ANALYSIS OF G+6 BUILDING IN DIFFERENT SEISMIC ZONES OF INDIA USING METHOD OF STATIC ANALYSIS

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Abstract: *There is a large portion of India which is affected by damages caused by earthquake. So it is necessary to consider seismic load in design of structure. From the recent earthquakes it is concluded that not only non-engineered but also the engineered structure is affected by earthquake. The main objective of this analysis work is to analyze and design G+6 building in three dimensions for different seismic zones of India using STAAD Pro. In this work whole structure is analyzed including load calculation using STAAD Pro. Limit state method of design adopted in whole analysis work. IS 1893:2002 used for seismic analysis and detailing. A regular RCC framed structure for 7 floors i.e. G+6 is designed. The focus of the research paper is to analyze the structure in different seismic zones by the method of static analysis.*

Keywords: STAAD Pro; Lateral Forces; Aftershock; Seismic zone; Special Moment Resistant Frame

1 INTRODUCTION

Earthquake- Earthquake is the process of shaking of earth which causes more or less destruction to life's of human being earthquake is the disturbance which is occurred naturally. It occurs due to release of elastic energy which causes sudden motion of earth i.e. ground in few seconds. It is an unpredictable activity which affects a large area. It causes large destruction of transport, cities, villages, towns and causes loss of life. Earthquake engineering is the branch of engineering in which we are studying the harmful effects of earthquake and how we reduce the damages which is caused by earthquake. To minimize the damages of earthquake it is necessary to investigate the solutions and apply it in practical operations i.e. planning, designing, constructing etc.

Physical damage- Physical damage include damage to the physical quantities i.e. structure, railway, road, pipelines, infrastructure, bridges, towers, buildings, human life etc. Aftershocks also cause major damages to those structures which is already weaken due to earthquake. Aftershocks may be defined as the small vibrations occur after the major earthquake. Some major effects of earthquake are landslides, fire, dam failure which causes flooding in the neighboring area. Due to earthquake many people lost their shelter which affect the local population of that area and also affect their standard of living, it also causes blockages of communication system.

Earthquake zones- In India earthquake occurs at different locations shows different behavior at that particular area. So to construct a building in different locations or different zones a seismic map is required to know the properties of that area. In India there are four seismic zones which is zone II, zone III, zone IV and zone V.

Seismic design approach- For tall building lateral forces are the major factors. In tall building lateral forces causes sway of structure which produces undesirable vibrations which creates undesirable stresses produces critical stresses in the structure. Sway of structure is defined as the displacement of its top surface with respect to its base. According to the scenario of seismic design people should live in the building which would not cause any type of damage in small and frequent shaking intensity and provide proper service after earthquake. The structure should be able to withstand moderate earthquake without causing any structural and non-structural damage. While designing by limit state method the earthquake forces taken for calculation is equal to stronger than past earthquake.

2. LITERATURE REVIEW

The author [1] worked on analysis of G+6 building by STAAD Pro., on the basis of assumption that lateral forces are act along gravity loads. In this paper the analysis is carried out for a residential building using STAAD Pro by static analysis method. Analysis of building of 20 stories done by [2] and every storey height taken as 3 m. **T**he main objectives of this project are- to know that how the seismic analysis of the structure should be done, to study the behavior of structure under the action of wind and seismic load and to compare the results obtained by analysis of building in different zones using ETABS. In this project they analyze the building of 20 stories in which height of each storey is 3m. For the whole analysis process 5 models are used to find bay length and bay width is kept constant in two horizontal directions for convenience.

In the project author [3] analyze the structure in two different conditions first is with earthquake and second is without earthquake. In this paper they calculate earth load and gravity load manually according to IS1893-2000. This study shows behavior and changes in steel quantity for the whole structure in different seismic zones of India using STAAD Pro. By this software they calculate bending moment and shear force for beams and axial load in column and compared the axial load in different seismic zones of India.

In the project the author [4] uses four different shapes of same area in a multistory building using a computer software ETABS follows IS-875-Part 3 and IS-1893-Part 1. In this paper they studied the building with 15, 30, 35 stories. Parameters which affect high rise building are displacement, base shear, overturning moment, acceleration and time period are well studied and calculated. The main purpose of the study carried by [5] on STAAD Pro and ETABS used for analysis and design of rectangular plan with regular and irregular plan which include vertical geometry irregular multistory building. This study is used to find out advantages of ETABS over STAAD Pro. It is observed that ETABS software is easy to operate gives more accurate results than STAAD Pro and many more advantages of ETABS over STAAD Pro is discussed in their paper. In the paper author [6] find that the behavior of G+11 multistory building for a regular and irregular building is very difficult to understand and wind loads are assumed to act simultaneously with earthquake loads. For the analysis purpose they use software STAAD Pro and ETABS. For this study it is assumed that behavior of material is linear and both static and dynamic analysis is carried out in this process. This study is carried out in different seismic zones of India and for each zone three different soil conditions are taken which is hard soil, medium soil, and soft soil.

3. METHODOLOGY

The analysis of seismic forces is carried out on the basis of assumption that the lateral forces are act along gravity load. In this project we are analyzing an existing building in different seismic zones of India by using STAAD Pro V8i. For the whole analysis process is followed by IS1893-2002.

Table 1. Showing detailing of building structure

Sl. No.	Particular	Input Value
1	Length of building	30 m
2	Width of building	20 m
3	Height of building	21 m
4	Height of each floor	3 m
5	Total number of floor	7

Table 2. Showing detailing of beam, column and slab

S.no.	Particular	Zone II	Zone III	Zone IV	Zone V
1	Size of beam	0.5 m x 0.3 m	0.50 m x 0.35 m	0.60 m x 0.45 m	0.60 m x 0.50 m
2	Size of column	0.5 m x 0.5 m	0.45 m x 0.45 m	0.50 m x 0.50 m	0.60 m x 0.50 m
3	Thickness of slab	0.100 m	0.115 m	0.115 m	0.150 m

Table 3. Values adopted for seismic calculation at different seismic zones

1.	Zone factor for Zone II	0.10
2.	Zone factor for Zone III	0.16
3.	Zone factor for Zone IV	0.24
4.	Zone factor for Zone V	0.36
5.	Response reduction factor for SMRF	5.0
6.	Important factor for all general building	1.0

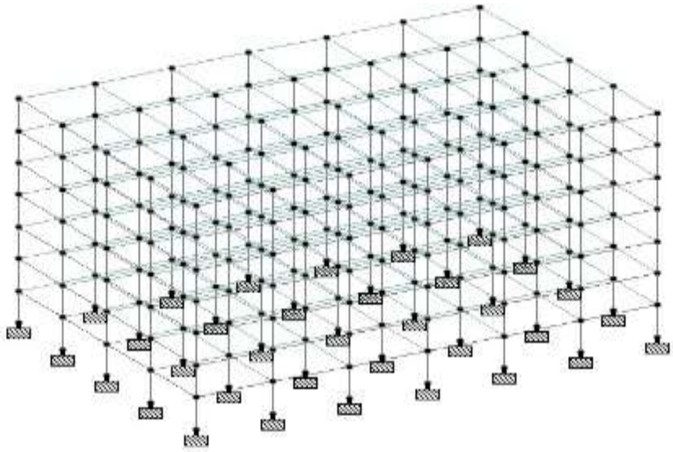

Fig 1. Isometric view of basic model

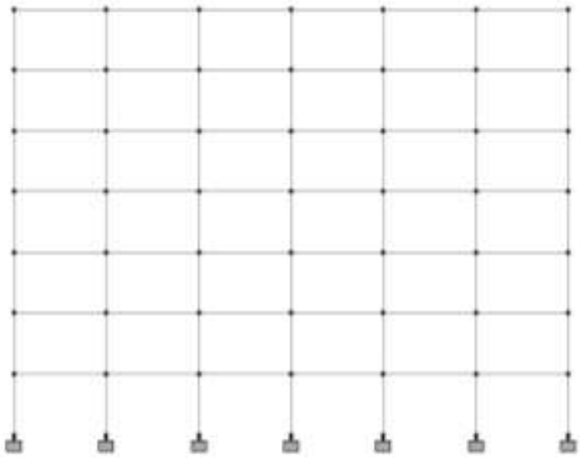

Fig 2. Front view of basic model

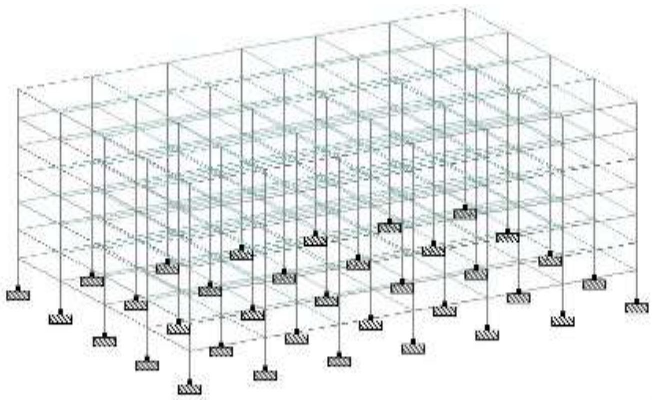

Fig 3. Isometric view of model with support

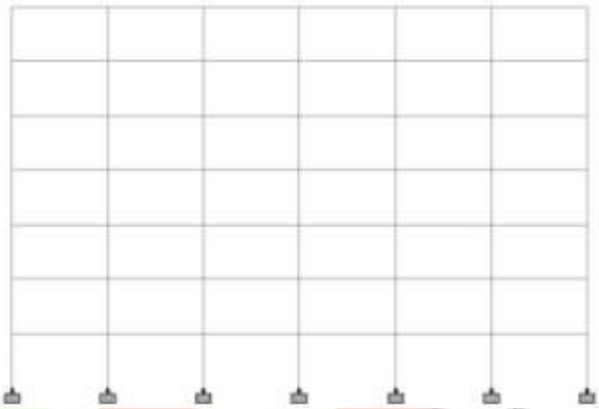

Fig 4. Front view of model with support

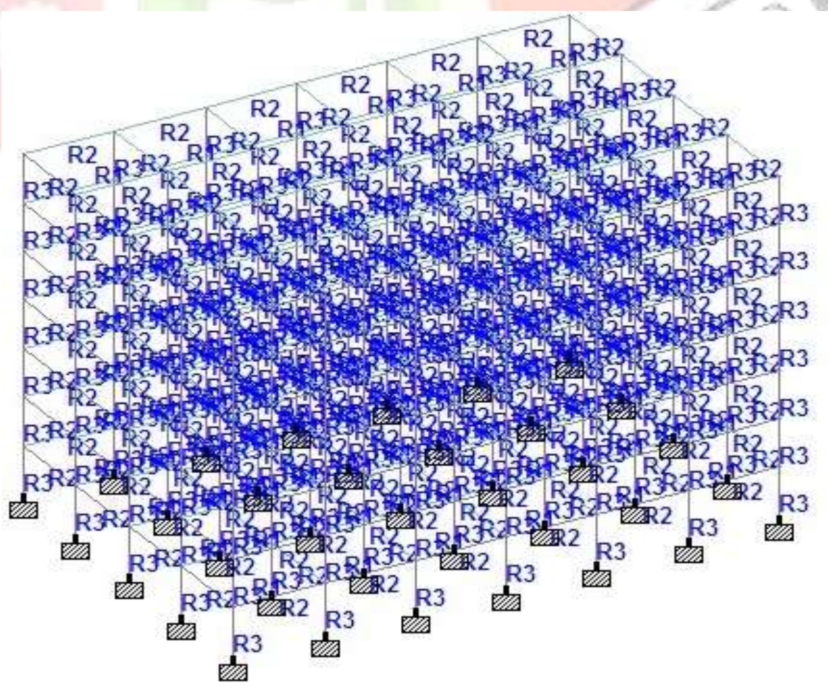

Fig 5. Isometric view of model showing beam, column and slab

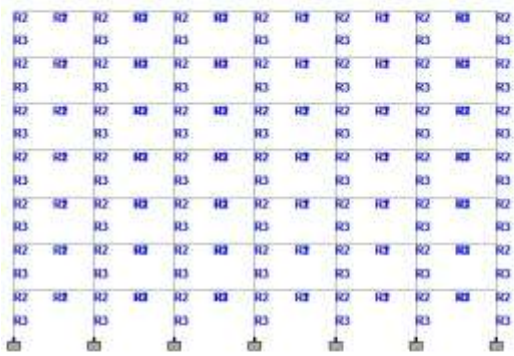

Fig 6. Front view of model showing beam, column and slab

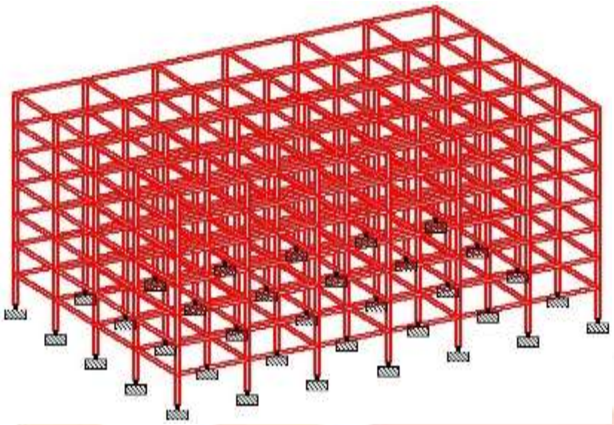

Fig 7. Structure showing beam in X and Z direction and column in Y direction

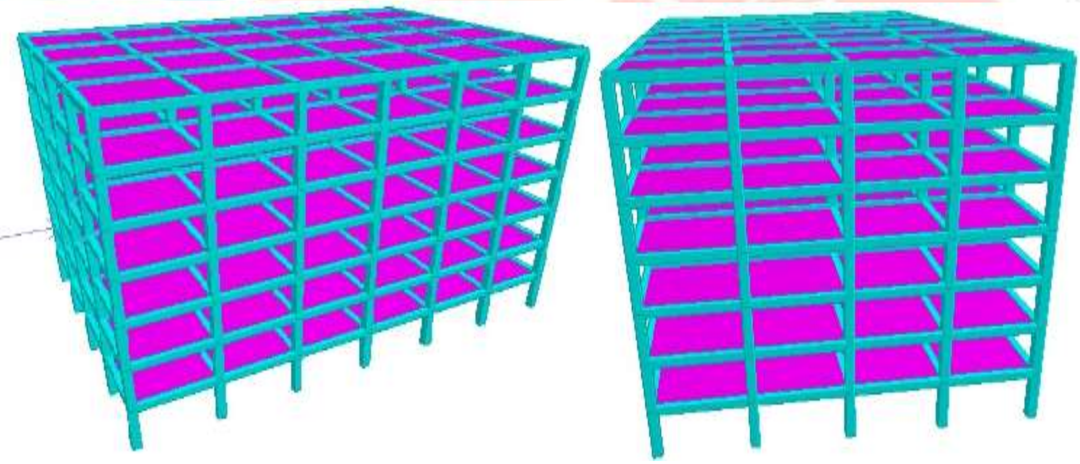

Fig 8. Showing 3D rendered view of the whole G+6 Building structure

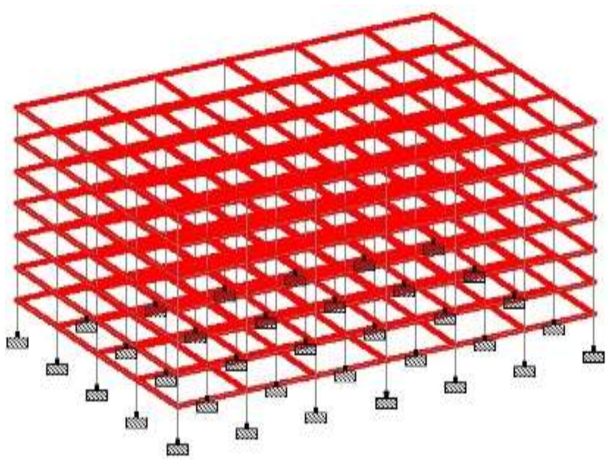

Fig 9. Building structure showing slab in x and z direction

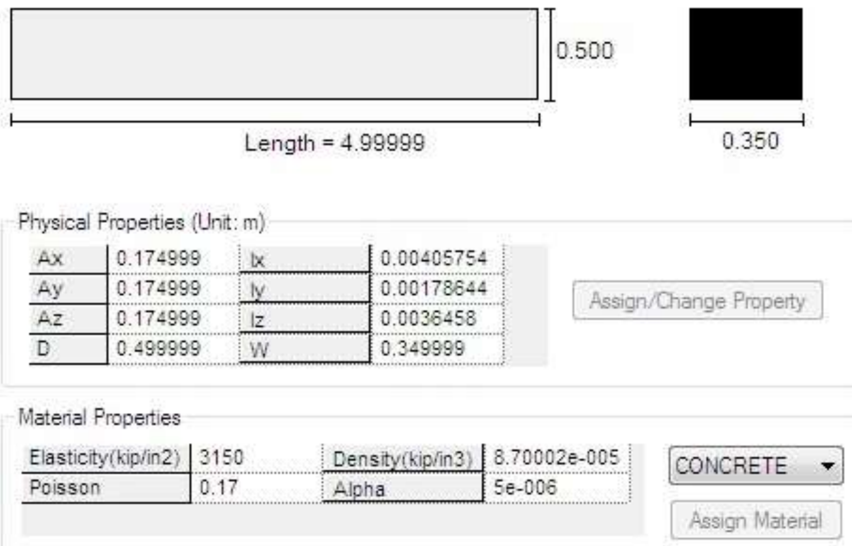

Fig 10. Showing various properties of beam used for analysis

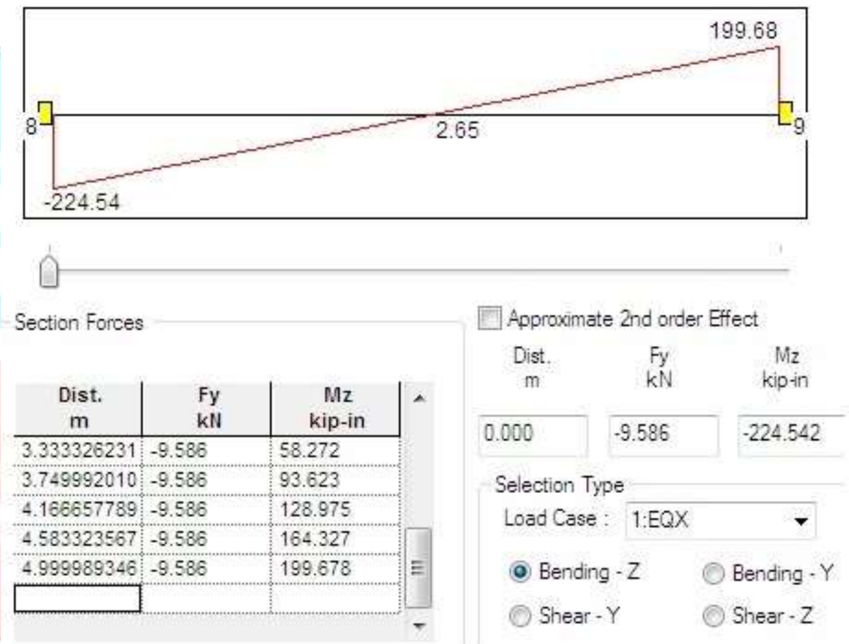

Fig 11. Showing shear force and bending moment in a beam

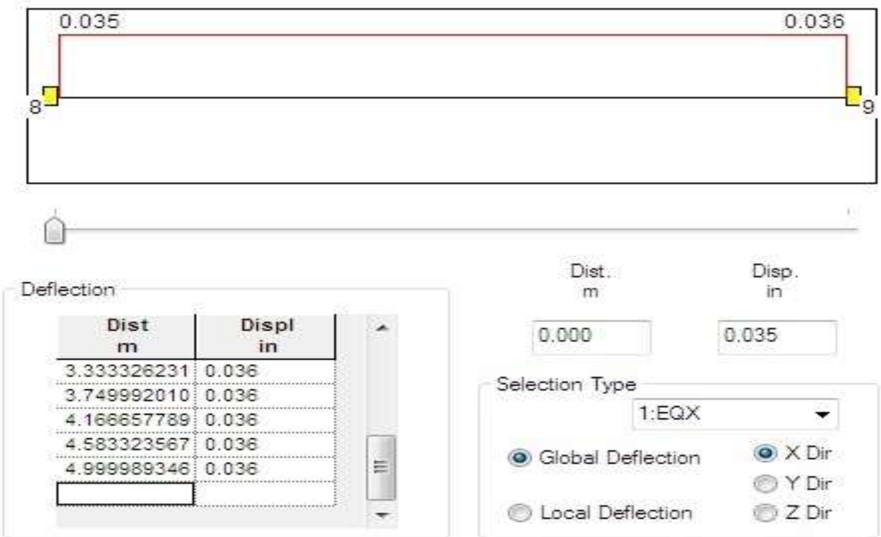

Fig 12. Figure showing deflection in x-direction in a beam

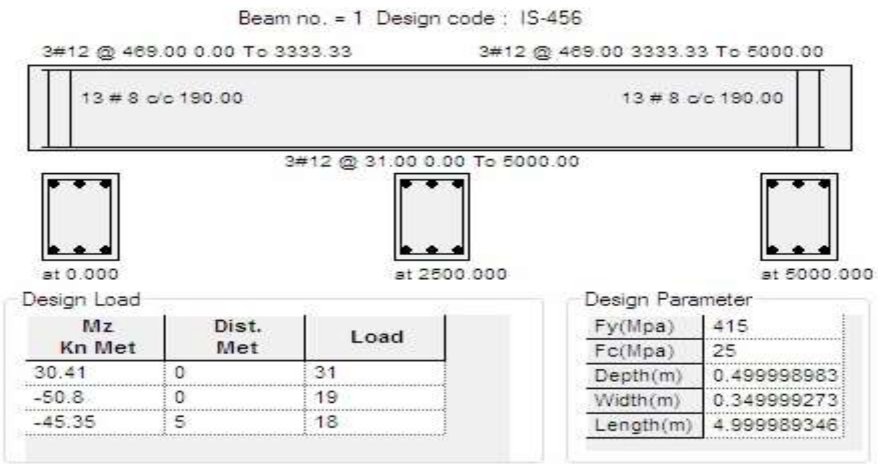

Fig 13. Showing reinforcement detailing in a beam

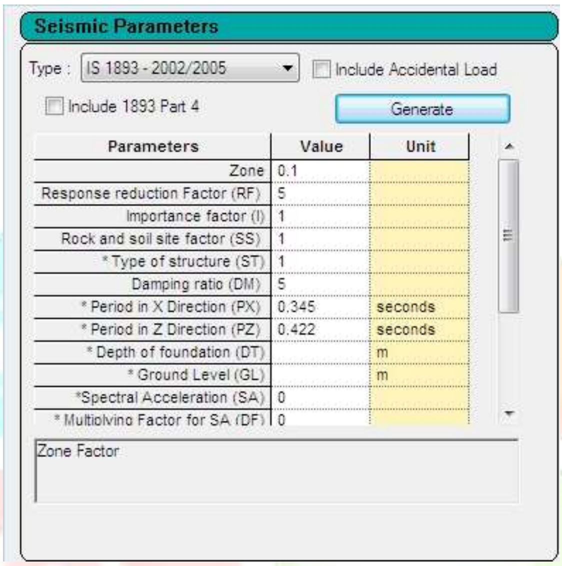

Fig 14. Showing seismic parameter for Zone II

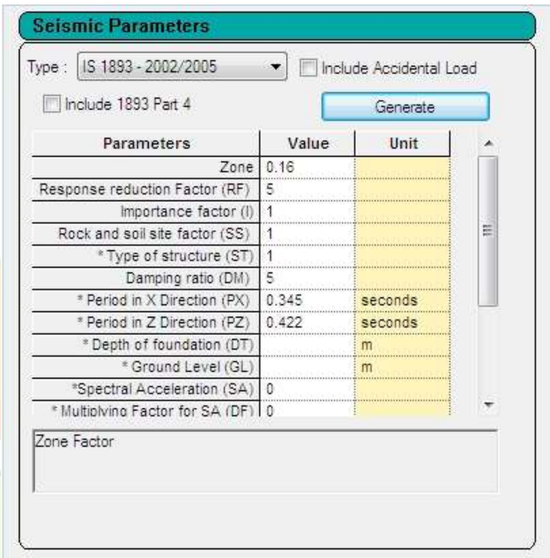

Fig 15. Showing seismic parameter for Zone III

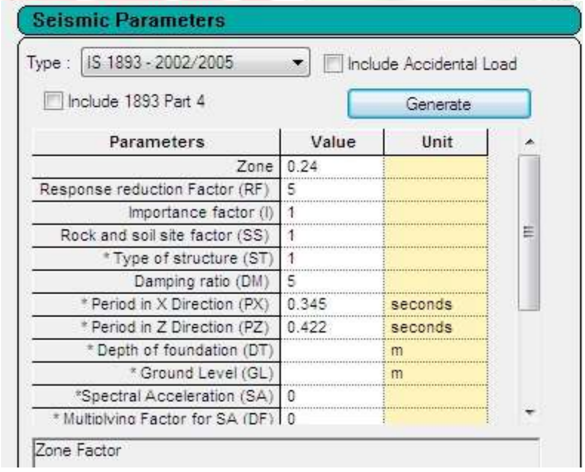

Fig 16. Showing seismic parameter for Zone IV

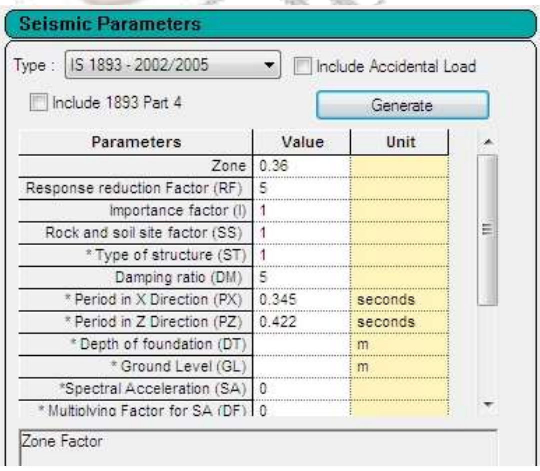

Fig 17. Showing seismic parameter for Zone V

Period in X direction can be calculated as **P=0.09 x h / √ d**

Where h= height of building = 21m
D= length in X and Y direction i.e. length and width of building
For X direction take d=30m and for Y direction take d=20m
P for x direction = 0.09*21/√30 = 0.345
P for Y direction = 0.09*21/√20= 0.422

4. RESULT

Volume of concrete and weight of steel required for the design of G+6 building using STAAD Pro obtained for different seismic zone. Table 4 shows the volume of concrete in cubic meter whereas Table 5 shows weight of steel in Newton obtained using STAAD Pro for different seismic zone. Fig. 18 shows the graph for volume of concrete in cum whereas Fig. 19 shows the graph for weight of steel in Newton used for design of G+6 building using STAAD Pro.

Table 4. Volume of concrete in cum obtained using STAAD Pro for different seismic zone of G+6 building

Sl. No.	Zone	Volume of concrete in cum
1	Zone II	488.3
2	Zone III	504.1
3	Zone IV	731.9
4	Zone V	829.5

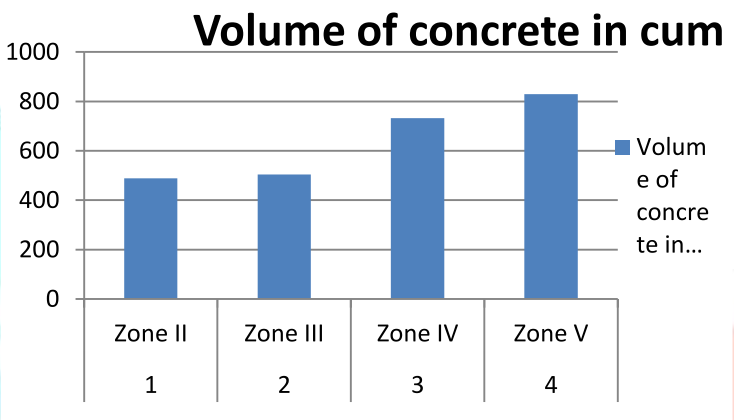

Fig 18. Volume of concrete in cum obtained using STAAD Pro for different seismic zone of G+6 building

Table 4. Weight of steel in Newton obtained using STAAD Pro for different seismic zone of G+6 building

Sl. No.	Zone	Weight of steel in Newton
1	Zone II	311543
2	Zone III	300385
3	Zone IV	410576
4	Zone V	533215

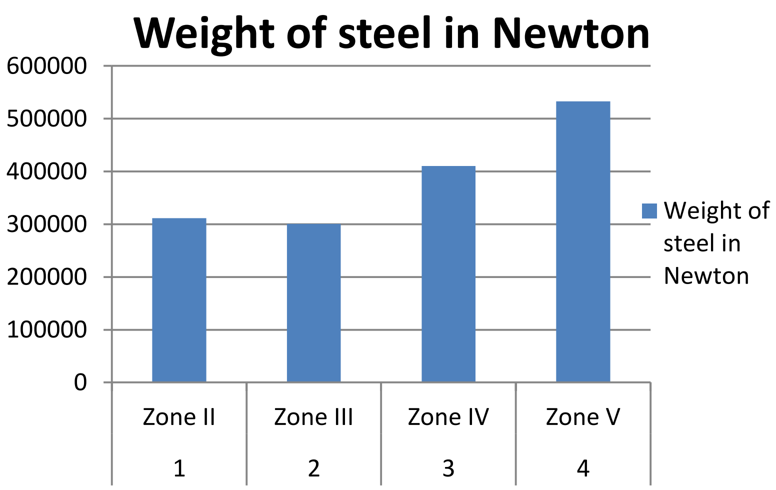

Fig 19. Weight of steel in Newton obtained using STAAD Pro for different seismic zone of G+6 building

5. CONCLUSION

From the above analysis work and result obtained from STAAD Pro, it was found that:

1. Steel changes drastically from Zone II to Zone V i.e. it increases from Zone II to Zone V.
2. Support reactions are increasing from Zone II to Zone V.
3. Volume of concrete is also increasing from Zone II to Zone V due to increase in support reaction.
4. Shear force and bending moment zero at central span for all zones.
5. Deflection of beam is constant.

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