AN ANALYTICAL STUDY OF THE BEHAVIOUR OF A 3D RC FRAME WITH HOLLOW BLOCK INFILL UNDER SEISMIC LOADING USING E-TABS

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ABSTRACT
Reinforced concrete structures are being damaged by a severe earthquake that has struck a different place in the world. The bond between the structural elements and masonry infill of the building are affected often by an earthquake. Brick Masonry in-fills are often used to fill the voids between horizontal and vertical resisting elements of the building frame. An infill wall enhances considerably the strength and rigidity of the structure. It has recognized that frames with in-fills have more strength and rigidity in conditions comparison to the bared frames. In the present study the hollow blocks are used as infill between the frames. It is more advantages such as easy of construction, fire insulation and high strength and stiffness. The project aims in the performance of An Analytical study of the behavior of a 3d RC (Reinforced Concrete) Frame with Hollow Block Infill under Seismic Loading Using E-Tabs.

1. Introduction

Earthquake comes under the thrust area of natural hazard mitigation. The stimuli, which prompted the submission of the project proposal is a colossal loss of man and material in Bhuj and Khillari earthquakes. The earthquake is a phenomenon that releases a high amount of energy in a short time through the earth. Structures designed to resist moderate and frequently occurring earthquakes must have sufficient stiffness and strength to control deflection and prevent any possible collapse. It should control the deformations and transfer the force to foundation through enough lateral stiffness in ground motions.

Masonry infill walls are frequently used as interior partitions and exterior walls in low or middle rise RC buildings. In the design and assessment of buildings, the infill walls are usually treated as nonstructural Elements and they are ignored in analytical models because they are assumed to be beneficial to the structural responses. Therefore, their influences on the structural response are generally ignored. However, their stiffness and strength are not negligible, and they will interact with the boundary frame when the structure is subjected to ground motions. This interaction may or may not be beneficial to the performance of the structure. Most R.C frame buildings in developing countries are in-filled with masonry walls. The past earthquake experience has demonstrated the beneficial effects as well as the ill effects of the presence of infill masonry walls.

In at least two moderate earthquakes(magnitude 6.0 to 6.5 and maximum intensity VIII on MM scale) in India, RC frame buildings with brick masonry infills have shown excellent performance though the most such buildings were not designed and detailed for seismic response.

Experimental and numerical research on the performance of the buildings during severe earthquakes, have indicated that structural over strength plays a very important role in protecting buildings from collapse. The structural over-strength results from many factors and the most common sources of over-strength are material strength, confinement effect and member geometry and so on.

2. Hollow Block

For conventional bricks and stones in building construction hollow concrete blocks are used as substitutes. They are insubstantial than bricks, easier to place and also extend to economics in foundation cost and consumption of cement.

Comparing conventional bricks, they give the advantages of uniform quality, faster speed of construction, lower labor involvement and longer durability. From these advantages, hollow concrete blocks are being increasingly used in construction activities.

3. Literature Review

Suyamburaja Arulselvan, K. Subramanian, E.B. Perumal Pillai and A.R. Santhakumar , 2007 Conducted study on "RC Infilled Frame-RC Plane Frame Interactions for Seismic Resistance" Experimental investigation was planned and conducted to study the influence of brick masonry infill in a reinforced cement concrete frame. The analytical methods available needs validation by comparison with experimental results and more accurate methods of analysis like finite element analysis has to be used for the above purpose. In this study, RC frame with middle bay brick in filled representing a five-stories, three bay building in quarter-scale has been taken for experimental investigation and the available methods of theoretical analysis and finite element analysis using ANSYS software for the frames have been carried out. Until the cracks developed in infills, the contribution of the infill to both lateral stiffness and strength was very significant. The change in lateral stiffness, strength, ductility and natural period of the framed structure due to the presence of in fills change the behaviour of the building under seismic action. The object of this study was to investigate the behaviour of such infilled frames under seismic loads. For this purpose, five stories, three bay frames with central portion infilled with brick were tested under static cyclic loading simulating seismic action. Analytical works was done to understand the stiffness, strength and behaviour of these types of frames.

Mahmadsaeer at el (2015) Conducted study on the “Comparison Design Result of RCC Building using STAAD and ETAB software”. Comparison of STAAD PRO and ETAB software is getting the result different manner difficult to understanding and lot of confusing during the assign the loading parameter and design. From the design results of beams, we may conclude that ETABS gave lesser area of required steel as compared to STAAD PRO. Similarly the column section required area of the steel similar both software’s but in these case are considered in percentage 0.3% TO 0.5%.Form the design results of column; since the required steel for the column forces trendy this certain problem is less than the minimum steel limit of column (i.e., 0.85%), the amount of steel calculated by both the software’s is equal. Therefore, comparison of results for this case is not possible.

Venkataraj et al (2015) Conducted study on the "seismic performance of flyashed concrete building with flyash brick and burnt clay brick masonry infill". This paper presents the seismic performance of a flyashed concrete space framed building with two different types of masonry infills namely, clay brick masonry and flyash brick masonry using pushover analysis. Cement is replaced with flyash in concrete in the proportion of 30 %, 40 % and 50 % by weight of cement. The modeling and analysis of frames are carried out using the software SAP 2000. The lateral loads are calculated as per Indian Seismic code IS 1893:2002. The modal analysis shows that the fundamental frequency of the frames with flyash brick masonry is more than that of frames with clay brick masonry. The capacity curves obtained from the analysis reveal that the performance of frames with flyash brick masonry infill is superior to frames with clay brick masonry infill. The performance point is obtained for all the frames; more over the spectral displacement is lower in the case of frames with flyash brick masonry. The results of this analysis would encourage the end users to switch over to the usage of flyash leading to a sustainable and greener environment.

Syed HumayunBasha et al (2015) Presented a paper on, “Suitability of fly ash brick masonry as infill in reinforced concrete frames”. An experimental study was carried out to understand the lateral load response of reinforced concrete (RC) frame infilled with fly ash brick masonry. Results showed that the frame provided reasonably good results in terms of lateral strength, stiffness, deformation, and energy dissipation. Using an analytical model developed from the experimental results a parametric study was carried out to compare the influence of using both fly ash and burnt clay brick masonry as infill in RC frames. Finally, to understand the possible reasons for the weak and soft nature of fly ash bricks, three types of analyses were carried out to evaluate their chemical and mineralogical composition: X-ray fluorescence analysis, scanning electron microscope associated with energy dispersive spectrometer, and powder X-ray diffraction technique. It was concluded that due to incomplete pozzolanic reaction, fly ash bricks exhibited weak and soft nature. Addition of activators was recommended to improve their stiffness and compressive strength, in case it is required.

Vivek Tiwari et al (2014) presented a paper on “An Experimental Study of Fly-ash Brick Masonry Wall Panels Under Cyclic Loading”. This paper studies Fly ash bricks are new material and these bricks have certain advantages over clay bricks and no information regarding strength of these brick in masonry is available. Therefore goal of present work is to establish stress-strain curves for fly ash brick masonry having various H/T ratios under cyclic loadings. Also to establish envelope curve, common point curve and stability point curve. Since compressive strength of brick masonry depends upon various parameters viz. water absorption, mortar grade, slenderness ratio so these parameters are also taken into account. To achieve above objective Fly ash brick masonry wall panel of size 800mm X 100 mm X 200 mm, 800mm X 100 mm X 400 mm, 800mm X 100 mm X 600 mm and 800mm X 100mm X 800mm each constructed and cured for 28 days in 12 Nos., were tested to study of stress-strain relationship of fly ash brick masonry under monotonic, cyclic, fatigue loadings. The effect of H/T ratio is also studied. In the experimental work 48 panels specimens were tested and compressive strength is calculated and stress-strain curve is plotted for each specimen and these curves are also normalized. The results clearly indicate that the peak of the stress-strain curve obtained under cyclic compressive loading approximately coincides with the stress strain curve obtained under monotonic loading. Also cyclic load deformation history possesses locus of common points and locus of stability point Curves. It can be concluded that Fly ash brick masonry has average comparative strength is about 8.13 N/mm^2, which is approximately 1.3 times the strength of conventional brick masonry and these bricks are environmental friendly alternative to burnt clay bricks which are generally used for construction in India.

DevendraDohare (2014), Investigate the “Seismic Behavior of soft Storey Building”. In this paper an investigation has been made to study the seismic behaviour of soft storey building with different arrangement in soft storey building when subjected to static and dynamic earthquake loading. The concluded on RC frame buildings with soft story are known to perform poorly during in strong earthquake shaking. Because the stiffness at lower floor is 70% lesser than stiffness at storey above it causing the soft storey to happen. For a building that is not provided any lateral load resistance component such as shear wall or bracing, the strength is consider very weak and easily fail during earthquake. It has been found earthquake forces by treating them as ordinary frames results in an underestimation of base shear. Investigators analysis numerically and use various computer programs such as Staad Pro, ETABS, SAP2000 etc

Mulgund G.V (2012) investigated a paper on "Seismic Assessment of RC Frame Buildings With Brick Masonry In-fills". Is this paper deals with five reinforced RC framed building with brick infill were designed for seismic hazard in accordance with is code taking into consideration of effect of masonry. And also investigation has been made to study the behavior of RC frames with various configuration of infill when subjected to dynamic earthquake loading. The comparison is made between the results of bare frame and frame with infill effect. The results furnished were the calculation of earthquake forces by treating RC frames as ordinary frames without regards to infill leads tom under estimation of base shear. Therefore it is essential for the structural system to be selected with in-filled walls.

Manos.g.c et al (2012) presented a paper on "the behavior of masonry assemblages and masonry infilled rc frames subjected to combined vertical and horizontal seismic type loading". In this study the masonry in-filled reinforced concrete frames are subjected to combined vertical and horizontal loads. And to validate different modeling techniques for the numerical simulation of non linear behavior of masonry joints under shear loading. And also it examined the influence of different forms of interface between the masonry infill and the surrounding rc frame and also examines the influence of stiffness, load bearing capacity. From the analysis it is observed that numerical simulation of masonry infilled rc frames having their infill repaired with reinforced plasted and there is a increase in stiffness strength and energy dissipation due to presence of partially reinforced masonry in-fills.

Palanisamy. M et al(2012) investigated paper on, " experimental study on masonry infill material properties". In this paper infills walls are constructed using different types of structural blocks such as clay bricks, fly ash bricks, solid concrete blocks, hollow and cellular blocks. Constructions of bricks or blocks with cement mortar are called masonry. Masonry structures are durable in nature and are resistant to severe climatic conditions. The factors governing the strength of a masonry structure includes brick strength, mortar strength, elasticity, workmanship, brick uniformity and the method used to lay bricks. In this experimental study fly ash brick prism and clay brick prisms of sizes 230 x 230 x 300mm with cm1:4, cm1:5 and cm1:6 mix proportions were used. The compressive strength and modulus of elasticity tests was compared with curing period of 7th and 28th day's specimens of 3 each and of totally 108 prisms.

The results of fly ash brick masonry prism proved that it has achieved maximum compressive strength and young's modulus.

Table 1: Indian standard code IS 1893(PART1): 2002

Sl. No	Factors	Values
1	Lateral load resisting system I value for special RC moment resisting frame (SMRF)	5
2	Seismic zone factor (Z) for zone III	0.16
3	Importance factor (I)	1.5
4	Damping percentage	5%
5	Load combinations	1.5(DL+IL)+EL
6	Horizontal seismic coefficient (Ah)	Ah=ZISA /2RG

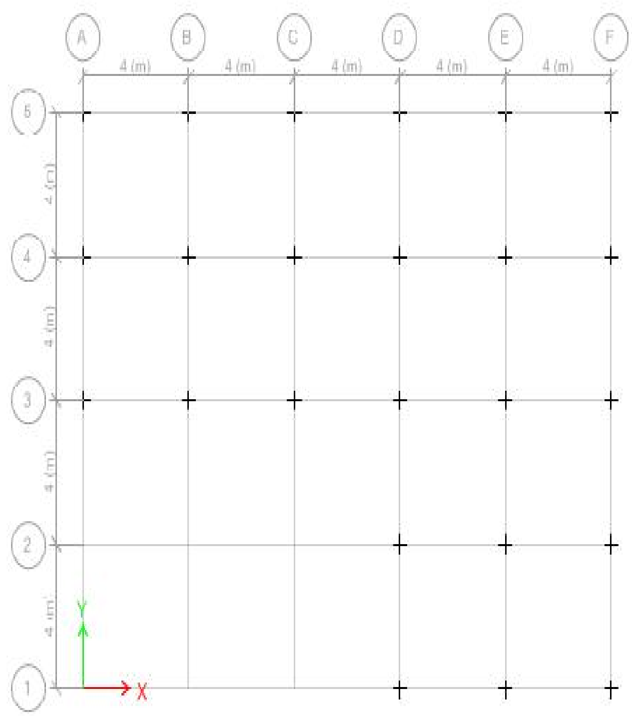

Fig. 1 Plan

4. Etabs Analysis

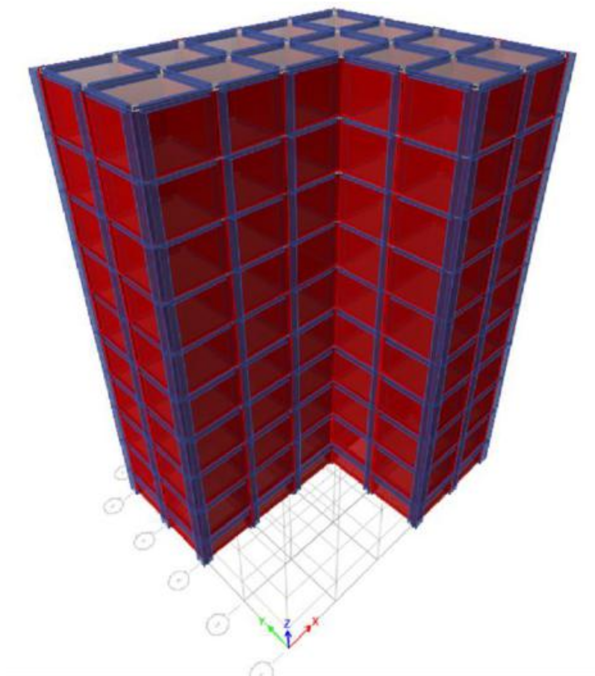

Fig.2 3D View Of The Structures In "ETABS"

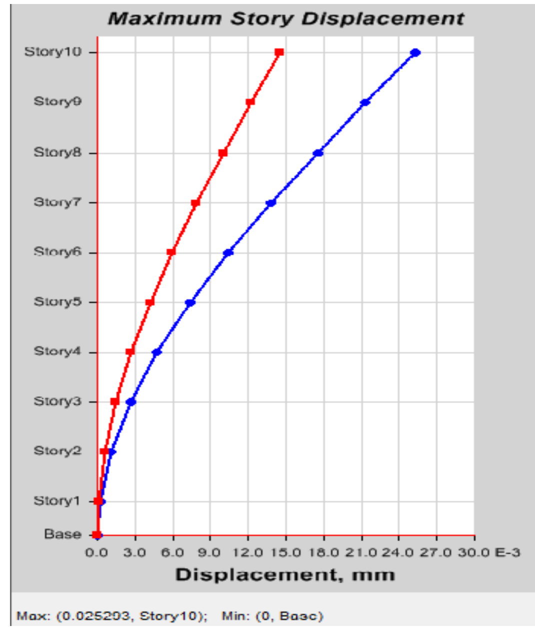

Fig .4 Maximum story Displacement

5. Analysis And Results

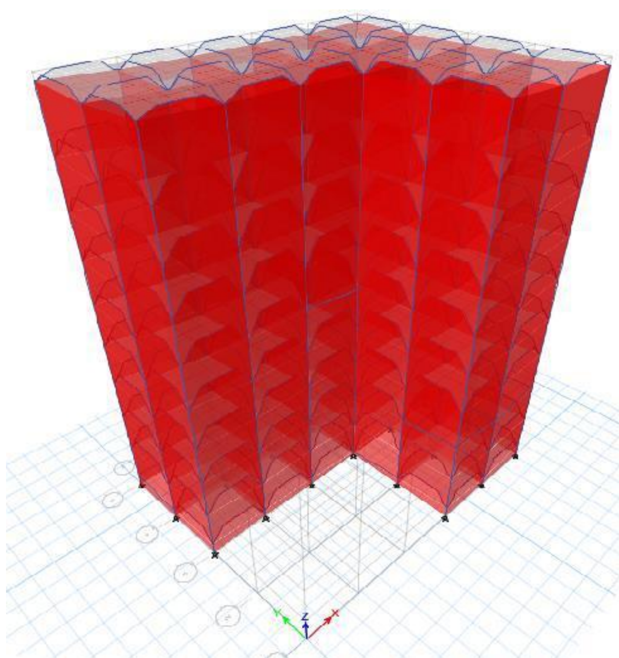

Fig. 3 Deformed shape

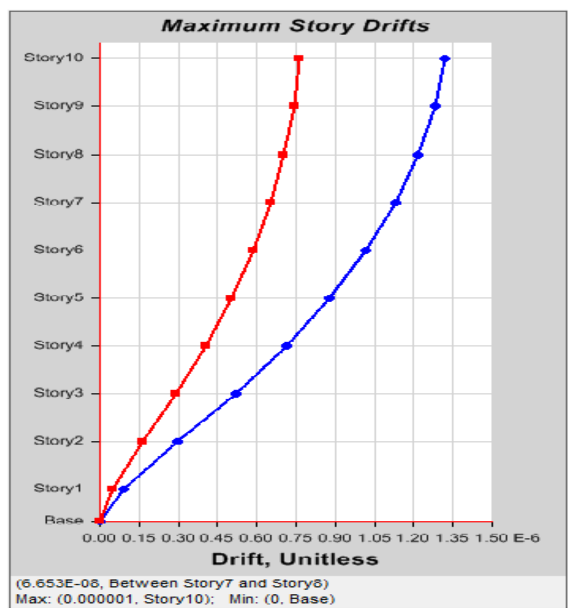

Fig.5 Maximum Story Drift

Fig .6 Maximum story Displacement

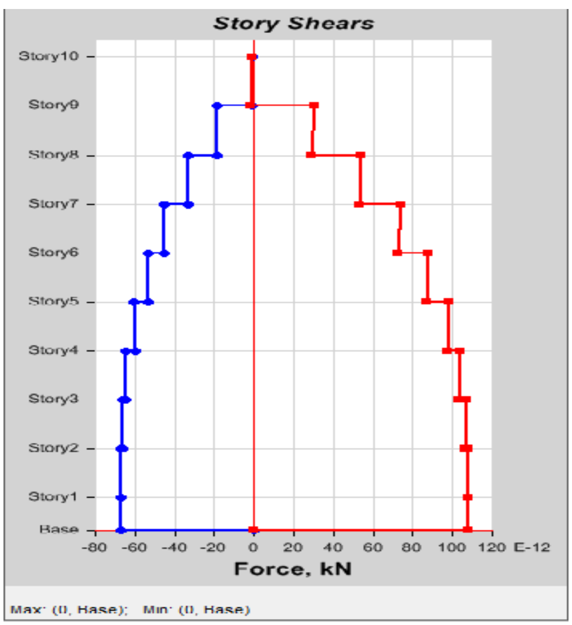

Fig.7 Maximum Story Shear

Table 2 Bending Moments, Shear Force and Axial Force

LOADING	FORCES	Fly ash	Hollow block
Dead load	BM Mx	0	0
	My	8.643kNm	6..450 kNm
	Mz	36.37kNm	35.10 kNm
	Shear force Fy	30.156 kN	28.197kN
	Fz	-3.134 kN	-2.10kN
	Axial force Fx	30.21 kN	29.31kN
Live load	BM Mx	0	0
	My	7.054 kNm	5.063kNm
	Mz	34.68 kNm	30.55kNm
	Shear force Fy	26.65 kN	25.78kN
	Fz	-2.137 kN	-1.326kN
	Axial force Fx	25.769 kN	24.564kN
Combined	BM Mx	0	0
Load	My	24.418 kNm	23.117kN m
	Mz	106.560 kNm	104.121kN m
	Shear force Fy	77.580 kN	74.323kN
	Fz	-7.77 kN	-6.67kN
	Axial force Fx	93.570 kN	90.450kN

6. Conclusion:

- Hollow blocks are known for very good building construction . Hollow blocks big in size comparing with fly ash bricks and will reduce cement consumption by 50% . So these blocks can reduce construction cost.
- Blocks will control the temperature inside the building. Any element like cement brick, plastering & cement flooring will absorb heat & will keep up the same temperature in night also.
- The displacements is found to be more in the structure where the in fills are not present.
- According to relative value of all parameters it can be concluded that provision of in fill wall enhances the performance in terms of storey displacement drift control and increase in lateral stiffness.
- From the design results of beams, we may conclude that Hollow block gave lesser area of required steel as compared to Fly ash using ETABS.

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