# STRUCTURAL MODIFICATION APPROACH FOR SEISMIC PROTECTION AND SEISMIC ASSESSMENT OF MULTI STOREY BUILDING

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**ABSTRACT-** To make earthquake resistant structure nowadays has become a trend for provision in building to get safe and durable structure to resist critical loading. But having taken the steadiness of building into consideration it is one of the typical steps to be considered in building design. Providing circling column needs proper care and strength to make suitable design for free implementation of loading. It is overlooked in multi-storeyed building to have floating column if they are in seismic resistant areas.

Structural Engineers keep on modifying structures to get best utilization of the structure as much as possible. So, they keep on changing the structural elements for proper loading pattern and to know how they can decrease the amount of material needed for construction to make economic structure.

Designs are made best in their look and complex in their structure to get new features and make great changes. Changes are made with time to time if it is found that design is good and follow all the rules of design and is applicable practically. In addition to this, researchers keep on changing to get new results and to compare them with existing ones. If it is found that the design is suitable and is done according to design standards. It is put under the process of experts who then go in detail to know the processes and if found up to mark. Then they give approval for its application. Various IIT's are trying to take this field on another level by making some revolutionary changes. Some processes are undergoing in process which include replacement of construction material with waste products to maintain ecological balance.

## I. INTRODUCTION

Being my interest in design, I selected this as my research topic so that I can make good hand on design and can know the design process in detail. This research not only increased my knowledge in designing field but also led me to learn some software's which I am using in this research to check the results. After all I found this one of the trending topics on which research is going on in many IIT's and abroad. This increase in need of conducting a comparative survey between different constructions to understand the real benefits and disadvantages of this software. It is essential to verify which digital technology is great and convenient for analysis and design purposes in order to obtain a secure and economical design. So, this provides us the real information needed to understand how to optimize a frame-resistant moment by using STAAD Pro to obtain economic deign.

Most instances consist of momentary frame resistance as it is nice to withstand lateral loads. If buildings are multi-storeyed then it is the utmost responsibility to provide proper detailing for the members. Five-story building is considered for research process; Earthquake loading and supplying various IS codes with IS 1893 should be considered as the primary recommendation code for Earthquake Design. Most of the resisting special moment comprises of monolithic beams and columns so they can readily transfer moment to other members. This study focuses on Engineers ' primary concern while developing the primary observation such as quality control, serviceability, and economy. An Engineer can achieve these points if and only if the design has gone by the earthquake design code as recommended.

## II. OBJECTIVE OF THE RESEARCH

Designing is one of engineering's key values. Once you have completed your engineering degree, you have technical expertise to design and deliver projects. But project delivery is not as easy as it looks, it requires knowledge of every aspect considered in a structure from the design of codes to the planning process. The primary goals of this research are as follows:

- To know protection structures to resist earthquake loading.
- To observe contribution of shear wall to resist lateral loads.
- To know the stresses being generated due to earthquake on structural members.
- To define cross section of members for critical loading conditions.
- The checking of deflection taking place in structural elements due to given loading.
- To assign a suitable cross section which will resist load as well as fulfill some design requirements such as economy and serviceability.

- The main aim is to check various modifications needed to protect a structure from external loading.
- Last but not the least is to check overall progress of building to resist earthquake loading and protective structures to resist lateral loads.

## III. OVERVIEW OF THE METHODOLOGY

The design work of the Project has been completed by using STAAD Pro V8i and AutoCAD, and with the help of following IS Codes : -

- I S:875 (First part)-1987 Indian code for de sign loads to make provision for "Dead Load "for buildings and structures.
- IS 875 (Part II)-1987 Design code to consider Live Loads on structures.
- IS 456:2000 Concrete design code for reinforced structures.
- IS:1893 (first part)-2002 Earth quake code to consider earthquake loading of Structures.
- IS 13920:1993 Indian standard code for Ductile description of concrete reinforced structures exposed to seismic forces.
- IS: 4326-1993, Earthquake Resistant Building Design-Code of Practice (Second Revision).

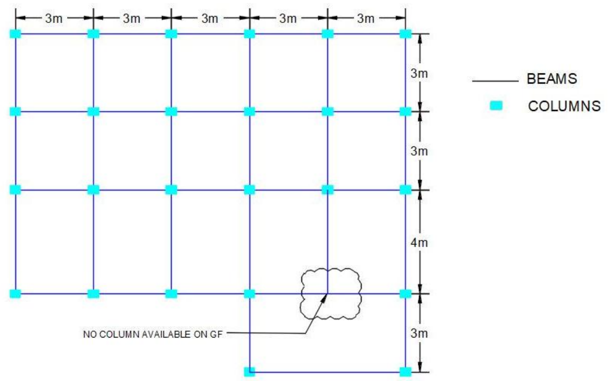
### A. STAAD PRO

The STAAD. Pro package includes :

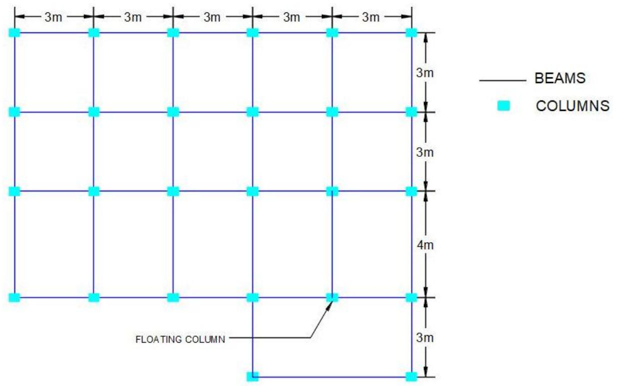
- STAAD. Pro Graphical User Interface (GUI): the model that can be analyzed using the STAAD motor is created.
- The GUI can also be used to display the results graphically after completion of the evaluation and design.
- STAAD analysis and motor design: a general purpose calculation system for the construction of structural engineering and embedded steel concrete , wood and aluminium.
- STAAD Pro is an object model that is fully component. With STAAD Pro, any third-party software can be used.
- The user interface for STAAD Pro is the industry standard. It is easy to generate complex models.
- STAAD Pro supports codes of multi-material design such as wood, steel, concrete and aluminum.

## IV. PARAMETERS OF THE STRUCTURE

No of Story: G+5
Location (Assumed): Lucknow
Size of Beam,
Width = 300mm
Depth = 350mm
Size of column,
Width = 300mm
Depth = 400mm
Main wall thickness = 9"
Partition wall thickness = 4.5"
Dens ity of con crete = 25 kn/m3
Den sity of brickwork = 19 KN/m3
Thickness of slab = 150 mm
Floor Live Loading = 4 KN/m2
Roof loading = 2 KN/m2
Type of soil = Medium
Height of story =3 m
Damping =0.05
Seismic Zone = I I I
Factor of zone = 0.16
Factor for Importance =1.5
Reduction Factor (R) = 5




PLAN(GF)




PLAN (FIRST FLOOR)

Fig 1: PLAN of building with dimensions (STAAD Pro).

Note: All dimensions are in meters.

The plan of a building is symmetrical. A G+4 Building with some floating column at ground floor is being modelled in STAAD Pro to check the results about the behaviour of those columns in structure and their contribution in stability of structure.

Above two figures give us clear representation about a building with floating column and its location. Here lines show beams and rectangles represent section of column. As we are showing plan here so we can see only cross section of columns. Above building is designed for earthquake loading and it is being observed that the effect of earthquake loading will affect up to what extent. This research will give us clear idea about changes being made if there are some floating columns in building. In my case I have considered only one column and I will check stress as well as change in loading due to this column missing on ground floor.

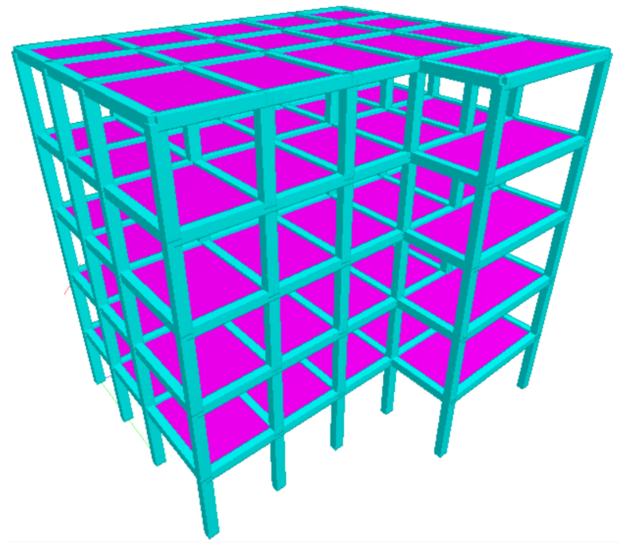


Fig 2: Rendered view of Structure.

The above figure gives the full description of the model taken to complete this research. The model of a building consists of five floors with symmetric structure. The number of bays taken in X direction are five while as number of Bays in Z direction are four. Bays in X direction are having same spacing while as bays in Z direction are of unequal spacing.

This project is basically focussing on impact of earthquake loading on a structure. Static analysis is being done using design tool STAAD Pro. The Loading applied on a structure depends upon the type of structure. The loading is considered based on type of building and its function. The loading is taken by specific codes according to country where building is located. In India Bureau of Indian Standards have provided separate codes for different types of loading.

**V. ANALYSIS RESULT**

**A. INTRODUCTION**

Research is called the effect of loading on the structure. Research is known as analysing the generation of Shear Force, Bending Moment, Torsion, Stresses etc because of loading on the structure. Section wise is given the various analytical outcomes with correct diagrams:

**B. SHEAR FORCE**

The force generated by external forces between two surfaces is called shear force. When two surfaces are in touch, the shear force is discovered to be maximum. SF is discovered to be maximum at ends as supports are present. SF gives us the idea of how much reinforcement is needed to counter the external forces in the case of beams. Stirrups in beams occur as reinforcement of shear force, while primary reinforcement is decided on the basis of Bending Moment. Shear reinforcement is called rings in the case of columns. Stirrups can be supplied with two legged, three legged and more depending on member and amount of primary reinforcement bars.

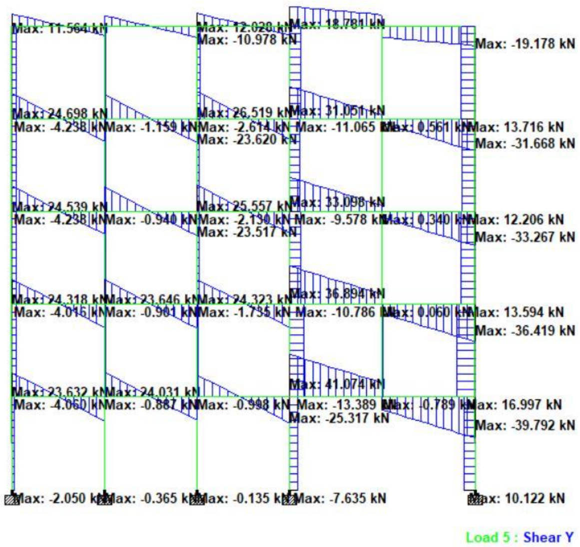



Fig 3: Shear Force Diagram of frame.

As the loading is always evenly distributed this is why the above diagram shows shear force increasing evenly as we step beyond support and it will be zero at centre. Same form of diagram is found in every member but there be change in intensity according to loading.

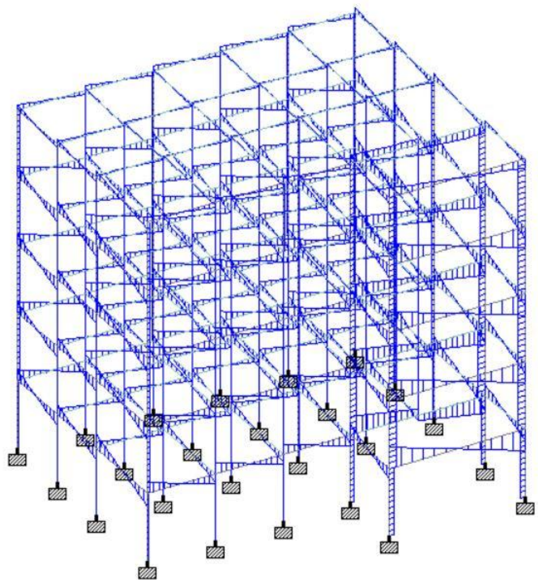


Fig 4: Shear Force diagram of whole structure

### C. BENDING MOMENT

The moment of bending determines how much force a particular section is accountable for bending. At the charging point, bending should be full. It is evident from the diagram that owing to uniformly distributed loading, the bending moment is made. Moment will change linearly in the case of point loading the Bending, while in the case of uniformly distributed loading bending moment diagram will change parabolically. There will be transfer of moment at joints as the structure is framed type.

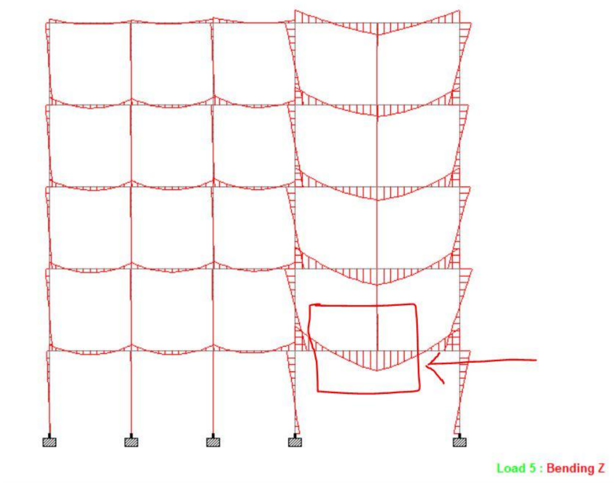



Fig 5: Bending moment diagram of a structure.

With the help of bending moment values, we can decide how many bars are needed to get embedded in the member so as to resist applied loading. Bending moment also gives us the idea about provision of spacing provided. Ultimate moment at any member is selected for calculation of area of reinforcement required. The required area of reinforcement is then revised to get area of reinforcement provided. Clear cover for beams is taken as greater or equal to 20mm and in case of columns clear cover is taken as greater or equal to 40mm.

### D. DEFLECTION

Deflection is the main concern for civil engineers to control. With economical section structural Engineers should kept in mind to minimize deflection as much as possible. According to IS-456 the deflection does not exceed to L/250. Where “L” represents the time and is measured in millimetres.

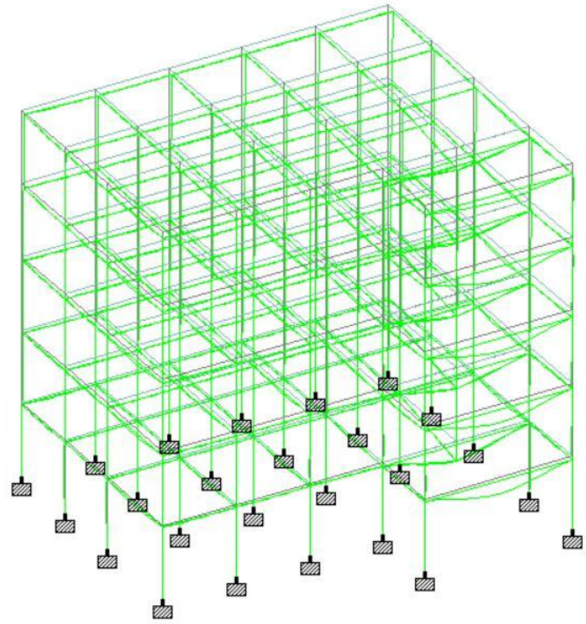


Fig 6: Deflection in top beams due to load combination 1.5(DL+LL).

It is obvious that deflection maximum deflection is found in long span beams but it can be minimised by placing a column in between or to change section properties. In some cases, sectional changes cannot decrease deflection value. So, it is necessary to place a vertical member to resist that amount of deflection.

Deflection takes place due to loading and loading is of various types. So, Deflection is checked due to Load combination. The deflection is mainly in two directions i.e. vertical deflection and horizontal deflection. Vertical deflection is found due to gravity loads which include self-weight of structure and live loading. Whereas horizontal deflection is found due to lateral loading which in other terms known as Earthquake loading.

**VI. MATERIAL TAKE-OFF.**

Material take-off gives the estimation of materials which includes volume of concrete and weight of steel. The weight of reinforcing bars is calculated separately according to diameter of bars. The volume of concrete consists of total volume of concrete used for beam and column casting. STAAD Pro does not give estimation of other materials as those materials are not modelled in STAAD Pro, their loading is applied by manual calculation and then applied at a particular place in STAAD Pro. The brick walls are not modelled in STAAD Pro. Instead of brick walls loads are applied directly on beams. The main wall load is applied to external columns while as partition wall load is applied to interior beams. Wall load is calculated by multiplying thickness of wall to unit weight of brick to get load in UDL form.

Total volume of concrete = 115.7 $m^3$

Table 8.1: Reinforcing data.

| Dia of Bar. | Weight |
|---|---|
| (mm) | (Newton) |
| 8.0 | 25460 |
| 10.0 | 1416 |
| 12.0 | 32410 |
| 20 | 37443 |

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*** Weight of steel = 96729 ***

Here total weight of steel needed for construction is 9672.9 kg and volume of concrete is 115.7 $m^3$.

**VII. CONCLUSIONS**

This Research led me lot of knowledge about the behaviour and interrelationship of members in earthquake resistant structures with nearby members. This project helped me to deeply analyse structure with seismic loading. The main observations which I came to know while going through this research are pointed below:

1. The total variation in percentage of steel in the structure can be minimized by providing floating columns.
2. The percentage of steel in case of beams get increased whereas in case of columns no increment takes place in case of reinforcing bars.
3. In analysis process if grade of concrete increases the area of reinforcement decreases.
4. The reinforcement percentage in edge and interior columns are more compare to exterior columns.
5. The percentage reinforcement in external beams are more compare to internal beams.
6. In case of beams, the reinforcement percentage in bottom middle portion is same in all cases.
7. The base shear increases as the seismic Zone increase.
8. The displacement of structures increased as the seismic zone increase.
9. The moments in building increases gradually according to seismic zones, but in some cases certain variation in values has been noticed.
10. If there is a smaller number of floating columns in structure then it has not huge impact on the building in case building is not more than three storeys.
11. Floating column must be ignored in case of earthquake resistant building.
12. For open spaces and parking lots curved roof must be preferred instead of floating columns as they directly transfer loads to columns and there is generation of compressive forces only.
13. Floating columns are suitable if columns are nearer to each other so that they can distribute loads normally and will not have much impact on adjacent beams.

**VIII. REFERENCES**

1. Analysis and Design of a multi-storey building by Singhania and Paresh (2011).
2. Design by Software to check analysis result by Poonam et al. (2012).
3. Dynamic Analysis of a structure using latest technologies by Prasanth's et al. (2012)
4. Analysis and Design of Multi-storey building by Mahesh Suresh Kumawat1* and L G Kalurkar [2014].
5. Analysis and Design of G+22 Residential Building by Abhay Guleria [2014].
6. Analysis and Design of Structure by Tushar R. Agrawal et el [2015]. Source: IRJET.
7. Software approach for analysis and design by Sagar R Padol1 et el [2015].
8. Static check of a framed structure by Mahammad sober et el [August 2015].
9. Seismic Analysis and Design of Multi-Storied Building by Rinkesh R Bhandarkar et el [2016]..
10. Analysis and Design of a Multi Storied Residential Building Of (Ung-2+G+10) By Using Most Economical Column Method by M. Mallikarjun1 [2016].