Analysis and Design of Residential Building (G+4) By STAAD Pro

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ABSTRACT

Structural Analysis is a branch which involves in the determination of behavior of structures in order to predict the responses of real structure such as houses, bridges, trusses etc. The design of G+4 multi-storied building starts with the forecasting of the residential building equally for individual house and total plan of the building. The building has an overall area of 153 sq.m. Ground floor is used for parking with a capacity of 4 cars. Total building is designed in AutoCAD and analyzed by STAAD Pro. After being analyzed by STAAD Pro the results are verified by manual design using code books IS 456-2000. STAAD Pro is the new advancement in structural engineering. This software is used for analysis and design of concrete, steel, timber and aluminum. The model is being created and analyzed under various load condition such as earthquake load, dead load, live load, wind load and some combination of load. As a result of analysis, shear force, bending moment and support reaction are evaluated. Based on analyzed result, the structure is designed manually and cross referenced with the software results.

Keywords: Multi-storied building, Analysis and Design, STAAD Pro.

INTRODUCTION

The creation in the 21st century is becoming challenging day by day as in order to achieve more economy and efficiency. In the early ancient periods humans survived in caves, over trees or under trees, to shelter themselves from wild animals, rain, sun, etc. as the times passed as humans' life started living in huts made of timber branches. The shelters of those old have been developed currently into attractive houses. Designing and analyzing of G+4 multi storied residential building using analyzing software STAAD Pro. AutoCAD is a computer aided design software established by the Autodesk. It allows you to draw and edit digital 2D and 3D design more rapidly and easily you could by hand. The files can also be simply saved and kept in the cloud, so they be accessed anyplace at any time. STAAD Pro is a user-friendly software which is used for analyzing and designing of structure by the structural engineers. STAAD Pro was firstly developed by Research Engineers international at Yorba Linda, CA in year 1997. In late 2005 Research Engineer International was bought by Bentley System. STAAD Pro provides a lot of exact and correct results than manual techniques. It's the foremost computer code for 3-D model generation and multi-material design. Here in this project work based on software called STAAD Pro has been used.

1.3 Types of Building

Depending upon the character of occupancy or the category of use, buildings can be classified into different groups as follows:

A) Residential Building
B) Educational Building
C) Institutional Building
D) Assembly Building
E) Business Building
F) Industrial Building
G) Mercantile Building
H) Hazardous Building
I) Storage Building

A) Residential Building: -
A building should be considered a residential building when more than half of the floor area is hired for dwelling purposes.
A residential building has mostly:

- A sleeping room(bedroom)/space
- A living room/space
- Conveniences (as in toilet and bath)
- Cooking room/area (kitchen).

B) Educational Building: -
These buildings contain any building used for school, college, or daycare purposes linking assembly for teaching, education, or recreation.

C) Institutional Building: -

These buildings include any structure or part which is used for health treatment etc. Such as Hospitals, nursing homes, orphanages, sanatoria, prisons, mental hospitals, etc.

D) Assembly Building: -

These buildings may contain any structure or part of a building where a group of persons gathers for recreation, amusement, social, religious, or such categories of purposes such as dramas, assembly halls, exhibition halls, restaurants, museums, club rooms, auditoria, etc.

E) Business Building: -

These shall include any building type or part of a building that is used for business transactions, keeping records of accounts, town halls, city halls, courthouses, etc.

F) Industrial Building: -

These types of building mainly used for manufacturing purposes. Here products or materials of all kinds and properties are fabricated, assembled, or processed, for example, gas plants, refineries, mills, dairies, etc.

G) Mercantile Building: -

These shall include those buildings which are used for soap, market, stores, wholesale or retail.

H) Hazardous Building: -

These types of buildings include any building which is used for storage, handling, manufacture, or processing of highly combustible explosive materials or products that are liable to burn extreme rapidly which may produce poisonous fumes, a building that is used for storage, handling, or manufacturing highly corrosive, toxic, acid or other liquids or chemicals producing flame, fumes explosive, etc.

I) Storage Building: -

These buildings are generally used for the storage or sheltering of goods, wares, or merchandise like warehouses, cold storages, garages, stables, transit sheds, etc.

STRUCTURAL COMPONENTS OF BUILDING

1. Slabs
2. Beams
3. Column
4. Footing
5. Staircase

LITERATURE REVIEW

1. Kunal Wailkar, Pranay Chude, Manthan Shende, Jinendra Ralekar, Dhanshree Walke, Atul Kurzekar (2021) this paper deals with structural analysis and design of Multistoried apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project STAAD Pro software is used for analyzing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.

2. Banavanru Vinod Kumar Ready, Shaik Rehman, S Zubeeruddin (2021)he says that the one of the major problem country facing is the growing population. Because of the less availability of land, multi-storey building can be constructed to serve many people in limited area. Efficient modelling is performed using STAAD Pro and AutoCAD. Manual calculations for high rise buildings are tedious and time consuming. STAAD Pro provides us a quick, efficient and correct platform for analyzing and coming up with structures.

3. Mr. M Durga Rao, CH. Pavan Sai, K. Ravi Teja, K. K Nagendram, B Ram Jaswath (2020)has been designed and analysed G+6 multi-storey building adopting STAAD.Pro in limit state methodology. STAAD.Pro contains an easy interface that permits the users to produce the mount and the load values and dimensions are inputted. The members are designed with reinforcement details for RCC frames. The analysis is completed for two dimensional frames and then it is done for more multi-storeyed 2-D and 3-D frames under various load combinations.

4. IS: 875 (Part 1) – 1987 for Dead Loads, Indian Standard Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures

5. IS: 875 (Part 2) – 1987 for Imposed Loads, Indian Standard Code of Practice for Design Loads (Other Than Earthquake), For Buildings and Structures

6. IS: 875 (Part 3) – 1987 for Wind Loads, Indian Standard Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures

**7. IS: 1893(Part1) -2002,** Indian Standard Criteria for Earthquake Resistant Design of Structures

8. IS: 875 (Part 5) – 1987 for Load Combinations, IndianStandard Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures
9. IS 456 -2000, Indian standard code of practice for plain and reinforced concrete (fourth revision), Bureau of Indian Standards.
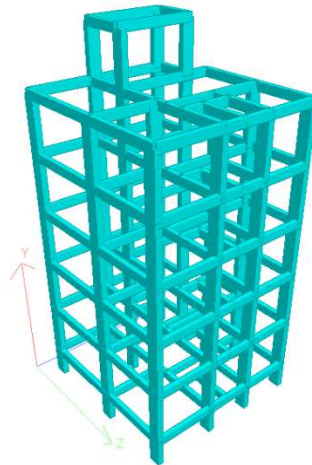
METHODOLOGY

1. Planning
2. Modelling
3. Loading
4. Structural Analysis and Design

1. Plan
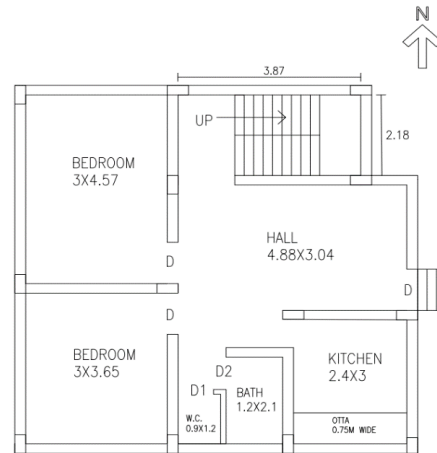
2. Modelling

Parameter

1. Types of Building – G+4 residential building.
2. Number of Storey – 4 storeys.
3. Types of Foundation – Isolated.
4. Height of Building – 15 m from ground level.
5. Total gross area of Building – 153 Sq. m
6. Column Size – 0.6 x 0.3 m.
7. Beam Size – 0.45 x 0.23 m.
8. No. of column – 13.

3. Loading

The loads in buildings and structures can be classified as vertical loads, horizontal loads and longitudinal loads. The vertical loads consist of dead load, live load and impact load. The horizontal loads consist of wind load and earthquake load. The longitudinal loads i.e., tractive and braking forces are considered in special cases of design.

The estimation of various loads acting is to be calculated precisely. Indian standard code IS: 875–1987 and American Standard Code ASCE 7: Minimum Design Loads for Buildings and Other Structures specifies various design loads for buildings and structures. Each of them is discussed below.

Load case details

- Earthquake load
- Dead load
- Live load
- Wind load
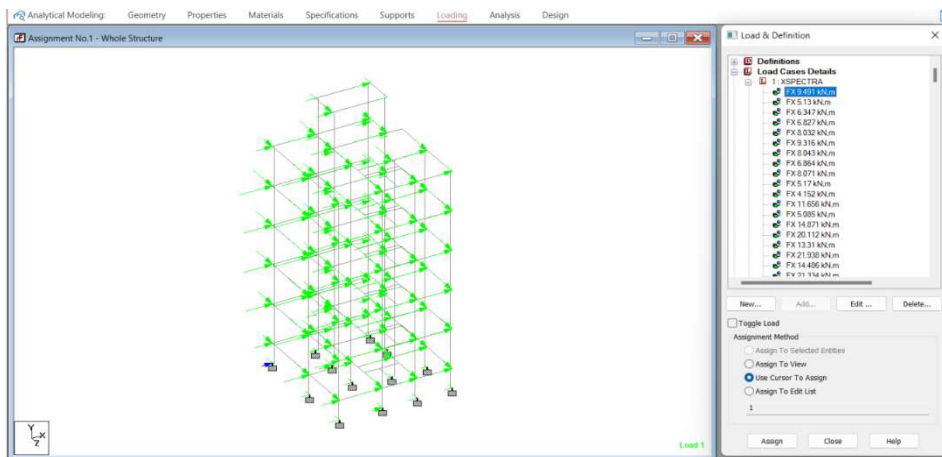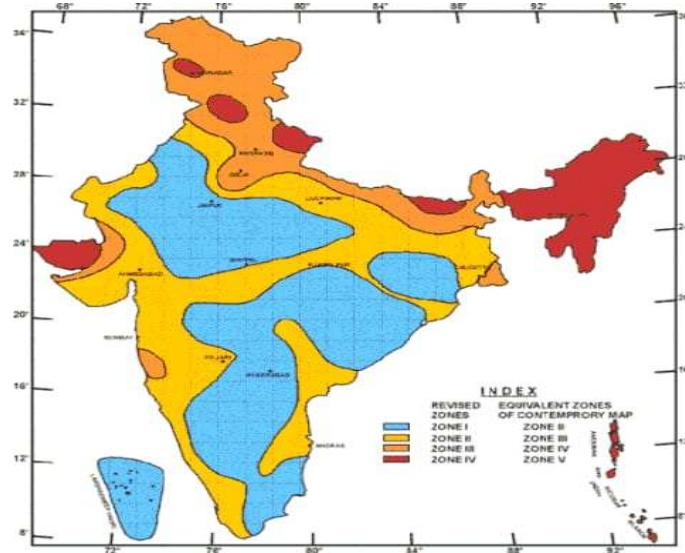- Load combination

3.1. Earthquake Load

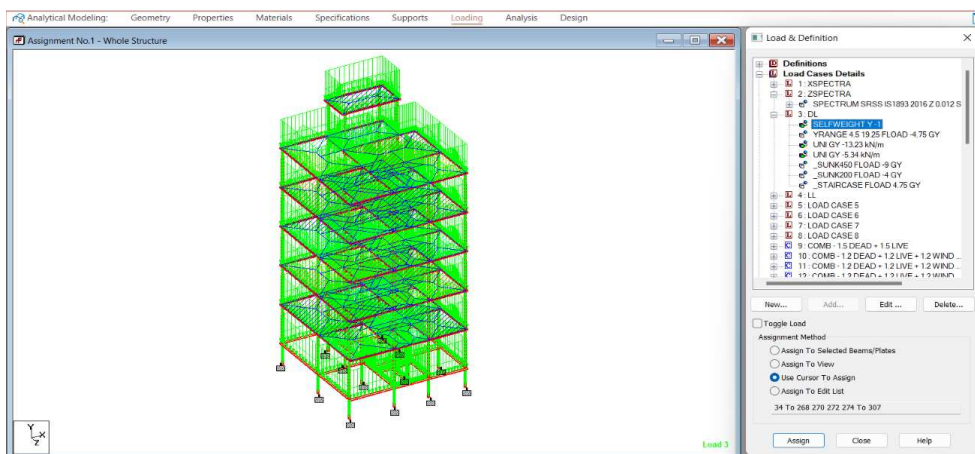Fig. : Earthquake load applied

3.2. Dead Load

Fig. : Self-weight applied
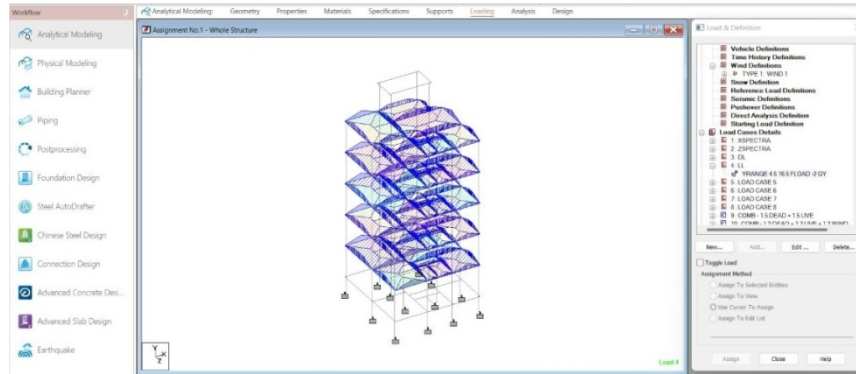
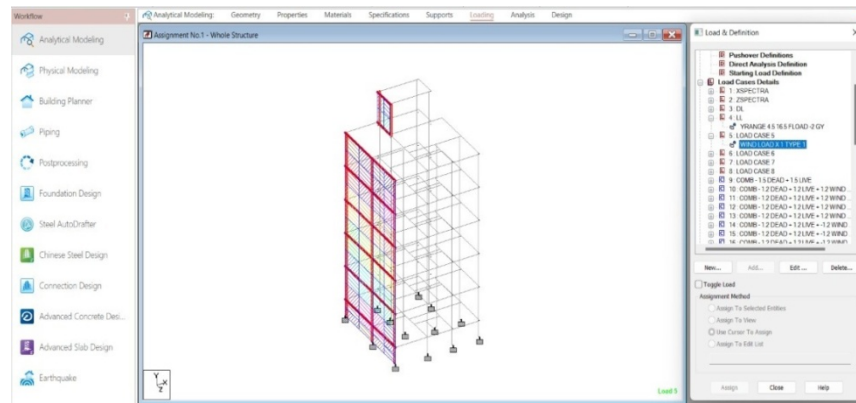### 3.3. Live Load

Fig. : Live Load applied

3.4. Wind Load

Fig. : Wind Load

3.5. Load Combination
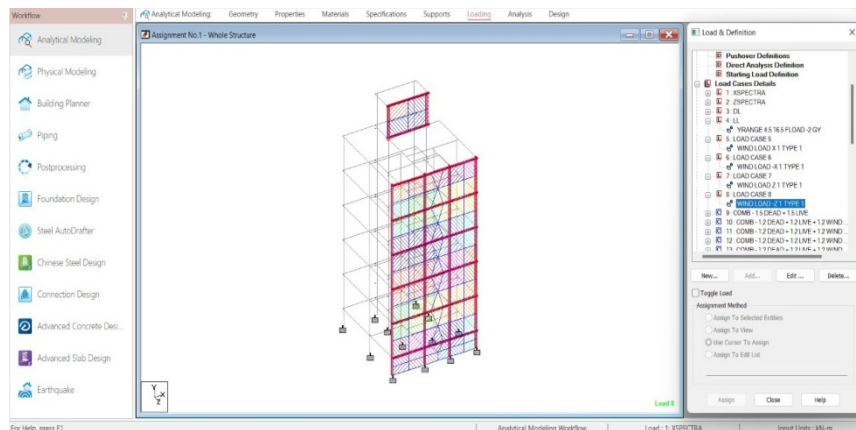
Fig. : Load Combination.

4 Structural Analysis and Design

IS-456   L I M I T   S T A T E   D E S I G N
      B E A M N O.   254   D E S I G N R E S U L T S

M25   Fe500 (Main)   Fe415 (Sec.)

LENGTH: 3230.0 mm   SIZE: 230.0 mm X 450.0 mm   COVER: 30.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

| SECTION	0.0 mm	807.5 mm	1615.0 mm	2422.5 mm	3230.0 mm
TOP REINF.	227.84 (Sq. mm)	162.27 (Sq. mm)	162.27 (Sq. mm)	162.27 (Sq. mm)	257.09 (Sq. mm)
BOTTOM REINF.	0.00 (Sq. mm)	161.87 (Sq. mm)	161.87 (Sq. mm)	161.87 (Sq. mm)	161.87 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	807.5 mm	1615.0 mm	2422.5 mm	3230.0 mm
TOP REINF.	3-10d 1 layer(s)	3-10d 1 layer(s)	3-10d 1 layer(s)	3-10d 1 layer(s)	4-10d 1 layer(s)
BOTTOM REINF.	2-12d 1 layer(s)	2-12d 1 layer(s)	2-12d 1 layer(s)	2-12d 1 layer(s)	2-12d 1 layer(s)
SHEAR REINF.	2 legged 8d @ 140 mm c/c	2 legged 8d @ 140 mm c/c	2 legged 8d @ 140 mm c/c	2 legged 8d @ 140 mm c/c	2 legged 8d @ 140 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 715.0 mm AWAY FROM START SUPPORT
VY = 37.50 MX = -1.53 LD= 9
Provide 2 Legged 8d @ 140 mm c/c

_ STAAD SPACE   -- PAGE NO. 139

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -46.24 MX = -1.53 LD= 9
Provide 2 Legged 8d @ 140 mm c/c
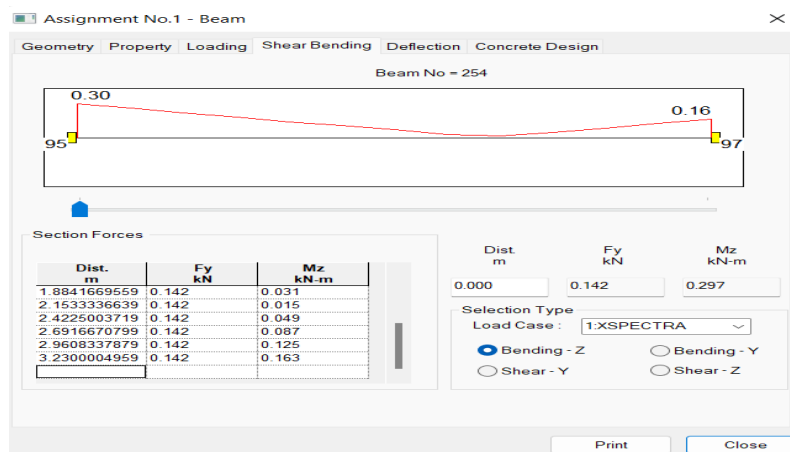
Result and Discussions

1. This project is mainly concentrated with the analysis and design of multi-storied residential building with all possible cases of the loadings using STAAD. Pro.
2. We may also check the deflection of various members under the given loading combinations.
3. Very less space is required for the storage of the data.
4. STAAD.Pro Connect advanced software which provides us a fast, efficient, easy to use and accurate platform for analyzing and designing structures.

Table No.5.1: Loads and Moments

Load			Moment		
Fx	**Fy**	**Fz**	**X**	**Y**	**Z**
1.843	14.340	0.500	1.804	0.333	2.082
2.025	14.382	0.738	1.980	0.334	2.111
2.744	15.932	0.683	4.176	0.438	2.256
3.267	5.810	0.680	0.699	0.560	3.044
3.849	4.276	0.497	0.666	0.123	8.953
2.334	10.458	1.505	4.836	0.478	4.259
4.426	9.240	0.483	0.264	0.261	10.671
3.361	4.537	0.685	0.868	0.612	3.425
5.118	2.290	0.562	0.625	0.298	8.469
3.007	8.330	0.560	0.846	0.173	7.044
2.882	17.353	0.531	0.411	0.069	5.432
2.004	13.872	0.896	4.097	0.374	2.170
3.265	23.016	0.513	0.962	0.124	3.749