Dynamic Analysis of a Tall Unsymmetrical Building Frame Considering Effect of Infill Masonry & Steel Bracing System

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Abstract— In a country like India, where population is growing rapidly with development of the nation, this is resulting in lack of space ultimately asking for tall structures in order to create space for every individual. Some parts of India are under seismic zone V, which needs utmost care and safety, thus there is a need of lateral load resisting members in a tall structures. In this study we are analyzing a G+12 tall structure, considering seismic zone V (response spectrum method) with soft soil condition, for analysis and modelling, ETABS'17 is used. Here we are considering infill masonry wall frame and steel bracing system frame for comparison. The steel bracing system and Infill masonry in reinforced concrete frames is viable for resisting lateral forces, steel bracing is easy to erect occupies less space and has flexibility in design for meeting the required strength and stiffness whereas Infill masonry is easy to assign with unskilled labors. In this comparative study, it is concluded that Steel bracing at exterior shows desirable stability than other cases in terms of resisting forces and moment. Also, in terms of cost effectiveness steel bracing system is quite suitable for lateral load resisting whereas Infill masonry structure is second alternate whereas bare frame case shows worst result. Therefore, it can be justifying that steel bracing frame is overall more stable than bare frame.

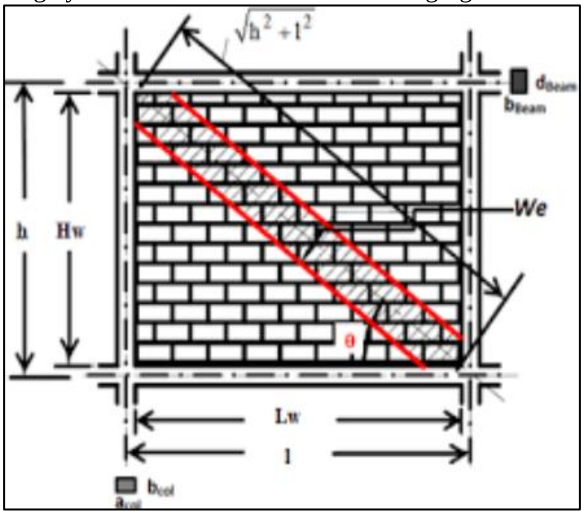
Key words: ETABS, Infill, Structural Analysis, Response Spectrum, Tall Structure, Bracings, Cost Analysis

I. INTRODUCTION

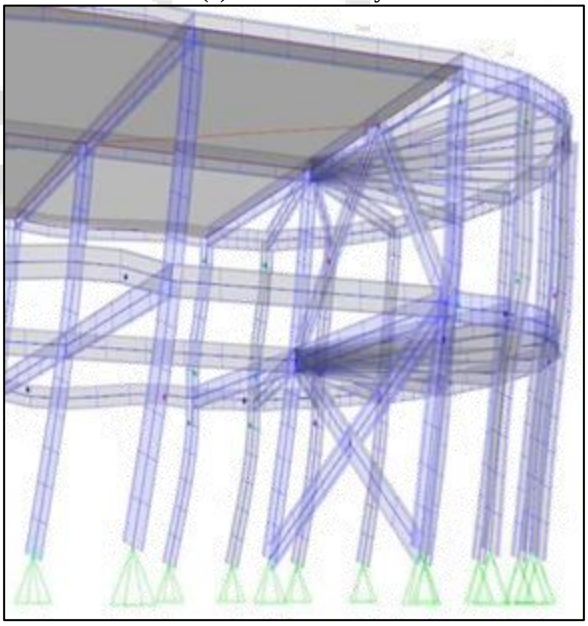
Seismic analysis is a part of structural analysis used for calculation of building or structures response to earthquakes. It is the process of structural assessment or earthquake engineering, structural design and retrofit in the prevalent earthquakes regions.

Infill masonry provide resistivity with the lateral effect or deformation of the reinforced concrete frame; Generally collision of frame and infill takes place along same (one diagonal) and a compression inclined member known as strut is forms along the other. Therefore, infill masonry adds stability and lateral stiffness to the building.

Steel bracing of RC frames has received some attention in recent years both as a retrofitting measure to increase the shear capacity of existing RC buildings and as a shear resisting element in the seismic design of new buildings. Earlier investigators focused on the retrofitting aspect of bracing and studied external bracing of buildings as well as internal indirect bracing of individual bays of the RC frames. Lately, the direct bracing of RC frames has attracted more attention since it is less costly and can be adopted not only for retrofitting purposes, but also as a viable alternative to RC shear walls at pre-construction design level. Experimental works, as well as analytical investigations have studied the capabilities of the direct bracing system of RC frames with encouraging results.



(a) Infill masonry



(b) Steel bracing

Fig. 1: Lateral Load Resisting Members

II. LITERATURE SURVEY

Patilet. al. (2018) Studied the effective bracing system for G+20 building by using STAAD.pro v8i. The purpose of this study is to analysis and design different parameter in high rise steel structure. In this research G+20 structure is taken with eccentric bracing system under different types of lateral loading.

Krishna et. al. (2017) Studied that with the upsurge in the tallness of the structure surges the intensity & effects of Lateral loads comprising of seismic & wind loads. Wind load resistance becomes a governing factor once the structure achieves the description of tall structure due to the inefficiency of rigid or semi rigid frames to control the displacement & deflection. Thus, reducing the strength & stiffness of the structure. Braced frame system is a highly competent & cost-effective method to control the deflections arising due to the fluctuating wind loads. In the present investigation three different types of concentric braced frame systems were analyzed in terms Shear force, bending moment, nodal displacement & reactions by using STAAD.Pro V8i software as per Equivalent static analysis method. An (G+11) irregular high-rise structure was assumed to be situated in Bhuj with Basic wind speed 50m/s.

Tamboli and Karadi (2012) presented a comparative study on the results of bare frame, infilled frame and open first storey frame in modeling. The Equivalent diagonal Strut method was used for the masonry infill panels along with software ETABS for the analysis of all the frame models. It has been concluded that the seismic analysis of RC (Bare frame) structure leads to under estimation of base shear. Along these lines other reaction amounts, for example, day and age, common recurrence, and story float are not huge. The under estimation of base shear may prompt the crumple of structure amid earthquake shaking. In this way it is vital to consider the infill walls in the seismic investigation of structure.

Aliaari and Memari (2012) proposed infill wall “structural fuse” system for use in building frames to prevent damage to frame or infill walls due to infill wall-frame interaction during potentially harming earthquakes by segregating them through a "conciliatory" segment or an auxiliary circuit. The outline approach incorporates a strategy for plan and use of the wire framework in a multi-cove, multi-story building with minute opposing casings. The experimental condition created to anticipate the in-plane quality of masonry infill walls furnished with auxiliary circuit is examined. A figuring technique is proposed to indicate a fitting breaker component limit plan in a building outline keeping in mind the end goal to accomplish attractive and controlled basic execution. The design procedure is shown through application to two buildings used for example, a low-rise (4-story) and a mid-rise (8-story) building. The consequence of the investigation exhibits that the proposed confinement framework has justifies and can possibly enhance the seismic execution of masonry infill walls by ensuring the infill divider and the edge from harms because of their cooperation.

Surendran and Kaushik (2012) reviewed and compared past relevant studies and seismic codes of different countries on in-plane lateral load behaviour and modeling approaches for masonry infill RC frames with openings. This comparative study shall help designers and code developers in selection to recommend suitable analytical models for estimating strength, stiffness, failure modes, and other properties of infill RC frames with openings. The author has included Different opening aspect ratios, positions and sizes in order to understand the behaviour of infilled frames under the action of lateral loads.

Deierlein et.al. (2010) contemplated in points of interest of the displaying issues, nonlinear conduct and examination of the RCC outline with shear divider basic framework. Utilizing rough strategy programming Etabs which depends on the continuum approach and one dimensional limited component technique for sidelong static and dynamic investigations of multi-story building.

III. Objectives & Scope of Study

This study aims to investigate the effect of brick masonry infill wall and external steel bracing system on a RC moment resisting structure comparing with a bare frame under dynamic analysis. The specific objectives of the study are:

1) To determine the effect of response spectrum (dynamic analysis) on a tall structure.
2) To justify the effectiveness of lateral load resisting frame over conventional bare frame.
3) To present a comparison between lateral load resisting members i.e. infill masonry walls and steel bracing system in terms of building stability and stiffness.
4) To justify the cost effectiveness of structure with infill masonry and steel bracing system as per S.O.R. 2017, Public work department, Bhopal M.P.

The present study attempts to provide a justification for preferring lateral load resisting members also computing cost reduction factors which are on demand in developing nations.

IV. Methodology

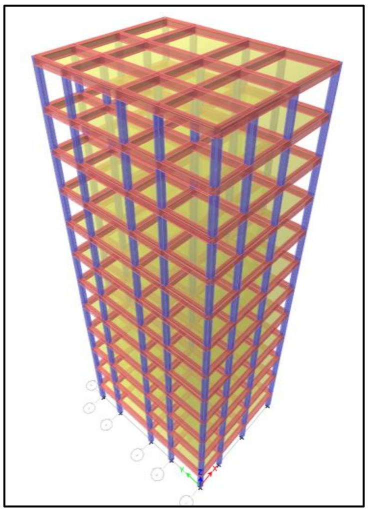
Following steps should be follow to complete this research work:

1) Step 1: The very first step is to study past research work related to our work.
2) Step 2: To prepare modelling of all cases using ETABS’17.
3) Step 3: To assign section properties and lateral load resisting member’s .i.e infill and bracings.
4) Step 4: To assign loading as per I.S. 875 –I & II, seismic loading as per I.S. 1893-I: 2016.
5) Step 5: To perform analysis of all cases as per response spectrum method.
6) Step 6: To prepare a comparative result in graph form using M.S. Excel.

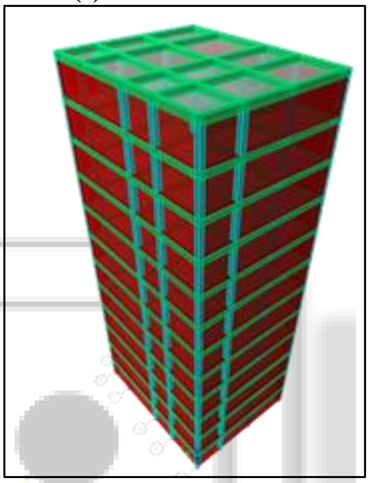
In the present scenario, because of the wide range of plans possible, the accumulated understanding is still limited, thus there is need of an attempt to investigate the behaviour of irregular plans in RCC building frame.

Cases selected for comparative study are as follows:

- Case 1: Conventional (bare) frame, G+12
- Case 2: Frame with infill masonry walls

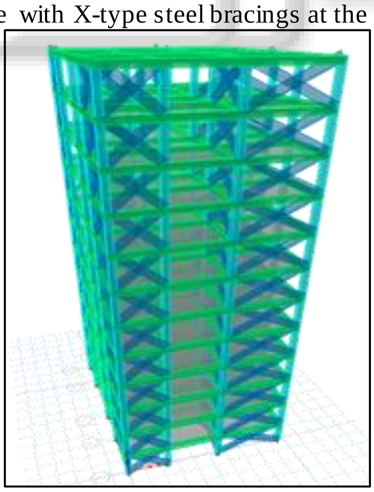


(a) Case 1 bare frame



(b) Case 2 Infill masonry

Case-3 Frame with X-type steel btracings at the edges.



(c) Case 3 steel btracing system

Fig. 2: Different cases adopted

A. *Geometrical Properties*

Design data of building	Dimension
Plan dimension	12 x 15 m
No. of bay in X direction	3 Bay
No. of bay in Y direction	4 Bay
No. of storey	G+12
Typical storey height	3.0 m
Bottom storey height	2.5 m
Column size	450 x 450
Beam size	450x 300
Thickness of slab	150 mm
Grade of concrete	M-20
Grade of steel	Fe-415
Wall thickness	230 mm for external wall
Steel Bracing	I.S.A 200 X 150 X 15 mm

Table 1: Geometrical Properties

V. RESULT ANALYSIS

A. *Results*

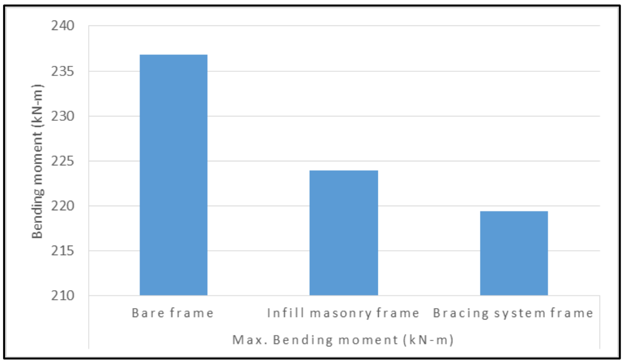


Fig. 3: Max. Bending Moment

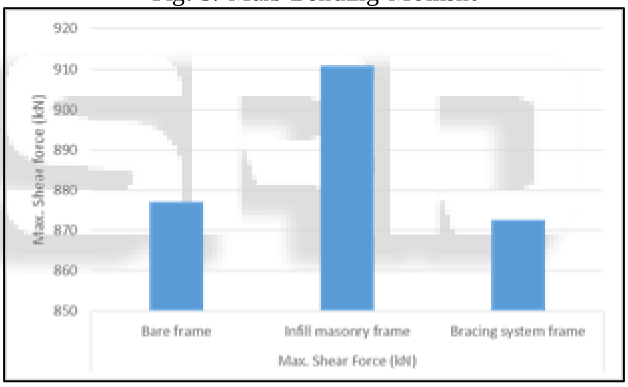


Fig. 4: Max. Shear Force

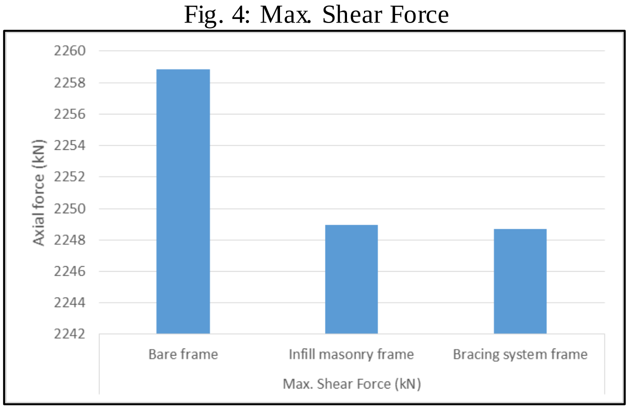


Fig. 5: Max. Axial Force

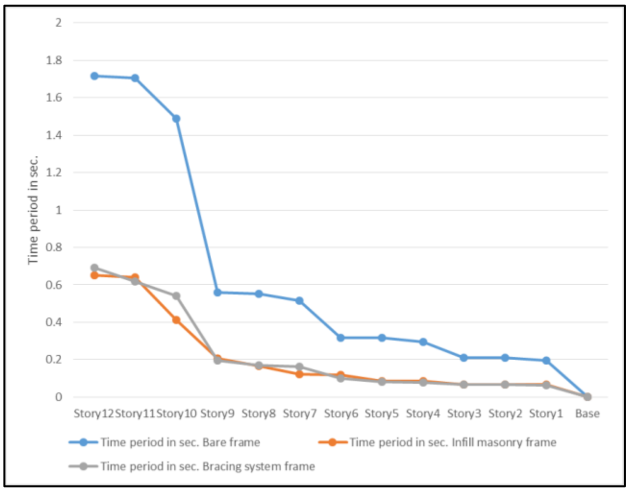


Fig. 6: Time Period in Sec

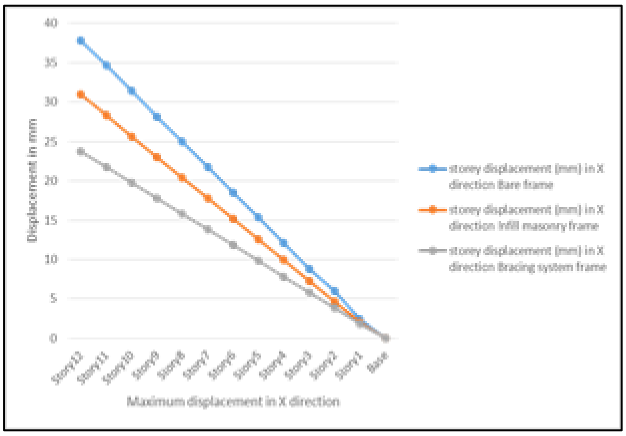


Fig. 7: Storey Displacement

B. *Cost analysis*

S. No.	Frame type	Concrete cu.m	Rate of concrete (m^3) as per S.O.R.	Cost of concrete in INR (Rupees)
1	Bare frame	110.98	5757	6,38,911.86
2	Infill masonry frames	96.98	5757	5,58,313.86
3	X bracing system frame	96.5	5757	5,55,550.50

Table 2: Cost Analysis

S. No.	Frame type	Reinforcement in kg	Rate of Rebar kg as per S.O.R.	Cost of Rebar in INR (Rupees)
1	Bare frame	9454.23	72.75	6,87,795.23
2	Infill masonry frames	9552.87	72.75	6,94,971.30
3	X bracing system frame	9423.87	72.75	6,85,586.54

Table 3:

VI. CONCLUSION & FUTURE SCOPE

In the present study it has been found that Steel bracing system structure is comparatively showing less moment, shear force, deflection, time period and good in cost effectiveness. Whereas infill masonry system is second best and bare frame system is worst.

In this study tall structure with load resisting members i.e. bracings and infill masonry is considered in future following conditions can be considered:

- In future infillmasonry with different materials can be consider for analysis
- In this study response spectrum analysis is considered whereas in future time history or pushover analysis can be considered.
- In this study G+12un-symmetrical frame is considered in future it can be extended to some more height and symmetrical frame can be considered.

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