Journal of Science and Technology (JST)
Volume 2, Issue 3, May - June 2017, PP 27-33
www.jst.org.in *ISSN: 2456 - 5660*

Using Stadd Pro: Building Design And Analysis

J. Mohan[1] C. Selin Ravikumar[2] and T.S. Thandavamoorthy[3]

[1](Samskruti College of Engineering and Technology, Hydrabad)
[2](Samskruti College of Engineering and Technology, Hydrabad)
[3](Adhiparasakthi Engineering College, Melmaruvathur)

Abstract : *The design of modern civil engineering structures is highly complicated and the basic design is very important on various aspects. The design involves load calculations manually and analysis of the whole structure by STAAD Pro. The design ways utilized in STAAD-Pro analysis square measure Limit State style conformist to Indian customaryCode of follow. STAADpro options state of the art programme, visual image tools, powerful analysis and style engines with advanced finite part (FEM) and dynamic analysis capabilities.STAAD Beava STAAD Advance Analysis STAAD (X) Tower RM Bridge LEAP Bridge. From model generation, analysis and design to visualization and result verification, STAAD.Pro is a professional's choice. In this paper the writers analyzed and designed a G+5 storey building by considering dead, live, and wind loads. The writers further considered a 3-D RCC frame with 5 bays in x-axis and 4 bays in z-axis. The y-axis consisted of G+5 floors. The floor height was 3 m. The structure was subjected to self weight, dead load, live load, and wind load prescribed under various load cases presented in the paper. The writers also checked the deflection of different members under the given loading combinations. The design of the building relies upon the minimum needs as prescribed within the Indian customary Codes. The minimum needs bearing on the structural safety of buildings ar being lined by method of birth down minimum stylehundreds that got to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear. Strict conformity to loading standards recommended to the IS codes was adhered to.*

Keywords - *STAAD, 3-D RCC, G+5 floors*

I. INTRODUCTION

This project involves analysis and design of multi-storeyed [G +5] using a very popular designing software STAAD Pro. The writers have chosen STAAD Pro because of its following

Advantages:

- easy to use interface,
- conformation with the Indian Standard Codes,
- versatile nature of solving any type of problem,
- accuracy of the solution.

STAAD.Pro options a progressive computer program, mental image tools, powerful analysis and style engines with advanced finite part and dynamic analysis capabilities. From model generation, analysis and style to mental image and result verification, STAAD Pro is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more. Aman et al[1] state that to perform an accurate analysis, a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior. A few standard problems also have been solved. Varalakshmi et al[2] described the design and analysis of multistoreyed G+5 building at Kukatpally, Hyderabad, India. The study included design and analysis of columns, beams, footings and slabs by using well known civil engineering software STAAD PRO.Test on safe bearing capacity of soil was obtained by Jayachandran and Rajasekaran[3] for the design and analysis of multistoreyed G+4 building at Salem, Tamilnadu, India. The study included design and analysis of footings, columns, beams and slabs by using two softwares namely STAAD PRO and RCC Design Suit. Kalurkar[4] (not available under references???) carried out the design and analysis of multistoreyed G+5 building using composite structure tor earthquake zone-III. A three dimensional modeling and analysis of the structure were carried out with the help of SAP 2000 software. Equivalent Static Method of Analysis and Response spectrum analysis method were used for the analysis of both Composite and RCC structures. The results were compared and found that composite structure was more economical.

1.1 Modelling

Type of structure - Multi storey fixed jointed 3D frame.

All external columns = 0.23 * 0.40 m (until ground floor)
All internal columns = 0.23* 45 m (until ground floor)
Columns at the ground floor: 0.4 * 0.4 m
External Main Beams = 0.23 * 0.5 m
Internal Main Beams = 0.23 * 0.45 m
Secondary beams = 0.23 * 35 m
All slabs = 0.15 m thick
Terracing = 0.15 m thick
Parapet = 0.115 m thick wall

II. LOADS CONSIDERED

The following loads were considered in the design of the structure

Dead Loads

All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights.

The unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as

Density of materials:

Plain concrete -24.0 kN/m3
Reinforced concrete - 25.0 kN/m3
Flooring materials (CM) - 20.0 kN/m3
Brick masonry - 19.0 kN/m3
Fly ash - 5.0 kN/m3

Imposed Loads

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

Live loads as per IS 875-86:

Live load on slabs - 3.0 kN/m3
Live load on passage - 3.0 kN/m3
Live load on stairs - 3.0 kN/m3

Wind Load

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small; the term `wind' denotes almost exclusively the horizontal wind, vertical winds are always identified as such. The wind speeds are assessed with the aid of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground.

Design Wind Speed (V,)

The basic wind speed (V,) for any site shall be obtained from and shall be modified to include
the following effects to get design wind velocity at any height (V,) for the chosen structure:

a) Risk level;
b) Terrain roughness, height and size of structure; and
c) Local topography.

It can be mathematically expressed as follows:
Where:

V_z = Vb * K1 * K2* k3
Vb = design wind speed at any height z in m/s;
K1 = probability factor (risk coefficient, 1.0)
K2 = terrain, height and structure size factor and - 0.98
K3 = topography factor – 1

Risk Coefficient

Risk Coefficient (K1 Factor) gives basic wind speeds for terrain Category 2 as applicable at 10 m above ground level based on 50 years mean return period. In the design of all buildings and structures, a regional basic wind speed having a mean return period of 50 years shall be used.

Terrain, Height and Structure Size Factor (K2 Factor)

Terrain

Selection of terrain categories shall be made with due regard to the effect of obstructions which constitute the ground surface roughness. The terrain category used in the design of a structure may vary depending on the direction of wind under consideration.

Wherever sufficient meteorological information is available about the nature of wind direction, the orientation of any building or structure may be suitably planned.

Topography (K3 Factor)

The basic wind speed Vb takes account of the general level of site above sea level. This does not allow for local topographic features such as hills, valleys, cliffs, escarpments, or ridges which can significantly affect wind speed in their vicinity. The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliff, steep escarpments, or ridges.

III. DESIGN CONSIDERATIONS

- The design of reinforced concrete members have been carried out in accordance with IS 456-2000 using limit state method.
- Live load on floors and roofs has been considered as per IS 875 part 2-1987 as 3 kN/m^2 and 1.5 kN/m^2.
- Floor finishes on floors and roofs have been considered as per IS 875 part 1-1987 as 1 kN/m^2.
- Concrete of M25 grade is considered for all concrete members.
- High yield strength deformed bars confirming to IS 1786 is considered for all R.C.C members.
- As per soil reports, the safe bearing capacity is considered as 250 kN/m^2 for design of footings.
- IS 1893 part 1-2002 has been used for calculation of base shear.
- Zone factor is taken as 0.1 (zone 2)
- Importance factor is taken as 3
- Average response acceleration coefficient is taken as 2.5 (from curves)

IV. DESIGN OF SLABS

RCC slabs are the most widely used structural elements of modern structural complexes. A slab is a thin flexural member used in floor and roofs of structures to carry loads, which are /supported by walls or beams along its edges.

One way Slab:

When a slab is supported along any two opposite edges with aspect ratio (ly/lx) > 2) sign are one way slabs. One way slab can be analyzed essentially as a rectangular beam of comparatively larger width.

Entire bending moment is assumed to be resisted by the environmental provided the short span and distribution steel provided along long span which merely takes temperature and shrinkage stresses but not any bending moment.

Two way Slab

When the slab is supported on four edges and aspect ratio (ly/lx) < 2 the slabs are two way slabs.

In two way slabs when the slab is loaded it bends in surface bending along both long span directions causing bending moments in both directions. To resist the slab must be reinforced with main reinforcement in both directions. For bending moments in two way slabs are treated as two way slabs.

The following are the design constants for design mix of M25 grade concrete and the steel. The floor slabs over the building are divided into S1 to S8 panels as shown in the layout plan depending on their edge condition.

Torsional reinforcement

As two way slabs deflects in both directions their corners are subjected to twisting mo ments. Therefore to prevent twisting torsion reinforcement is provided at the corners laving discontinuous edges. This torsion reinforcement should be of 4 layers, two layers at top and two layers at bottom at discontinuous edges of slab.

Design of Slabs

Based on the above particulars the design of the slabs was carried out and the results are summarized in Table 1.

Table 1 Summary of slab design

Slab	D (mm)	d (mm)	Load (kN/m^2)	Lx (m)	Ly (m)	L/LX	B.M coeff	B.M (kN/m)	spacing
s1	150	130	12	3.515	5.57	1.584	negative/ positive	11.638	8mm @ 176 c/c
s2	150	130	12	3.515	5.97	1.698	negative/ positive	12.82	8mm @307 C/C
s3	150	130	12	3.515	5.57	1.584	negative/ positive	11.638	8mm @280 C/C
s4	150	130	12	3.515	5.97	1.698	negative/ positive	12.82	8mm @200 C/C
s5	150	130	12	3.515	5.57	1.584	negative/ positive	11.638	8mm @280 C/C
s6	150	130	12	3.515	5.97	1.698	negative/ positive	12.82	8mm @200 C/C
s7	150	130	12	3.285	5.57	1.69	negative/ positive	11.293	8mm @270 C/C
s8	150	130	12	3.285	5.97	1.817	negative/ positive	12.82	8mm @307 C/C

Design of Staircase

Staircase is an important structural element that provides access for floors of the building at various levels. The staircase consists of a series of steps with landing al appropriate intervals. The width of staircase depends upon the types of building in which it is provided. It varies from 1 m residential building to 2 m from public buildings.

The length of staircase situated between two landings is called a flight. The number of steps in a flight will depend on the tread of various steps. The rise of the steps depends on the types of building and varies from 150 to 300 mm. The tread varies from 200 mm to 300.

Different Types of Staircase

1. Single flight staircase.
2. Quarter turn staircase.
3. Doglegged staircase.
4. Open well staircase.
5. Spiral staircase.
6. Geometrical staircase.

The design particulars were given earlier in 1.1 Modeling section.

V. DESIGN OF FOOTING FG B-1

Loads passed on footing from both frames were calculated as 689.60 kN inclusive of load factor. The footing was designed both for bending shear and punching shear, Necessary reinforcements were provided.

Table: 2 Footing reinforcement

S.no.	Design	Ultimate load on Footing kN	SBC kN/m2	Footing Size m2	X-Direction	Y-Direction
1	F1,F12,F18,F20	960	250	3.84	16mm@180mm c/c	16mm@160mm c/c
2	F2,F10,F15	1003.2	250	4.01	16mm@180mm c/c	16mm@160mm c/c
3	F3,F7,F8	1003.2	250	4.01	16mm@180mm c/c	16mm@160mm c/c
4	F4,F9,F11	1003.2	250	4.01	16mm@180mm c/c	16mm@160mm c/c
5	F5,F16,F17	965	250	3.86	16mm@180mm c/c	16mm@160mm c/c
6	F6,F14,F19	980	250	3.92	16mm@180mm c/c	16mm@160mm c/c

The idealized 3D frame for modeling is shown in Fig. 1. Front view of the same frame is shown in Fig. 2. The member properties are presented in Fig. 3. Floor loads are presented in Fig. 4. Figure 5 shows the wind loads on building.

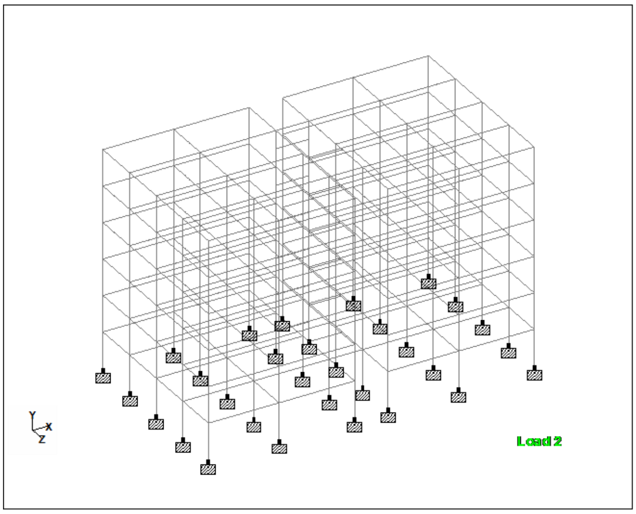

Fig.1 3D view of the G+5 storey building

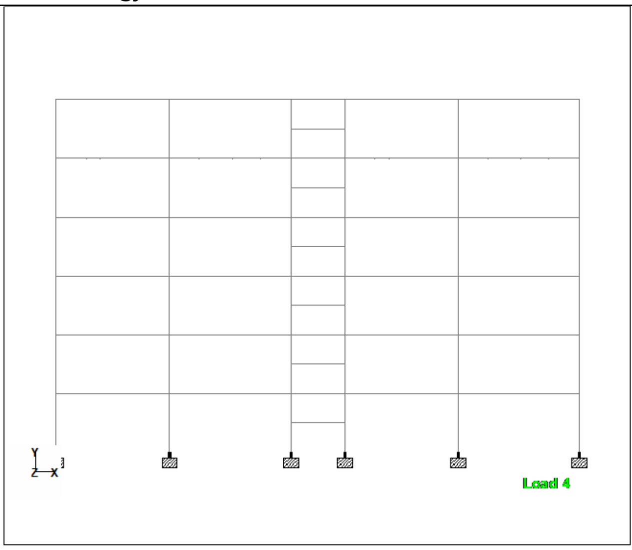

Fig.2 Front views

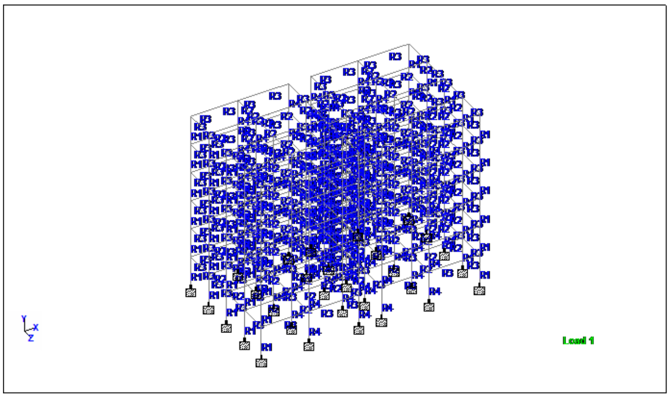

Fig. 3 Generation of member property

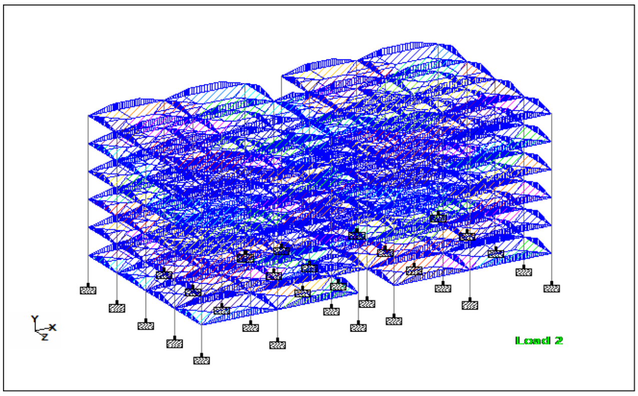

Fig. 4 Floor loads

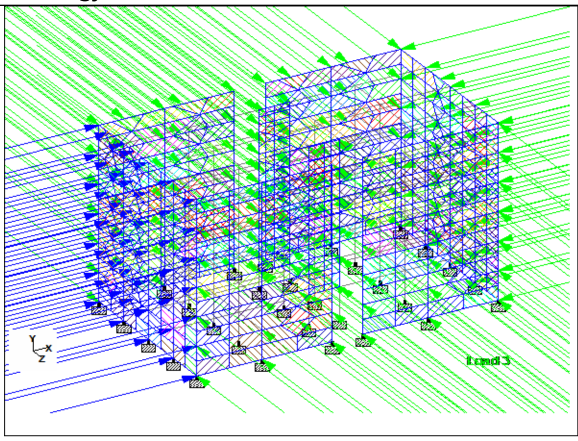

Fig 5 wind load effect on structure

VI. DISCUSSION

This project is located at Madhapur Hyderabad in the state of Telangana India. It is a linear framed structure and the loads considered are Live load, Dead load, Wind load and Earthquake load is not considered as Hyderabad is in Zone-V. The basic wind pressure in Hyderabad is 43m/s, here we have consider150 m/s wind pressure to calculate the wind load and the total number of 460 Nodel points were used in the frames

CONCLUSION

For accurate and better analysis Staad Pro is the best method when compared to manual analysis.
And for design of slabs, footings manual design is best method when compared with Saad Pro analysis.
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.

REFERENCE

1 Aman, Manjunath Nalwadgi, Vishal, T, Gajendra, "Analysis and design of multistorey building by using STAAD Pro", International Research Journal of Engineering and Technology (IRJET) Volume 03, No: 06, 2016.

2.Varalakshmi, V., Shiva Kumar, G. and Sunil Sarma, R., "Analysis and design of G+5 residential building," Mini Project Report, Marri Laxman Reddy Institute of Technology and Management, Dundigal, Hyderabad, India, 2014.

3 Jayachandran, . P. and Rajasekaran, S., .Structural Design of Multi-story Residential Building in Salem, India," Mini Project Report, PSG College of Technology, Coimbatore, Tamil Nadu, India, 2006.

IS CODES FOR THE DESIGN
IS 456-2000 (Design of RCC structural elements)
IS 875-Part 1 (Dead Load)
IS 875-Part 2 (Live Load)
SP-16 (Depth and Percentage of Reinforcement)
SP-34 (Detailing).