Analysis of Flat Slab System with Masonry Infill Subjected To Seismic Loading

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***Abstract* - As we know all structural systems are enclosed with infill and they improve the performance of a structure during earthquakes in spite of this also it is considered as non-structural elements due to the negligence of the interaction of infill with the frame. Now days, flat slab system became widespread and gaining prominence as they possess lot of benefits against the conventional beam column connection in terms of architectural flexibility and economical in point of view. For this we proposed a flat slab structure with drop. A G+ 30 storey building with 7 bays in both directions with spacing of 6m was considered. The flat slab frame with masonry infill with and without perimeter beams by varying infill percentage at various sections such as 12.25%infill in inner core, 20% infill in second core, 30%infill in outer core and 50%infill in double outer core over the total area of building were considered. The structure was modeled using E-tabs for Bhuj earthquake time history analysis. After analysis the results of displacement, overturning moment and storey shear were tabulated.**

Key Words: Infill, flat slab system, masonry, perimeter beams, time history analysis, Bhuj earthquake.

1. INTRODUCTION

A perceivable shaking of surface of the earth resulting from the sudden release of energy in the earth crust that creates seismic waves is an earthquake. Shaking and ground rupture are the main effects of earthquake results in severe damage to buildings and other rigid structures. The severity of indigenous effects is governed by earthquake magnitude, the distance from epicenter, and the geological and morphological conditions which diminish the wave propagation. Due to heavy population and scarcity of space leads to the construction of multi-story building. Frequent occurrence of earthquake shows vulnerability of structures and its severe failure causes property damage and life disaster. To slacken potential losses, devastation, expected mutilation and loss in urban areas, there is an intended need for an earthquake resistant structure which keeps the structure safe from structural and architectural point of view.

All structural systems are confined with infill wall which serves as partitions or as claddings. These are considered as non-structural elements with an assumption that infill do not subsidize in resisting lateral loads. But past earthquakes high lightened the prominent contribution of infill in the description of their seismic behavior.

2. INFILL

Infill wall is the supportive wall that encloses the perimeter of the building. These are built throughout the building at desired location as it adds strength and rigidity to the structures. Infill walls contribute to a structure's lateral-force-resisting capacity and raise its energy dissipation capacity. In addition, infill wall improves the building's initial lateral stiffness and diminish its initial vibration period, inter storey drift which can result in better performance in earthquake than a bare frame. It decreases the lateral deflection of building, displacement, bending moment in frames and enhances the axial force in columns and strength of frame. Finally reduces the probability of failure.

Masonry Infill

Masonry is the building of structures in which blocks are laid and are bound together by mortar. It is highly durable form of infill. The thickness is about 230mm.

Advantages of Masonry infill

- Masonry provides thermal insulation in hot climates
- Act as a moisture barrier.
- Economical as it lowers the life cycle cost in a structure.
- It is a fire resilient in nature.
- It acts as an acoustic barrier between outside noise and spaces.
- More resistant to projectiles such as debris
- Provides refuge and protection from invaders.
- Ductile as an infill.

2.1 Flat Slab System

Flat slab system is a special structural form of reinforced concrete construction known as beamless slab, in which slab is directly propped by columns. In the analysis and design, the flat slab is divided into column strip and middle strip because it has greater flexural deformation around the column due to lateral loading.

Now days, flat slab system became widespread and gaining prominence as they possess lot of benefits against the conventional beam column connection in terms of architectural flexibility and economical in point of view. It enables fast construction, saves time, simple design but it is more flexible to lateral loads makes the structure susceptible during earthquake.

2.2 Seismic Analysis By Time History Method

Seismic analysis can be performed either by static or by dynamic method of analysis. Dynamic analysis is performed to find lateral force in each floor over the height of the building and its redistribution in each floor as per IS.1893 (part 1):2002

We adopted time history analysis in which the model is subjected to real ground motion record which indicate the anticipated earthquake at the base of the structure. It is totally different from other mode of analysis. It is suitable for elastic and inelastic analysis. The stiffness characterization is assumed to be constant for whole duration of earthquake in case of elastic analysis.

3. METHODOLOGY

A G+ 30 storey building with 7 bays in both directions with spacing of 6m is considered. The main objective is to study the behaviour of masonry infill under seismic loading. Frame with masonry infill by varying the percentage of infill at various sections such as 12.25%infill in inner core, 20% infill in second core, 30%infill in outer core and 50%infill in double outer core at various sections over total area of building were considered with a fixed support at the base of the building.

2.1 Proposed Model Details

Type of structure	Flat slab structure with drop
Cases	With perimeter beams Without perimeter beams
Total number of stories	G+30
Floor to floor height	3 m
Grade of concrete	M40
Grade of steel	Fe 500
Column dimension	0.7mx0.7m, 0. 5mx0.5m
Beam dimension	0.23m X 0.45m
Thickness of slab	0.15m
Drop	0.25mm
Type of infill	Masonry
Dead load	1 KN/m^2
Live load	3 KN/m^2

2.2 Infill Properties Details

SI NO	INFILL PROPERTIES	MASONRY
1	Mass per unit volume(Kg/m^3)	1920
2	Modulus of elasticity(MPa)	1000
3	Poisson's ratio	0.18
4	Shear modulus(MPa)	423.73
5	Thickness of wall(mm)	230

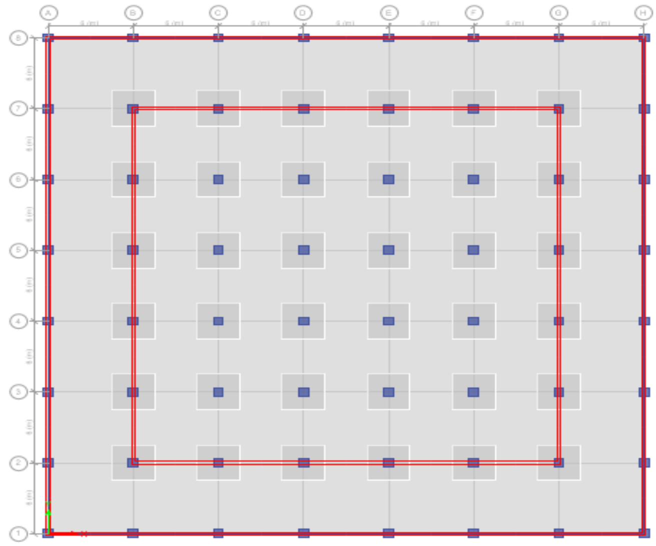

Fig 1: Plan of masonry infill with 50% infill in double outer core with perimeter beams in flat slab structure.

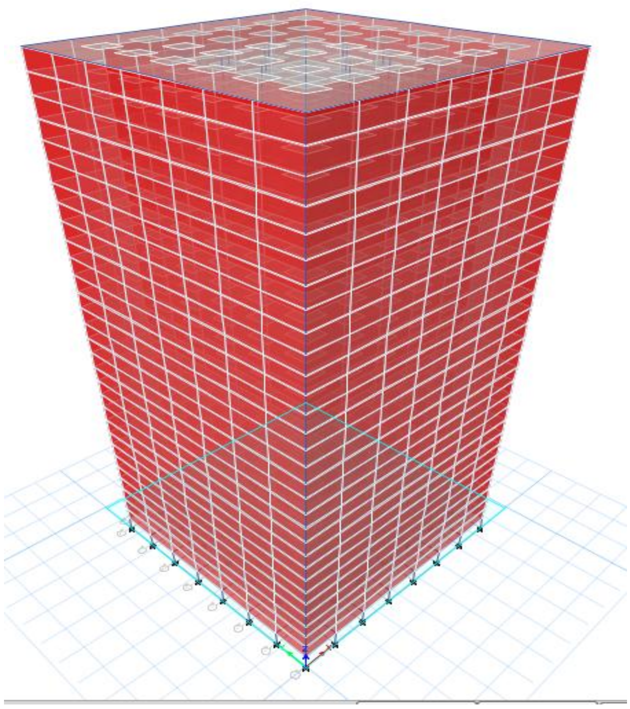

Fig 2: 3D view of building with masonry infill 50% infill in double outer core with perimeter beams in flat slab structure.

4. RESULTS

A linear time history method of analysis was performed as per IS.1893 (part 1):2002 to the models given below. Results are compared to each other in terms of storey displacement, overturning moment and storey shear.

The following models are considered for the analysis.

Model 1: Bare frame

Flat slab system without perimeter beams with masonry infill

Model 3A: 12.25% infill in inner core.

Model 3B: 20% infill in second core.

Model 3C: 30% infill in outer core.

Model 3D: 50% infill in double outer core.

Flat slab system with perimeter beams with masonry infill

Model 5A: 12.25% infill in inner core

Model 5B: 20% infill in second core

Model 5C: 30% infill in outer core.

Model 5D:50% infill in double outer core.

3.1 Maximum Storey Displacement

In time history method of analysis Bhuj earthquake record was considered. All the above models are analyzed and the maximum storey displacements of all the models were tabulated below. Here the masonry with 50% infill in double outer core shows the better results than a bare frame

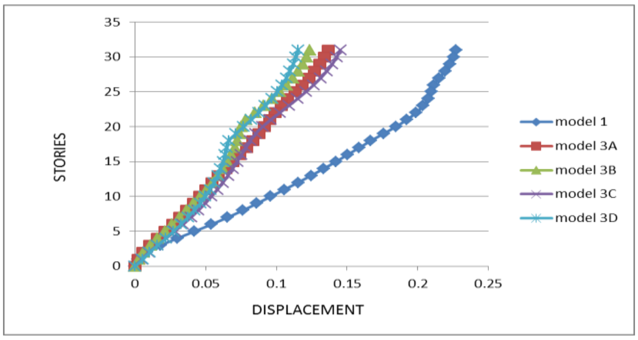

Chart 1: Maximum Storey Displacement of masonry infill in flat slab structure without perimeter beams

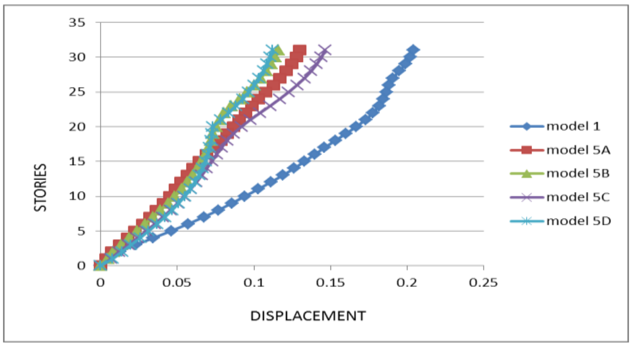

Chart 2: Maximum Storey Displacement of Masonry infill in flat slab structure with perimeter beams

3.2 Overturning Moment

In time history method of analysis Bhuj earthquake record was considered. All the models are analyzed and the overturning moments of all the models were tabulated below. Here masonry with 50% infill in double outer core shows the maximum value than bare frame.

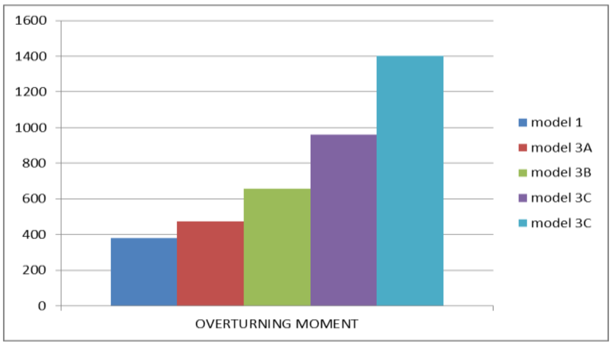

Chart 3: Maximum Overturning moment for Masonry infill in flat slab structure without perimeter beams

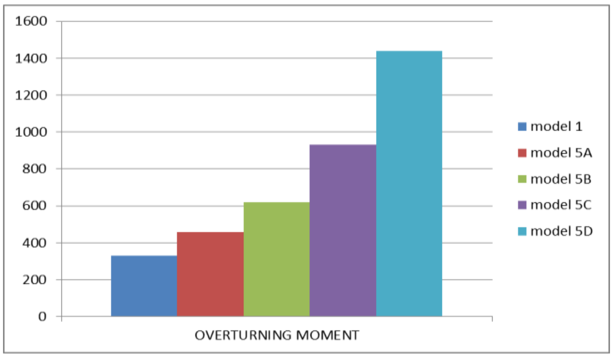

Chart 4: Maximum Overturning moment of Masonry infill in flat slab structure with perimeter beams.

3.3 Base Shear

In time history method of analysis Bhuj earthquake record was considered. All the models are analyzed and the base shears of all the models were tabulated below. Here masonry with 50% infill in outer double core shows the better results than bare frame.

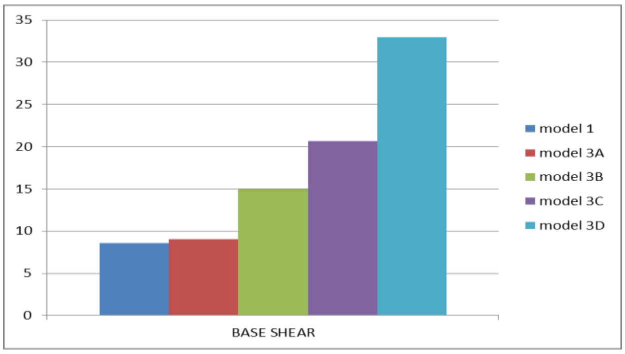

Chart 5: Base shear of masonry infill in flat slab structure without perimeter beams

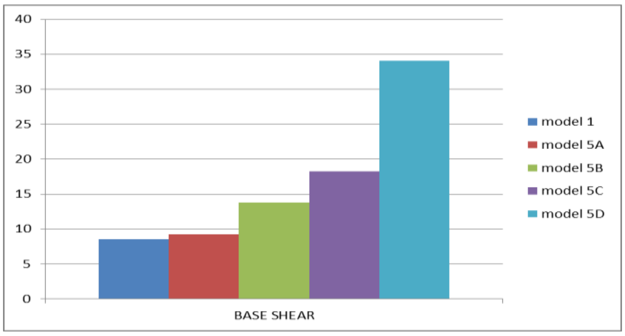

Chart 6: Base Shear Of Masonry Infill In Flat Slab Structure With Perimeter Beams

4. CONCLUSION

From the above results and discussions we can conclude that

- Masonry is a very efficient infill material than bare frame.
- Flat slab structure with perimeter beams is very efficient than flat slab structure without perimeter beams in resisting seismic loads with controlled deflection.
- As percentage of infill increases lateral stability of building increases.
- According to the present study the 50% infill in double outer core shows the better performance than other percentage of infill or bare frame.
- The masonry infill with perimeter beams in flat slab structure with 50% infill is the most efficient.

So we concluded it should be the flat slab system with perimeter beams with masonry 50% in filled in double outer core is the safer in resisting lateral loads.

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