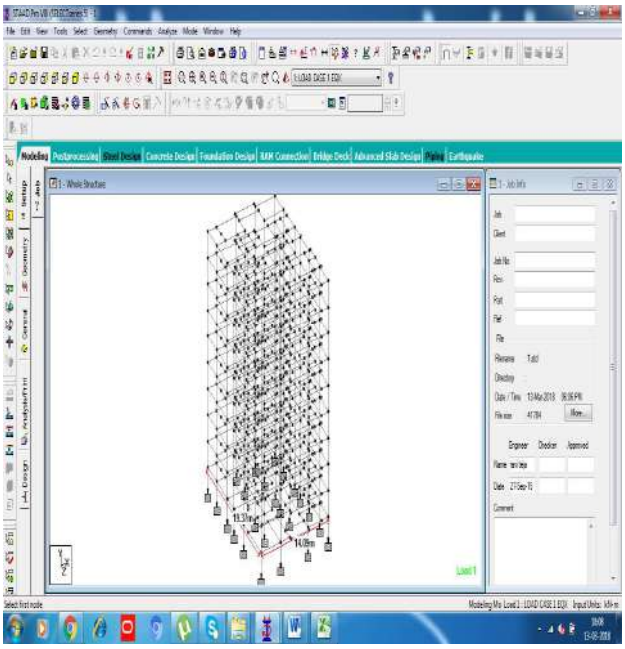


PLAN OF THE STRUCTURE



3D RENDERING

ISOMETRIC VIEW OF BUILDING



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

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

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

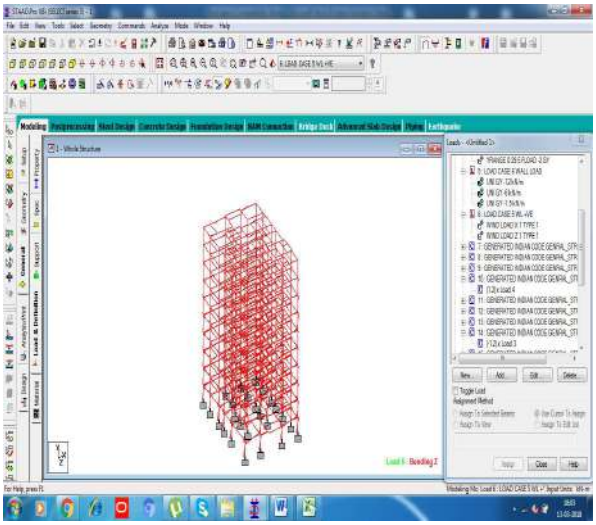
K2 – Terrain factor

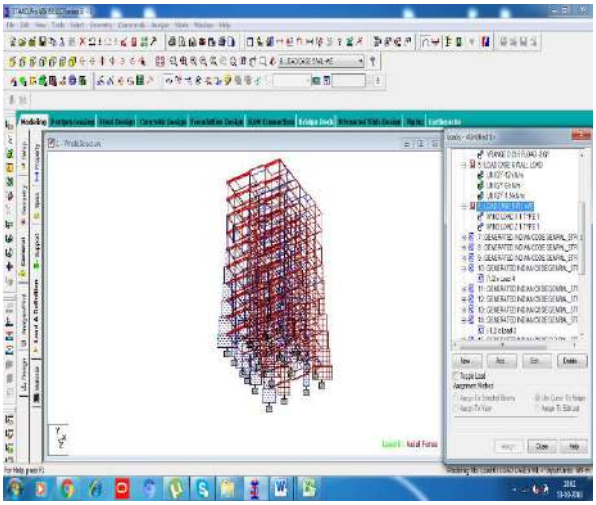
K3- Topography Factor

Exposure factor is -1.0 (As per code)

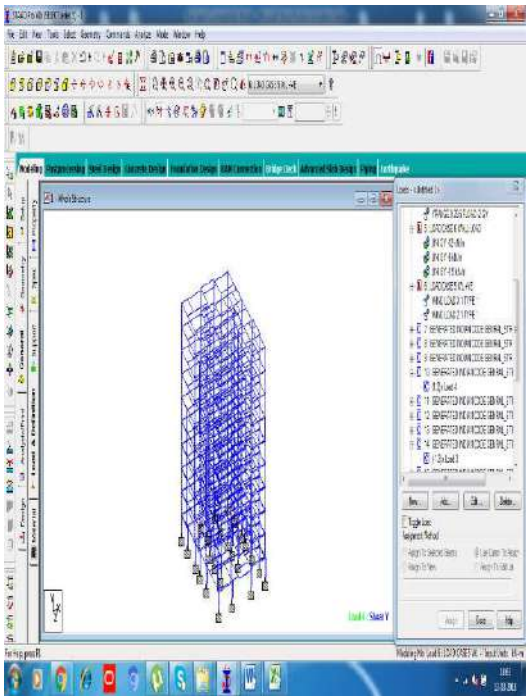
RESUL

Force in X Direction (Axial Force)



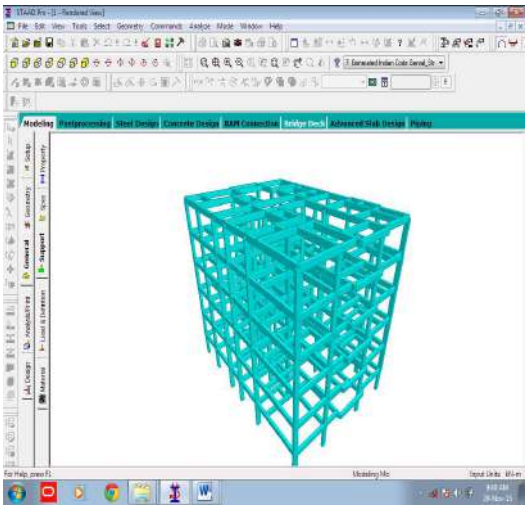


Bending Moment for Whole structure

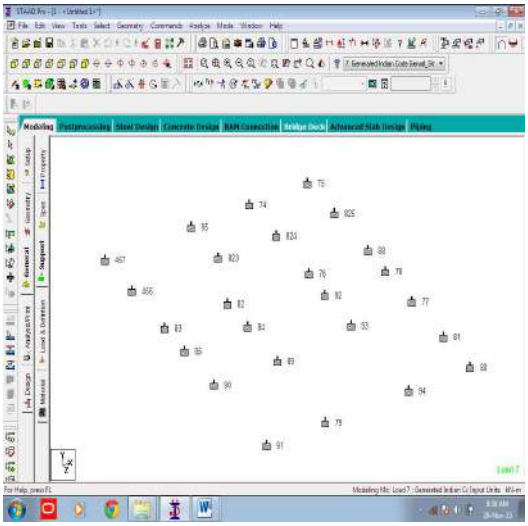


Shear force Moment for Whole structure

3D Rendering for Whole Structure

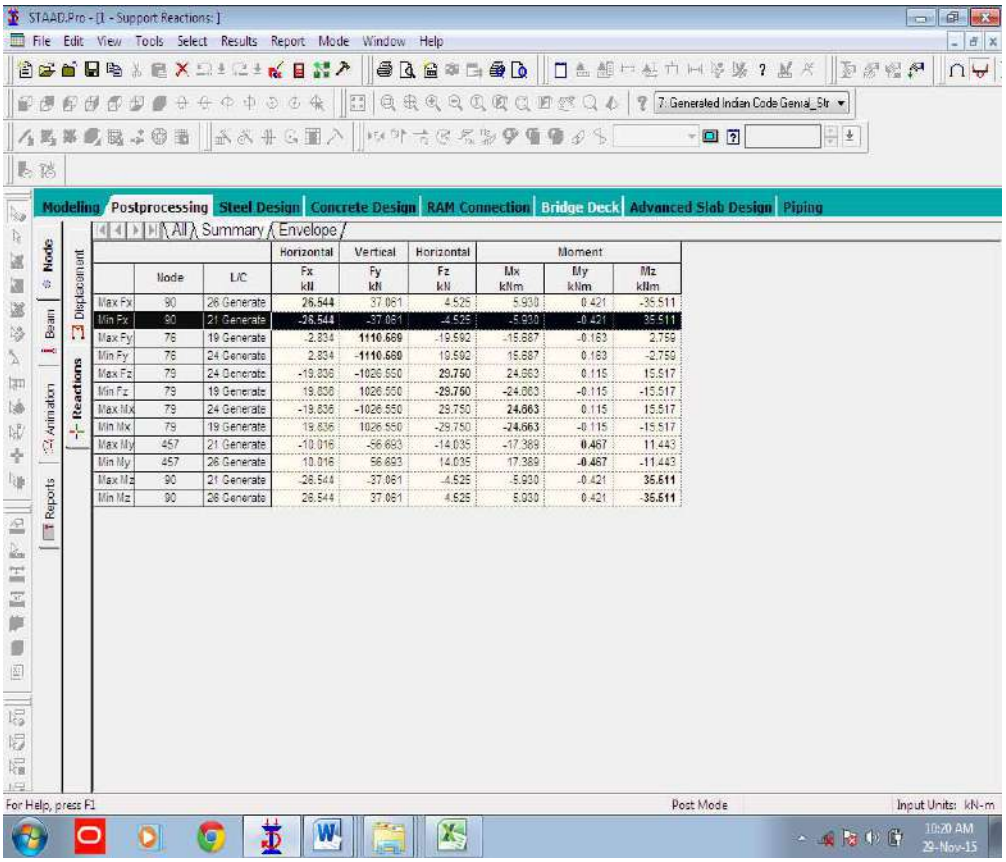


Support Reaction for Whole Structure



DEFLECTION CHECK

Deflection Summary of Whole Structure



	Node	L/C	Horizontal Fx kN	Vertical Fy kN	Horizontal Fz kN	Moment Mx kNm	My kNm	Mz kNm
Max Fx	90	26 Generate	26.544	37.061	4.525	5.930	0.421	-35.511
Min Fx	90	21 Generate	-26.544	-37.061	-4.525	-5.930	-0.421	35.511
Max Fy	76	19 Generate	-2.834	1110.689	-19.592	-15.687	-0.163	2.759
Min Fy	76	24 Generate	2.834	-1110.689	19.592	15.687	0.163	-2.759
Max Fz	79	24 Generate	-19.836	-1026.550	29.750	24.663	0.115	15.517
Min Fz	79	19 Generate	19.836	1026.550	-29.750	-24.663	-0.115	-15.517
Max Mx	79	24 Generate	-19.836	-1026.550	29.750	24.663	0.115	15.517
Min Mx	79	19 Generate	19.836	1026.550	-29.750	-24.663	-0.115	-15.517
Max My	457	21 Generate	-10.016	-56.693	-14.035	-17.389	0.467	11.443
Min My	457	26 Generate	10.016	56.693	14.035	17.389	-0.467	-11.443
Max Mz	90	21 Generate	-26.544	-37.061	-4.525	-5.930	-0.421	35.511
Min Mz	90	26 Generate	26.544	37.061	4.525	5.930	0.421	-35.511

Lateral deflection developed in the structure = 10.081 mm

Permissible limit = H/500

= 17500/500 = 35 mm

= 26.544 < 35 mm (SAFE)

Vertical deflection developed in the structure = 6.825

Permissible limit (minimum of) = L/350 or 20 mm

= 3830/350 = 10.95 mm

= 6.825 < 10.95 (SAFE)

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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2. Reinforced concrete – **Ashok.K. Jain.**
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AUTHORS PROFILE

MOHD IMRAN KHAN student in the Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.

LAIPHRAKPAM WILLAIM SINGH student in the Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.

MEER RIZWAN ALI student in the Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.

MOHAMMED ABDUL GAFOOR student in the Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.

SYED HUSSAIN AHMED student in the Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.

S.MAHESH Assistant Professor Civil Engineering from Sri Visvesvaraya Institute of Technology and Science, MBNR.