PERFORMANCE BASED EVALUATION OF RCC STRUCTURE WITH CRESCENT BRACES

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ABSTRACT- Earthquake is extremely common in all parts of the world Geographical statistics from India show that almost 55% of the land is susceptible to disasters. A performance-based analysis is designed to control structural damage based on accurate estimates of appropriate response parameters. The performance seismic design specifically assesses how a building is likely to perform, given its potential hazard, in view of uncertainties related to the quantification of potential hazards and un safety in the assessment of the real response of the building. The process begins with the choice of performance targets, followed by the development of a preliminary design, assesses whether the design is or not fulfilling the performance targets, and then redesigns and re-evaluates if necessary to achieve the desired level of performance. Performance based seismic design is an elastic design methodology based on the relationship of non-linear stress to building performance under the various lateral forces.

The CSB is a unique hysteretic lateral resisting device that provides additional design freedom to frame structures.For a specific building, the vertical resisting system is typically designed for the static loads and most likely is not characterized by a lateral force–displacement curve close to the desired seismic ''objective curve''. Thus, in order to translate the desired ''objective curve'' into the actual structural response, a specific bracing system should be added, capable of independently matching the required properties in terms of stiffness, strength and ductility. Common bracing devices (i.e. concentric stiff diagonal elements) do not usually allow to independently designing these three properties. Although many studies have been carried out on special typologies of steel bracing elements

The current study analyzes response spectrum analysis for RCC building G+10 and G+20 stories with crescent brace, that is assumed to be located in Zone IV to understand the building's seismic behavior effect and performance level. The result of Pushover analysis is a Pushover curve showing the building component performance levels and maximum building load capacity. The result is that the demand curve intersects the capacity curve from point B to C. Thus, residual strength and rigidity remain in all the stories. Mostly in the beams and a few in the columns were developed but had limited damage.

Keywords: *performance based design, crescent brace, response spectrum analysis, sap2000*

1. INTRODUCTION

A braced frame is a structural system generally utilized in structures subject to horizontal loads, for example, wind and seismic weight. The individuals in a supported casing are commonly made of basic steel, which can work adequately both in pressure and pressure.

The bars and sections that structure the casing convey vertical burdens, and the supporting framework conveys the parallel burdens. The situating of supports, be that as it may, can be dangerous as they can meddle with the plan of the façade and the situation of openings. Structures receiving cutting edge or post-pioneer styles have reacted to this by communicating propping as an interior or outer plan highlight.

Crescent Shaped Braces

The Crescent Shaped Brace (CSB) is a lateral hysteretic resisting steel device composed of two straight members which are connected with a specific angle. Its peculiar shape can be "ad hoc" defined in order to assess an independently desired behavior in terms of both lateral stiffness and yielding strength, on the contrary of common bracing devices, where these two parameters are dependent.

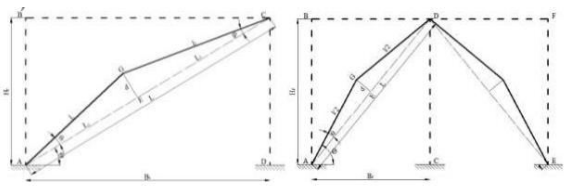

Fig1 : Geometry of CSBs inserted in a frame: (Left) bilinear configuration; (Right) doubly symmetrical configuration

The CSB devices can be inserted in a frame either in a bilinear configuration or in a doubly symmetrical configuration as shown in Fig.1.The geometrical characterizations of the frame are the following: Bf is the frame width. Hf is the frame height. L is the length of the diagonal of the frame or the projection of the CSB. Θ is the inclination of the reference diagonal. θ is the inclination of the elements of the CSB in reference to the diagonal. l1 and l2 are respectively the length of the two elements of the device (in the study presented here, l1= l2= l). d, referred to as "arm", is the orthogonal distance between the knee point G and the reference point E on the diagonal line.

SAP 2000 Software

SAP2000 is general-purpose civil-engineering software ideal for the analysis and design of any type of structural system. Basic and advanced systems, ranging from 2D to 3D, of simple geometry to complex, may be modeled, analyzed, designed, and optimized using a practical and intuitive object-based modeling environment that simplifies and streamlines the engineering process. The SAPFire ® Analysis Engine integral to SAP2000 drives a sophisticated finite-element analysis procedure. An additional suite of advanced analysis features are available to users engaging state-of-the-art practice with nonlinear and dynamic consideration. Created by engineers for effective engineering, SAP2000 is the ideal software tool for users of any experience level, designing any structural system.

Integrated modeling templates, code-based loading assignments, advanced analysis options, design-optimization procedures, and customizable output reports all coordinate across a powerful platform to make SAP2000 especially useful for practicing professionals.

Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of building by using IS 1893:2002
2. To design the earth quake resistant structure by using steel bracings in zone V.
3. To compare the results of lateral load, shear, bending, torsion, base shear, time period and frequency values.
4. To study the multi story buildings of G+10 and G+20 in SAP 2000 V19 by using response spectrum analysis analysis.

2. LITERATURE REVIEW

Jayaram Nayak B[1], Kiran Kamath[2], Avinash A R[3] et al.,(2018) The present investigation centers around seismic execution of three dimensional propped steel edge structures by fluctuating stature of bracings in edge structure. The supports have been connected in three levels: one story propping, two story propping and three story bracings. From this investigation it was presumed that, angle proportion of one demonstrate a superior seismic presentation when contrasted and rest of the models considered. All propped casing structures have demonstrated better seismic execution when contrasted with uncovered casing structure.

Mohd Mubeen[1], Khalid Nayaz Khan[2],Mohammed Idrees Khan[3], et al.,(2015) In this proposal, the nonlinear weakling investigation is done for skyscraper steel edge working with various examples of unconventional propping frameworks. From this examination it was reasoned that the relocation of the steel exposed edge model can be leveled out by Special Moment Resisting Frame, for example, steel propping as a parallel burden opposing framework. The base power has impressively expanded and the relocation has diminished.

Santosh shet[1], Dr.Akshatha shetty[2], et al.,(2017) In the present investigation, carbon steel casings are chosen in view of its high quality and carbon steel is regularly utilized in steel outline development in India. Displaying of the steel outline under the push over examination utilizing Seismo struct programming and the outcomes so got has been thought about. From this paper it was presumed that Target dislodging is less if there should arise an occurrence of weakling stacking is in X heading for higher base shear and more in the event of sucker stacking in Y bearing for little base shear steel structure displayed with 'I' area.

3. METHODOLOGY USED

3.1 RESPONSE SPECTRUM ANALYSIS

This method is also known as modal method or mode superposition method. It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own modal damping.

According to IS-1893(Part-l):2002, high rise and irregular buildings must be analyzed by response spectrum method using design spectra shown in Figure 4.1. There are significant computational advantages using response spectra method of seismic analysis for prediction of drifts and member forces in structural systems. The method involves only the calculation of the maximum values of the drifts and member forces in each mode using smooth spectra that are the average of several earthquake motions. Sufficient modes to capture such that at least 90% of the participating mass of the building (in each of two orthogonal principle horizontal directions) have to be considered for the analysis. The analysis is performed to determine the base shear for each mode using given building characteristics and ground motion spectra. And then the Storey forces, accelerations, and drifts are calculated for each mode, and are combined statistically using the SRSS combination.

However, in this method, the design base shear (V_B) shall be compared with a base shear (V_b) calculated using a fundamental period T. If V_B is less than V_b response quantities are (for example member forces, drifts, Storey forces, Storey shears and base reactions) multiplied by V_B/V_b Response spectrum method of analysis shall be performed using design spectrum. In case design spectrum is specifically prepared for a structure at a particular project site, the same may be used for design at the discretion of the project authorities. Figure 4.1 shows the proposed 5% spectra for rocky and soils sites.

3.2 MODAL COMBINATION

Modal Response quantities (member forces, drifts, Storey forces, Storey shears and base reactions) for each mode of response may be combined by the complete quadratic combination (CQC) technique or by taking the square root of the sum of the squares (SRSS) of each mode of the modal values or absolute sum (ABS) method.

(i) CQC METHOD:

The peak response quantities shall be combined as per the complete quadratic combination (CQC) method.

$$\lambda = \sqrt{\sum_{i=1}^{r}\sum_{j=1}^{r} \lambda_i \, \rho_{ij} \, \lambda_j}$$

Where

r= Number of modes being considered

ρ_{ij} = *Cross – modal coefficient*

λ_i =*Response quantity in mode I (including sign)*

λ_j=*Response quantity in mode j (including sign)*

$$\rho_{ij} = \frac{8\zeta^2(1+\beta)\beta^{1.5}}{(1+\beta)^2 + 4\zeta^2\beta(1+\beta)^2}$$

β = Modal damping ratio (in fraction)

ζ = Frequency ratio =$\frac{\omega_j}{\omega_i}$

(ii) SRSS METHOD

If the building does not have closely spaced modes than the peak response quantity due to all modes considered shall be obtained as

$$\lambda = \sqrt{\sum_{k=1}^{r}(\lambda_k)^2}$$

Where

λ_k = Absolute value of quantity in mode k, and

r = Number of modes being considered.

(iii) ABS METHOD

If the building has a few closely spaced modes, then the peak response quantity due to all modes considered shall be obtained as:

$$\lambda^* = \sqrt{\sum_{c}^{r}\lambda_c}$$

Where, the summation is for the closely-spaced modes only. This peak response quantity due to the closely spaced modes (λ^*) is then combined with those of the remaining well-separated modes by the method described above.

4. MODELING OF BUILDING

Problem statement

In the present study, analysis of G+10 multi-story building in Zone V seismic zones is carried out.

Basic parameters considered for the analysis are

1. Utility of building : Residential building
2. Number of stories : G+10and G+20
3. Shape of building : Rectangular
4. Geometric details
   a. Ground floor : 3m
   b. floor to floor height : 3m
5. Material details
   a. Concrete Grad : M30 (COLUMNS AND BEAMS)
   b. All Steel Grades : HYSD reinforcement of Grade Fe415
   c. Bearing Capacity of Soil : 200 KN/m^2
6. Type Of Construction : R.C.C
7. Column : 0.8m X 0.8m
8. Beams : 0.8m X 0.46m
9. Bracings : ISMB 200
10. Slab : 0.15m
11. Seismic Zone : V
12. Seismic design code :IS 1893:2016
13. Wind design code :IS875:2015-Part3
14. RCC code :IS 456-2000

Building models in SAP2000 Software

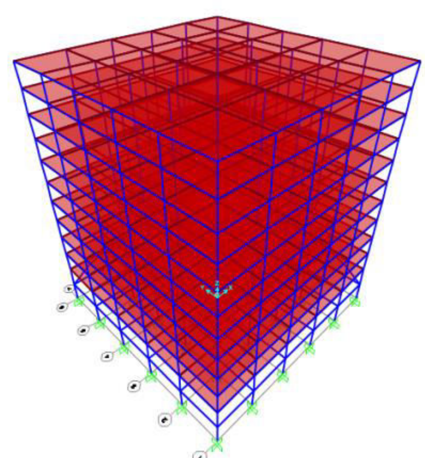

Fig 2: G+10 General Building

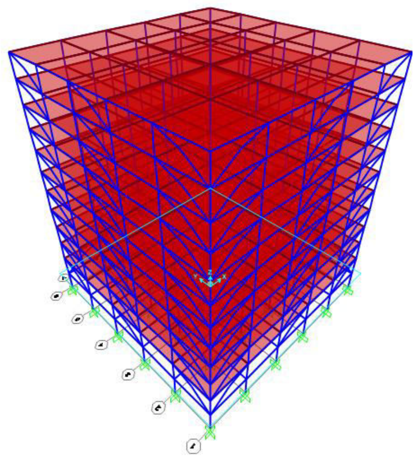

Fig 3:G+10 building with Bracings

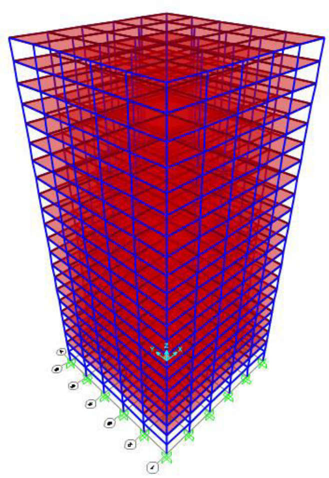

Fig 4:G+20 General Building

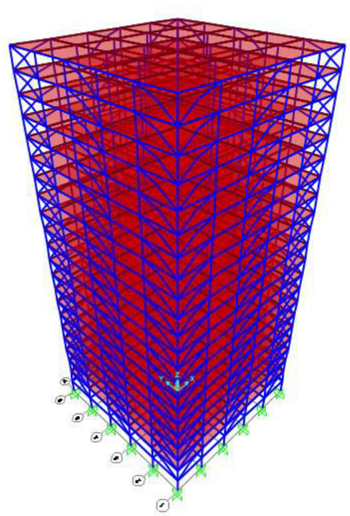

Fig 5:G+20 building with Bracings

5. RESULTS AND ANALYSIS

G+10 Building Results

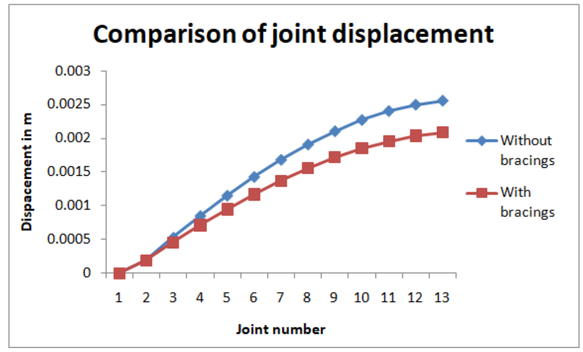

Fig 6: Comparison of joint displacement

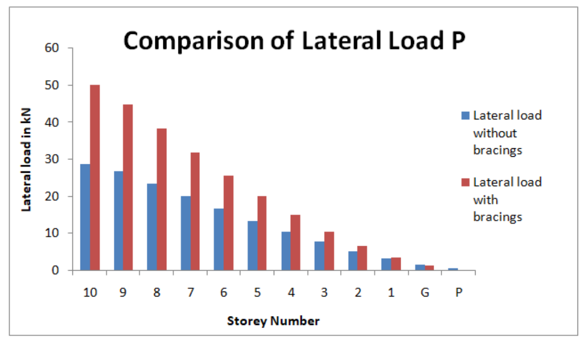

Fig 7: Comparison of lateral load P

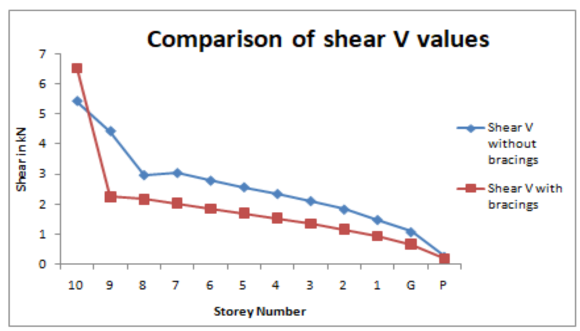

Fig 8: Comparison of Shear V Values

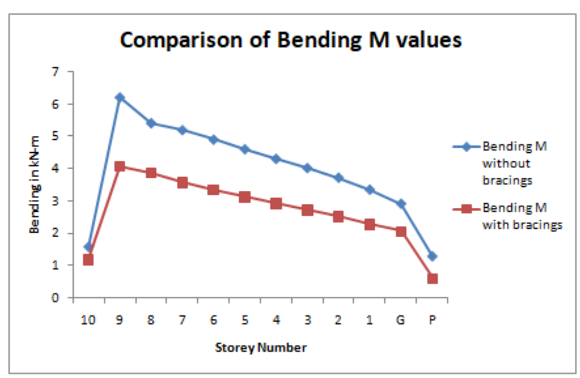

Fig 9: Comparison of Bending M Values

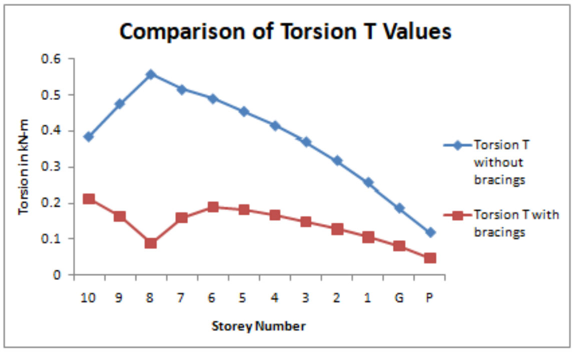

Fig 10: Comparison of torsion T Values

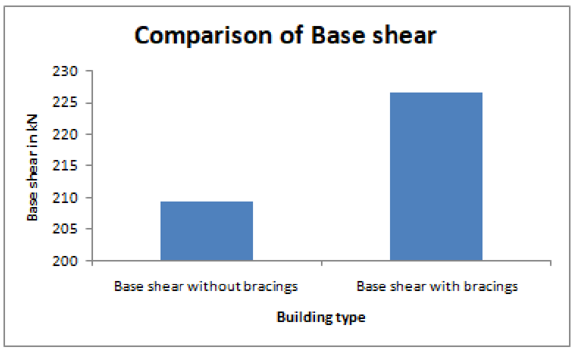

Fig 11: Comparison of Base shear values

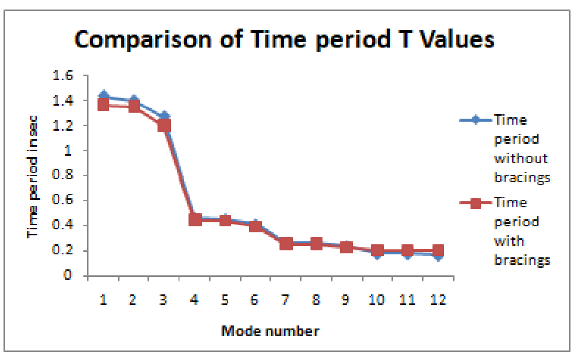

Fig 12: Comparison of time period T Values

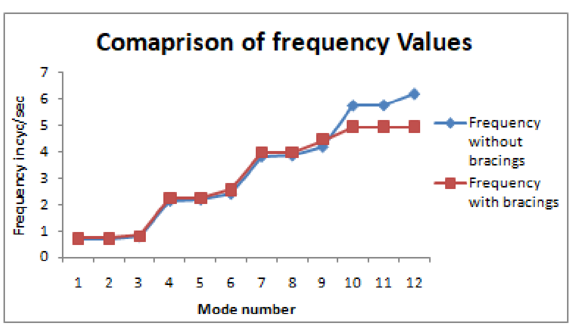

Fig 13: Comparison of frequency values

G+20 Building Results

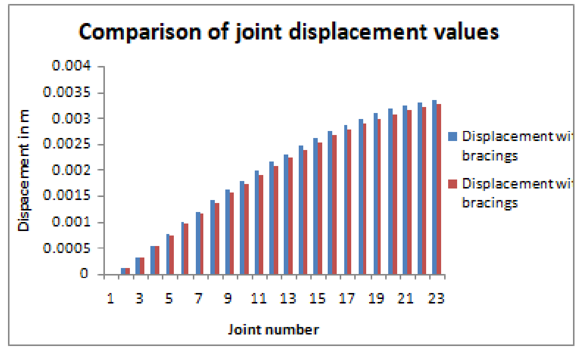

Fig 14: Comparison of joint displacement

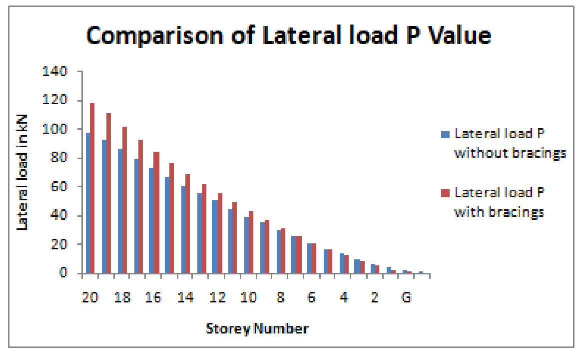

Fig 15: Comparison of lateral load P

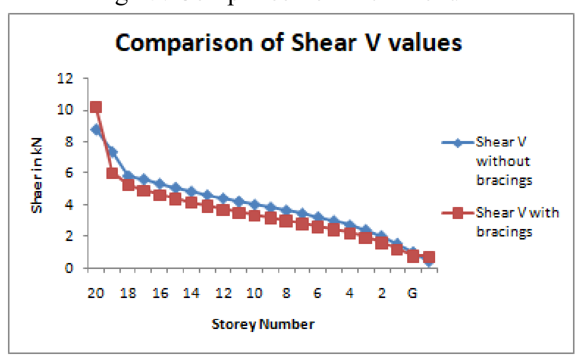

Fig 16: Comparison of Shear V Values

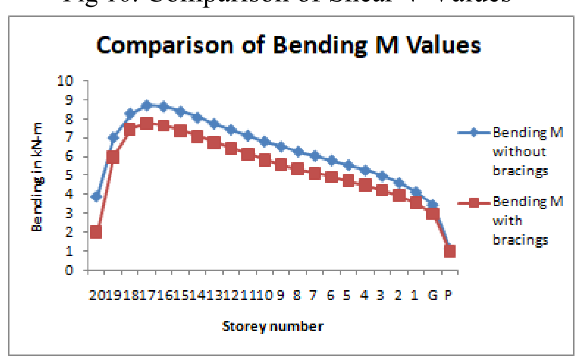

Fig 17: Comparison of Bending M Values

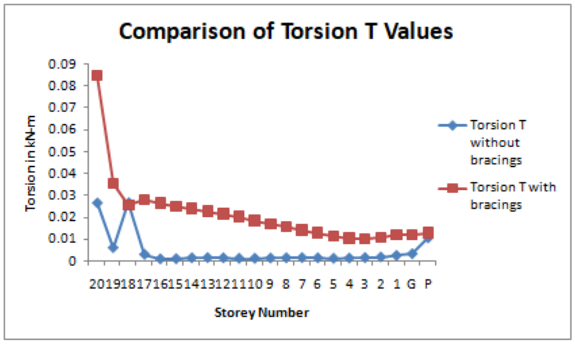

Fig 18: Comparison of torsion T Values

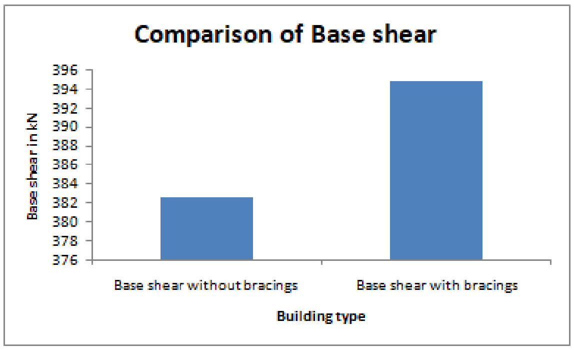

Fig 19: Comparison of Base shear values

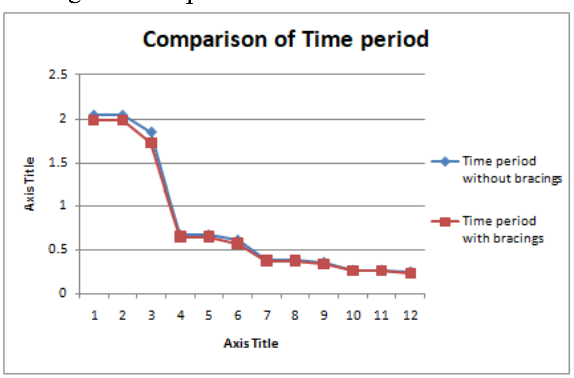

Fig 20: Comparison of time period T Values

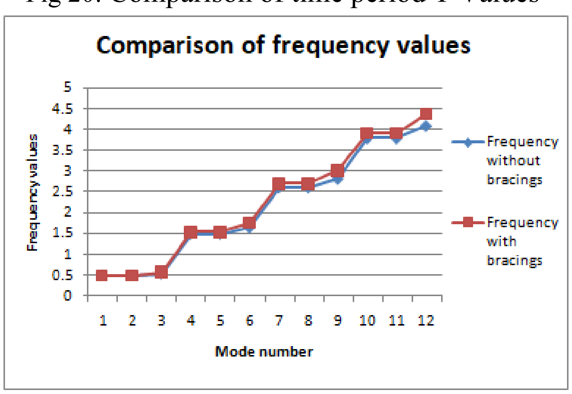

Fig 21: Comparison of frequency values

6. CONCLUSIONS

From the above study the following conclusions were made

1. By providing bracing for G+10 and G+20 buildings we can reduce the seismic load action on building and we can design the earth quack resistant structure.
2. The value of displacement in both the G+10 and G+20structure is obtained less values by providing crescent bracing systems when we compared without bracings case.
3. The value of axial load decreases from top storey to bottom storey in the both buildings (G+10 and G+20). Less intensity of axial load is seen in without bracings systems, due to the presents of extra load from the bracings the lateral load increases.
4. The intensity of shear values in both the building models of G+10and G+20 decreases from top storey to the bottom storey and the less intensity values are seen in case of crescent bracing systems when we compared without bracings case.
5. The values of bending in both the building models of G+10and G+20 decreases from top storey to the bottom storey and the less intensity values are seen in case of crescent bracing systems when we compared without bracings case.
6. The intensity of torsion in both the building models of G+10and G+20 decreases from top storey to the bottom storey and the less intensity values are seen in case of crescent bracing systems when we compared without bracings case.
7. The base shear values are obtained maximum in case of the model made with bracing systems when we compared without bracings models.
8. The value of time period decrease from node point 1 to node point 12. The maximum value is observed for building without bracings.
9. The value of frequency increase from node point 1 to node point 12. The less value is observed for building without bracings.

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