Seismic Analysis of Steel Structures with and Without Bracings in Different Seismic Zones

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***Abstract:** In the present study four G+5 steel structures were modeled without bracings and having X, V bracings and diagonal bracings with foundation depth of 2m support conditions are assumed to be pinned at the bottom or at the supports/footings, seismic loads are applied as per IS:1893-2002 The structures having length = 28.2 m, width = 17m and height = 20m. The structures modeled in STAAD.Pro structural analysis and design software by considering various loads and load combinations by their relative occurrence are considered the material properties considered are Fe250 rolled steel sections structures were considered in seismic zones 2, 3, 4 and 5 X type bracings systems are observed to better in high seismic zones.*

***Keywords** : bracings, seismic analysis, buildings*

I. INTRODUCTION

Steel is widely used material in India it has both compressive and tensile strength, steel can be developed in any state and members are connected by welding and bolting, steel members are erected as the materials are delivered to site, steel has less fire resistance its strength and stiffness changes with temperature, The tallest structures today (commonly called skyscrapers or high-rise) are constructed using structural steel due to its constructability, as well as its high strength-to-weight ratio. In comparison, concrete, while being less dense than steel, has a much lower strength-to-weight ratio. Structural steel and reinforced concrete are not always chosen solely because they are the most ideal material for the structure. Companies rely on the ability to turn a profit for any construction project , as do the designers. The high cost of energy and transportation will control the selection of the material as well. All of these costs will be taken into consideration before the conceptual design of a construction project is begun. Structures consisting of both materials utilize the benefits of structural steel and reinforced concrete . This is already common practice in reinforced concrete in that the steel reinforcement is used to provide steel's tensile strength capacity to a structural concrete member. A commonly seen example would be parking garages

II. LITERATURE REVIEW

Moein Amini & M. Majd, M. Hosseini made A Study on the Effect of Bracing Arrangement in the "Seismic Behavior Buildings with Various Concentric Bracings by Nonlinear Static and Dynamic Analyses, In this study a set of regular multi-story steel buildings were considered with three kinds of X, V and chevron bracing, in two placements of 'two adjacent bays' and 'two non-adjacent bays' along the building height, and their seismic behaviors were investigated. In all three kinds of bracings the arrangement in non-adjacent bays leads to lower stiffness but higher strength than arrangement in adjacent bays. In all cases the chevron bracing leads to higher stiffness compared to the other two types, while the other two types show almost the same stiffness. The employed seismic design code has resulted in more conservative design of upper stories compared to the lower stories of the buildings". This means that using a single value for response modification factor is not adequate.

Vishnu Sharma1, Raj Kumar2, Hemant Singh3, Waseem Ahmad4, Yogendra Pratap5 made A Review Study on uses of steel in construction and concluded that, Steel provide light weight structure in comparison to concrete. Steel structure easily allows alteration and expansion if needed. Steel provide rapid construction in comparison to concrete. Steel has its strength fix it did no gain strength with days as compared to concrete. Earthquake resistant buildings can "be made by the use of steel and it is economic also as compared to concrete. Steel is biodegradable and recyclable. Steel did not need curing. Steel structure provide long span. Steel structure result less health hazards, less waste, less Energy usage, less emissions and better Environmental work." Steel buildings are designed by trained structural engineers and build in control environment so the raw material is not wasted unlike the "conventional building material where the wastage is huge. Braced steel frame have more base shear than unbraced frames. Bracings reduce the lateral displacement of floors. Axial forces in columns increases from unbraced to braced system. Shear forces in columns decrease from unbraced to braced system. Diagonal braced columns undergo more shear force than cross braced."

Dhanaraj M. Patil[1*] and Keshav K. Sangle[2] Behaviour of Different Bracing Systems in High Rise 2-D Steel Buildings under Wind Loadings For this purpose, "a two dimensional dynamic wind analysis were carried out to on different braced high rise 2- D steel building frames of 10, 15, 20, 25, 30, and 35 storeys to capture the structural response. This research is carried out using five structural configurations of braced frames: moment resisting frames (MRF), chevron braced frames (CBF), V-braced frames (VBF)," X-braced frames (XBF), and zipper braced frames (ZBF). MRF high rise 2-D buildings show higher storey displacement and inter-storey drift ratios representing that MRF "building are more

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flexible than CBF, VBF, XBF and ZBF systems. Behaviour of CBF and ZBF under dynamic wind load is nearly similar in terms of storey displacement and inter-storey drift ratio for different heights 2-D high rise buildings. CBF and ZBF show lower top storey displacements than other systems in all storeys 2-D high rise steel buildings under wind loads. Storey displacement and inter-storey drift ratio is significantly reduced for ZBF and CBF than other systems representing these systems are stiffer than other systems.” VBF also shows nearly similar storey displacement and inter-storey drift ratio.

III. MODELING AND METHODOLOGY

In the present study four G+5 steel structures were modeled without bracings and having X, V bracings and diagonal bracings with foundation depth of 2m support conditions are assumed to be pinned at the bottom or at the supports/footings, seismic loads are applied as per IS:1893-2002 The structures having length = 28.2 m, width = 17m and height = 20m. The structures modeled in STAAD.Pro structural analysis and design software by considering various loads and load combinations by their relative occurrence are considered the material properties considered are Fe250 rolled steel sections structures were considered in seismic zones 2, 3, 4 and 5.

Structure-1: G+ 5 steel structure without bracings in seismic zone 2, 3, 4 and 5

Structure-2: G+ 5 steel structure with X bracings in seismic zone 2, 3, 4 and 5

Structure-3: G+ 5 steel structure with V bracings in seismic zone 2, 3, 4 and 5

Structure-4: G+ 5 steel structure with diagonal bracings in seismic zone 2, 3, 4 and 5

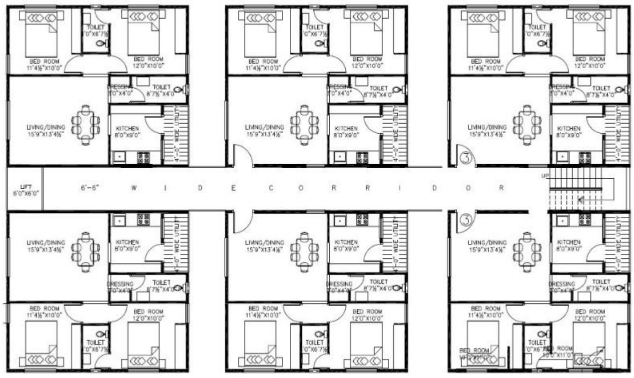


Fig: floor plan of residential buildings

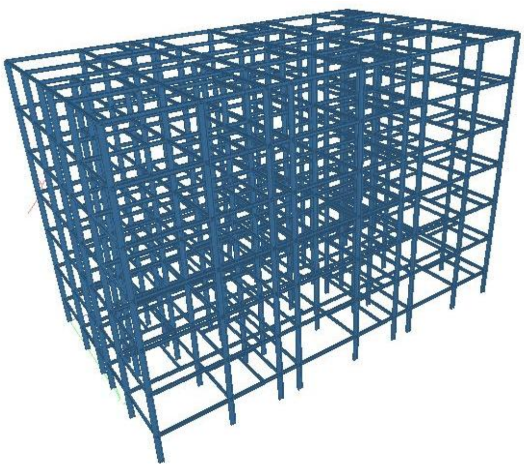


Fig : 3d view of structures without bracings

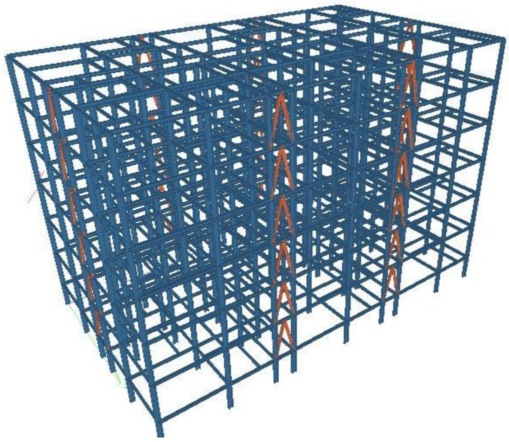


Fig: 3d view of structures with V bracings

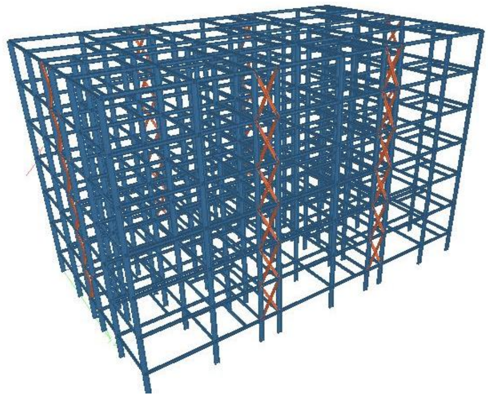


Fig: 3d view of structures with X bracings

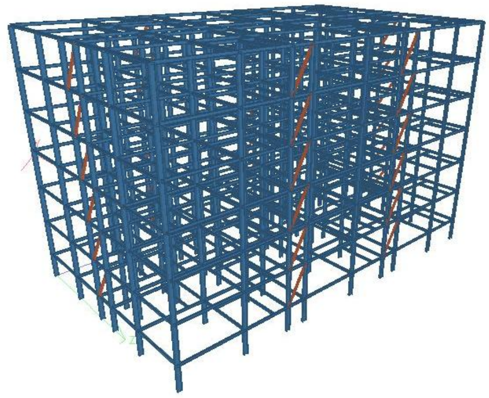
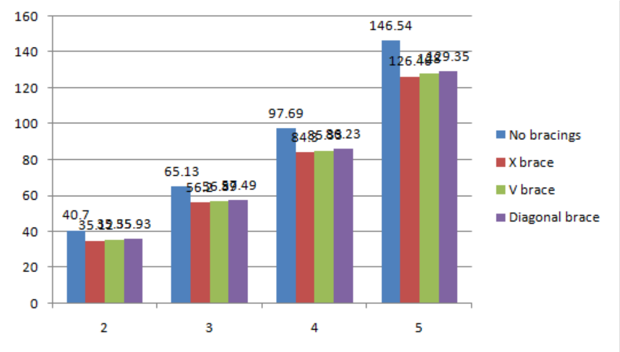


Fig: 3d view of structures with diagonal bracings

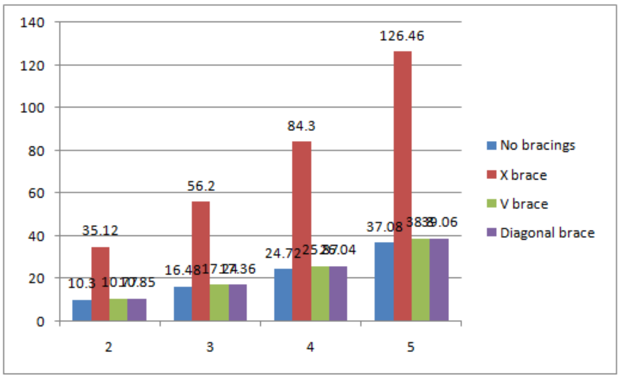
Table: design data for analysis of structures

Design data	Design values
Column	ISMB300
Beam	ISMB200
Bracings	ISMC150
Floor to floor height	3m
Foundation depth	2m
Length	28.2m
Width	17m
Height	20m
Wall thickness	150mm
Slab thickness	100mm
Type of bracings	X, V and diagonal
Seismic zones	2,3,4, 5

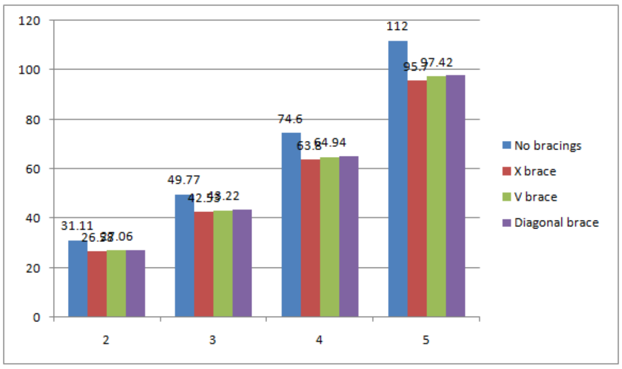
IV. RESULTS AND DISCUSSIONS



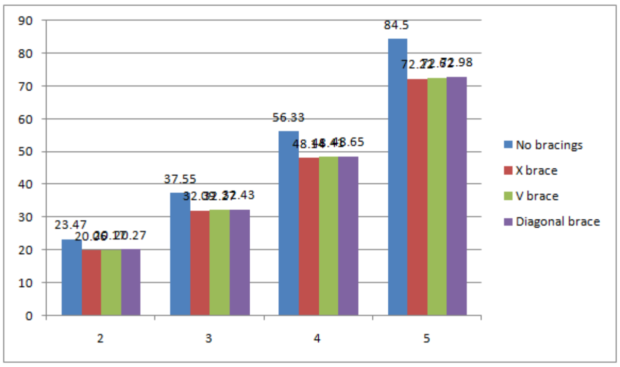
Graph: Displacement in all structures



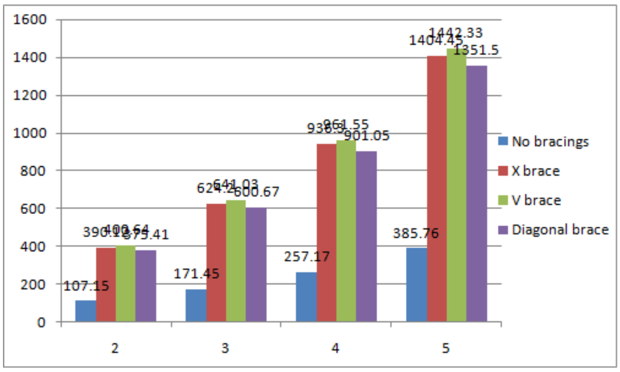
Graph : Support reactions in all structures



Graph: Shear force in all structures



Graph: Bending moment in all structures



Graph: Axial force in all structures

V. CONCLUSION

Following are the conclusions from the results of four G+5 steel structures were modeled without bracings and having X, V bracings and diagonal bracings with foundation depth of 2m support conditions are assumed to be pinned at the bottom or at the supports/footings, seismic loads are applied as per IS: 1893-2002 The structures having length = 28.2 m, width = 17m and height = 20m. The structures modeled in STAAD.Pro structural analysis and design software by considering various loads and load combinations by their relative occurrence are considered the material properties considered are Fe250 rolled steel sections structures were considered in seismic zones 2, 3, 4 and 5.

Structure-1: G+ 5 steel structure without bracings in seismic zone 2, 3, 4 and 5

Structure-2: G+ 5 steel structure with X bracings in seismic zone 2, 3, 4 and 5

Structure-3: G+ 5 steel structure with V bracings in seismic zone 2, 3, 4 and 5

Structure-4: G+ 5 steel structure with diagonal bracings in seismic zone 2, 3, 4 and 5

1. It is observed that with the increase in the seismic zones displacement, support reactions, shear force, bending moment and axial forces are increased.
2. By providing bracings support reactions, axial forces at the base are increased and shear force, bending moment are decreased.
3. Lateral displacement, shear force and bending moment are decreased in X type bracing system when compared V and diagonal bracings.
4. Support reactions and axial force are decreased in diagonal bracing system when compared X and V type bracings.
5. When compared with seismic zone 2 structure results displacement, support reactions, shear force, bending moment and axial forces are increased by 60%, 140% and 260% in seismic zone 3, zone 4 and zone 5.
6. Structure-2(X bracing) gives lesser results when compared to structure-1(no bracing), structure-3(v bracing) and structure-4(diagonal bracing).

   X type steel bracing is preferable in higher seismic zones for steel structures

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