Seismic Analysis and Design of G+10 Storey Building By Using STAAD PRO

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Abstract- *Various seismic data are necessary to carry out the seismic analysis of the structures in this study the seismic response of the structures is investigated under earthquake excitation expressed in the form of member forces, joint displacement, support reaction and story drift. We have taken the residential building, a G+10 storied structure for the seismic investigation and for the Zone III and district of Maharashtra in India.The main objective of this project is to study different lateral forces acting on structure provided with column. The parameter studied and analyses are different types of loads and lateral displacement. The project also aims at finding the stability and design of a G+10 structure using Beam, Column, Shear Wall concept. The analysis is carried out using analytical methods a well as STAAD pro software.*

Keywords- Analysis, Design, Beam, Column, STAAD Pro.

I. INTRODUCTION

Now a day's construction of multistoried building is basic need because large increasing population day to day. We are used conventional design of manual method of building is time consuming and more possibilities of errors. So it is necessary to use of software are getting more accurate results. The design is made using software are structural analysis design (staad pro). The building subjected both the vertical load as well as horizontal loads. The vertical loads consist of dead load of structural component such as beam, column, slab footing etc. So it is necessary to use of software for getting more accurate results. Staad-pro is structural software accepted by much civil engineering. This can solve typical Problem like seismic analysis using various load combination to confirm various code like IS 456:2000, 1893:2002, IS875:1897etc. For multistoried buildings, the conventional load bearing structures tends to distribute the loads more uniformly and eliminate the excessive effects of localized loads. Become uneconomical as they require larger sections to resist huge moments and loads. But in a framed structure, the building frame consists of a network of beams and columns which are built monolithically and rigidly with each other at their joints. Because of this rigidity at the joints, there will be reduction in moments and also the structure Therefore in non-load bearing framed structures, the moments and forces become less which in turn reduces the sections of the members.Seismic analysis is performed to understand response of building when subjected to earthquake. Construction of multi-storey buildings has become inevitable both for residential and as well as office purposes. The high raised structures are not properly designed for the resistance of lateral forces. It may cause to the complete failure of the structures. The earthquake resistance structures are designed based on some factors. The factors are natural frequency of the structure, damping factor, type of foundation, importance of the building and ductility of the structure.

1.1. Objective of the Study

- The main objective is to check and design seismic response of proposed building to the conventional build using STAAD.Pro.
- To design high rise building using STAAD.Pro software to with stand the seismic loads.
- Study of the reaction force, shear force, bending moment and node displacement.

II. LITERATURE REVIEW

Various articles have been reviewed to get an overall idea of the research done in the field related to the project in the past. The date is presented to help get a rough idea of the research work performed before by various researchers.

2.1. Anoop Singh, et.al. (2016) have studied the "Seismic Analysis And Design Of Building In STAAD.Pro" In this study, the seismic response of the structures is investigated under earthquake excitation expressed in the form of member forces, joint displacement, support reaction and storey drift. The response is investigated for g+10 building structures by using STAAD.PRO designing software. We observed the response reduction of cases ordinary moment resisting frame.

2.2. Akshay R. Kohli and N. G. Gore (2017) have studied the "Analysis And Design Of An Earthquake Resisting

Structure Using STAAD.Pro"For this purpose, a G+11 residential building plan in Mumbai is considered. They concluded seismic and wind forces have been considered and the structure is designed as an earthquake resistant structure. Earthquake and wind-oriented deflections must be limited for multiple reasons and hence abundant structural stiffness is important. As a result, the inter-storey drift must be obtained within the specified limits. The actual relative displacement between every storey in the structure is below the inter-storey drift limit and hence safe.

2.3. B. Girish Babu (2017) represent paper on "Seismic Analysis and Design of G+7 Residential Building Using STAAD.Pro"In this study of the G+7 building, seismic load dominates the wind load under the seismic zone –II. Basically, the wind pressure is high for high rise building based on weather conditions such as coastal areas, hilly stations. For Building prominently seismic forces create the major cause of damage to the structure.The Storey drift condition for considered G+7 building, the base drift=0.0 at every storey. This says that the structure is safe under drift condition. Hence shear walls, braced columns are not necessary to be provided. Hence storey drift condition is checked for the G+7 building.

2.4. Prof. S.S. Patil, et.al. (2013) represent paper on "Seismic Analysis of High-Rise Building by Response Spectrum Method"

This paper describes seismic analysis of high-rise building using program in STAAD.Pro. with various conditions of lateral stiffness system. Some models are prepared that is bare frame, brace frame and shear wall frame. Analysis is done with response spectrum method. This analysis will produce the effect of higher modes of vibration & actual distribution of forces in elastic range in a better way. Test results including base shear, storey drift and storey deflections are presented and get effective lateral load resisting system.

2.5. T. Sasidhar, et.al. (2017) has been studied on "Analyzing And Designing Of A High Rise Building (G+10) By using STAAD.Pro"In this project we had analyzed the G+10 building for finding the shear forces, bending moments, deflections & reinforcement details for the structural components of building (such as Beams, columns & slabs) to develop the economic design. Finally, we will make an attempt to define the economical section of G+10 hospital building using STAAD.Pro software tool.

III. PROPOSED SYSTEM

The Structure under consideration here is a commercial structure in Seismic Zone III. The Plan Size is 20.62 x 20.59 m.

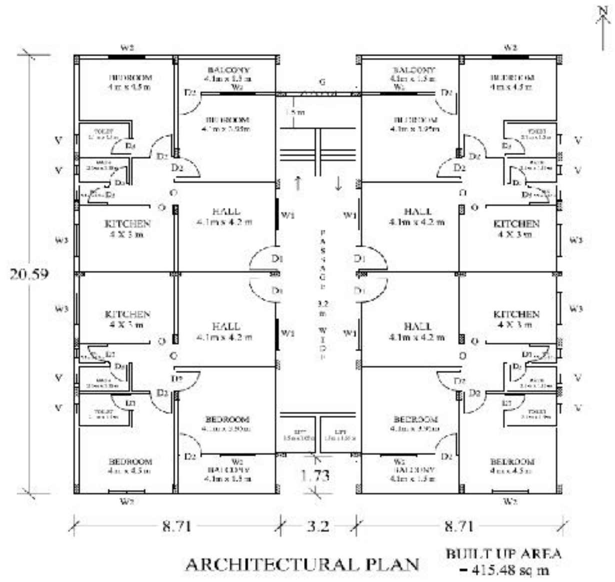

Fig. 1. Floor Plan of the Structure

In the G+10 building common parameter we consider as follows

3.1. Load applied

1. Dead load = wall load (19 KN/m3)
2. live load = 3 KN/m2
3. floor finish = 1.5 KN/m2
4. seismic load

3.2. Seismic Load Consideration

1. Zone factor = 0.16
2. Response reduction factor (RF) = 5 (Special RC Moment Resisting Frame)
3. Importance factor = 1

3.3. Other Parameters

1. Soil type = hard soil
2. Structure type = RC Frame Building
3. Damping Ratio = 0.05%

3.4. Load Combinations used

1. 1.5 (DL + IL)
2. 1.2(DL + IL+ EL)

3. 1.2(DL + IL – EL)
4. 1.5(DL + EL)
5. 1.5(DL – EL)
6. 0.9DL +1.5 EL

IV. ANALYSIS AND DESIGN

The Building is Analyzed and Designed according to Indian Standard Codes and details of the same is Given below.

4.1. Design of Beam

Sample Design of Beam 81 is given below.

```
B E A M  N O.    81  D E S I G N  R E S U L T S

M30               Fe500 (Main)           Fe415 (Sec.)

LENGTH:  2975.0 mm    SIZE:   230.0 mm X  450.0 mm   COVER: 25.0 mm

                 SUMMARY OF REINF. AREA (Sq.mm)
```

SECTION	0.0 mm	743.7 mm	1487.5 mm	2231.2 mm	2975.0 mm
TOP REINF.	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	164.22 (Sq. mm)
BOTTOM REINF.	164.22 (Sq. mm)	219.04 (Sq. mm)	225.39 (Sq. mm)	164.22 (Sq. mm)	164.22 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	743.7 mm	1487.5 mm	2231.2 mm	2975.0 mm
TOP REINF.	2-12i 1 layer(s)	2-12i 1 layer(s)	2-12i 1 layer(s)	2-12i 1 layer(s)	3-12i 1 layer(s)
BOTTOM REINF.	3-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)
SHEAR REINF.	2 legged 8i @ 140 mm c/c	2 legged 8i @ 140 mm c/c	2 legged 8i @ 140 mm c/c	2 legged 8i @ 140 mm c/c	2 legged 8i @ 140 mm c/c

Fig. 4.1. Sample Design of Beam

4.2. Design of Column

Sample Design of Column 1 is given below.

```
C O L U M N  N O.    1 D E S I G N  R E S U L T S

M30               Fe500 (Main)           Fe415 (Sec.)

LENGTH:  3000.0 mm  CROSS SECTION:  500.0 mm X  500.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    5 END JOINT:     1  SHORT COLUMN

REQD. STEEL AREA    :      2200.00 Sq.mm.
REQD. CONCRETE AREA:   247800.00 Sq.mm.
MAIN REINFORCEMENT : Provide  20 - 12 dia. (0.90%,   2261.95 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   4170.30   Muz1 :    115.96   Muy1 :    115.96

INTERACTION RATIO: 0.97 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:    13
END JOINT:     1 Puz :   4192.69   Muz :    120.05   Muy :    120.05   IR: 0.9
```

Fig. 4.2. Sample Design of Column

4.3. Design of Shear Wall

Sample Shear Wall Design is given below.

```
PANEL  NO.   1 OF SHEARWALL      5  DESIGN PER IS 456-2000

WIDTH :        1.90 M              FC :            30.00 MPA
HEIGHT :       3.00 M              FY :           500.00 MPA
THICKNESS : 230.00 MM              CONC. COVER :  25.000 MM

REINFORCING SUMMARY (REBAR SPACING/AREA UNITS: MM/MM^2)
===========================================================================
LEVEL    GOV.LOAD   LEFT EDGE      HORIZONTAL       VERTICAL        RIGHT EDGE
(M)      NO. FOR    AREA                                            AREA
         L. E. R.
         HOR.       RATIO          RATIO            RATIO           RATIO
         VER.
         R. E. R.  (MIN. RATIO)   (MIN. RATIO)     (MIN. RATIO)    (MIN. RATIO)
         LINK                      HOR. LINK        VER. LINK
---------------------------------------------------------------------------
-2.70        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 126.67    2 - DIA 12
             3        0.000                                        226.284
            13     0.00000        0.00100          0.00403         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-2.40        0     0 - DIA  0    DIA  8@ 218.00  DIA 10@ 228.00    2 - DIA 12
             3        0.000                                        226.284
            13     0.00000        0.00100          0.00360         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-2.10        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 190.00    2 - DIA 12
             3        0.000                                        226.284
            13     0.00000        0.00100          0.00288         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-1.80        0     0 - DIA  0    DIA  8@ 218.00  DIA 10@ 450.00    2 - DIA 12
             3        0.000                                        226.284
             5     0.00000        0.00100          0.00210         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-1.50        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 450.00    2 - DIA 12
             3        0.000                                        226.284
             3     0.00000        0.00100          0.00134         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-1.20        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 450.00    2 - DIA 12
             3        0.000                                        226.284
             3     0.00000        0.00100          0.00134         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------

-0.90        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 450.00    2 - DIA 12
             3        0.000                                        226.284
             3     0.00000        0.00100          0.00134         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-0.60        0     0 - DIA  0    DIA  8@ 218.00  DIA  8@ 450.00    2 - DIA 12
             3        0.000                                        226.284
             3     0.00000        0.00100          0.00134         0.00067
             3   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
-0.30        3     2 - DIA 12    DIA  8@ 218.00  DIA  8@ 450.00    2 - DIA 12
             3      226.284                                        226.284
             3     0.00065        0.00100          0.00134         0.00067
             4   ( 0.00000)      ( 0.00200)       ( 0.00120)      ( 0.00000)
                                  NOT REQUIRED     NOT REQUIRED
---------------------------------------------------------------------------
NOTE :
ALL HEIGHTS ARE IN LOCAL COORDINATE SYSTEM OF THE SURFACE.
NUMBER OF REINFORCING LAYERS IN EACH DIRECTION : 2
HORIZONTAL AND VERTICAL REINFORCING IS PER LAYER.
REINFORCING DISTRIBUTION BETWEEN LAYERS IS 50/50.
CENTROID OF EDGE REBAR ASSUMED AT 0.8 WALL WIDTH FROM COMPRESSION EDGE.

*******************END OF WALL PANEL DESIGN RESULTS*******************
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Fig. 4.3. Sample Design of Shear Wall

V. RESULTS AND DISCUSSION

Results of Various Parameters are Discussed below.

5.1. Bending Moment along Z Direction

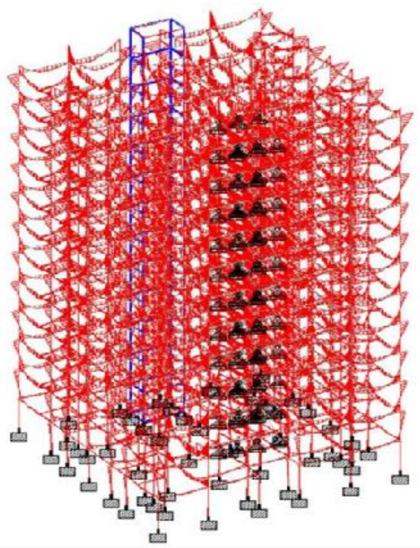

Fig. 5.1. Bending Moment Along Z Direction

5.2. Stress and Platesalong Mx and My

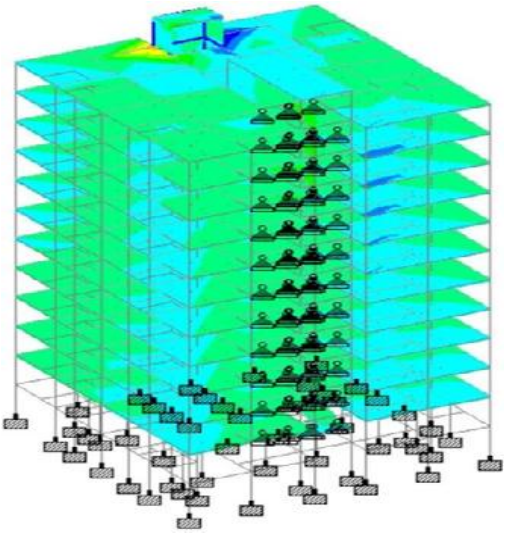

Fig. 5.2. Stress and Plates along Mx and My

5.3. Beam Stress

Beam Stress Results is Described below.

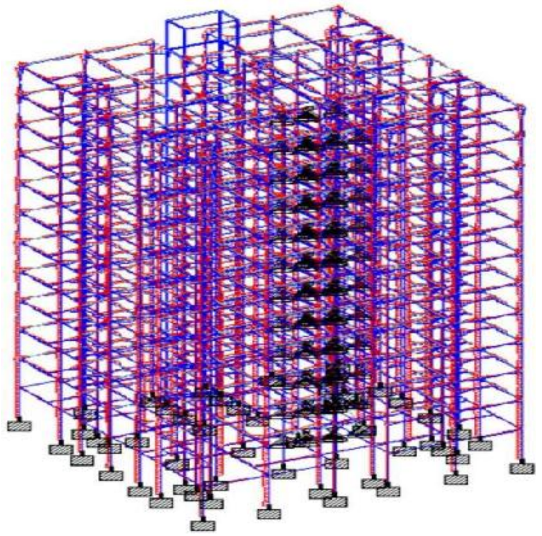

Fig. 5.3. Beam Stress Results

5.4. Comparison of Maximum Bending Moment

Comparison of Maximum Bending Moment is given below.

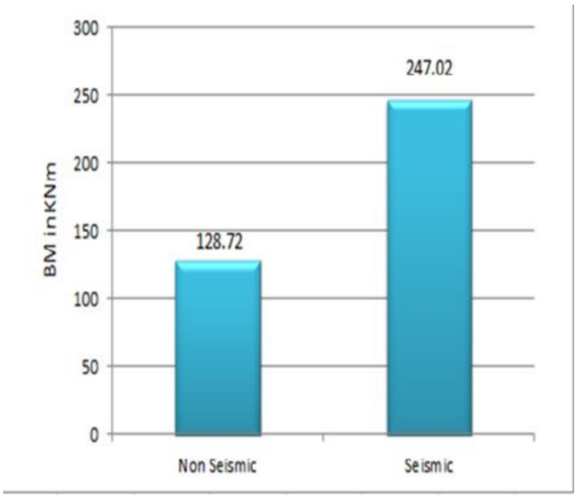

Fig. 5.4. Maximum Bending Moment

5.5. Comparison Maximum Shear Force

Comparison of Maximum Shear Force is given below.

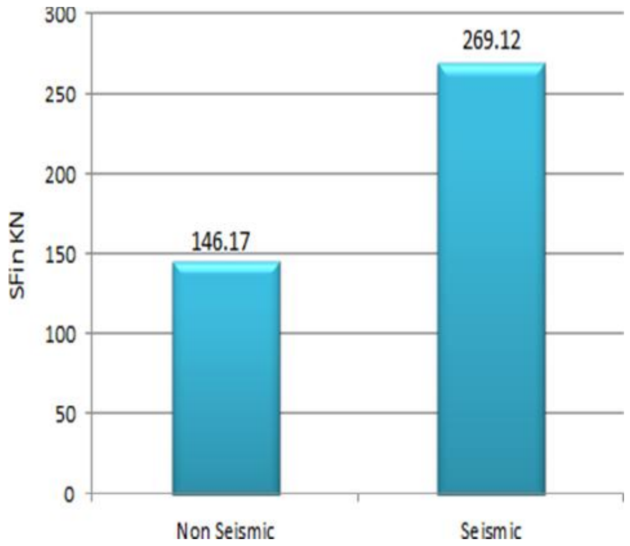

Fig. 5.5. Maximum Shear Force

5.6. Comparison of Maximum Axial Force

Comparison of Maximum Axial Force is given below.

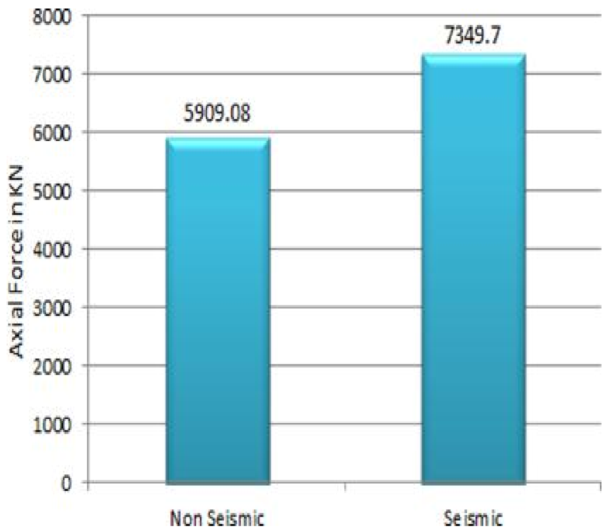

Fig. 5.6. Maximum Axial Force

VI. CONCLUSION

- It is concluded that STAAD pro package is suitable for the design of multi storied building.
- The default design output of the beam contains flexural and shear reinforcement along the length of the beam.
- To restrain the additional seismic loads of the structure, relevant design method is to be adapted like using seismic design strategies and devices in the construction.
- Columns are designed for axial forces and biaxial moments at the ends. The loading which yields maximum

reinforcement is called the critical load. Column design is done for rectangular section.

- Rectangular column is designed with reinforcement distributed on each side equally for the section under biaxial moments and reinforcement distributed equally in two faces for section under uniaxial moment.

VII. AKNOWLEDGEMENT

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