Analytical Investigation of Precast Panel and its Utilization in Low Cost Housing

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ABSTRACT

Abstract- Emigration toward metropolis for employments refugees to better country urbanization and globalization are the main reasons to scarcity of housing and increase in slum habitation. Slum dwelling is the challenge to both developed and under developed nation. Honorable Prime Minister of India has also dreamed to provide everyone shelter by 2020 under various housing schemes. There should be some advancement in construction practices and rational approach to use of material for low cost housing to achieve. From all the study and research done in the field of precast tilt up concrete and RCC wall panels its use as a structural member is clear, this paper explains the method to use of panel alone as a structural element for the construction of low cost frameless housing. Panel structure would be without beam and column erected on RCC tilt up wall panel with same panel is to be used in flooring. Capacity of wall panel can also be easily access due to advancement of latest method and research done in this segment. Two models are done one with Conventional RCC frame structure and other with frameless RCC panel structure with same plan in Etabs-15. Comparative results between two models are to be determined for static load and seismic effect in base shear, time period and displacement.

Keyword: - *Frameless structure, Tilt-up, RCC concrete panel, Slum rehabilitation, frame vs panel, and Etabs-2015.*

1. INTRODUCTION

Engineering is defined as application of science and mathematics for designing and creating structures for its utilization and beneficent to humanity. India being a developing country is a land of many slum dwellers, according to Government sources the Slum Population of India have exceeds the population of Great Britain. It has doubled in last two decades. According to the census in 2001, the slum dwelling population of India had risen from 27.9 million in 1981 to 61.8 million in 2001. Indian economy has achieved a significant growth of 8 percent annually in last four years, but there is still large number of people nearly 1.1 billion still survives on less than 1 $ (around 68 INR) in a day. Despite of Government efforts to build new houses and other basic infrastructure, most of the people living in slum areas do not have proper shelter. Mumbai is home to Estimated 6.5 million slum people which accounts to majority of its population. Objective of the author and many corporate Giants is to work with government to terminate slum dwellers and educate them with proper construction techniques so as to enhance their lifestyle and provide with structure to withstand all phases of nature i.e. earthquake wind force and sun stroke.

The conventional methods used for housing must be analyzed and replaced by new developed construction techniques based on technical experiments and analysis. Adoption of any alternative technology on large scale needs a guaranteed market and this cannot be established unless the product is effective and economical. Partial precast is an approach towards the above operation under controlled conditions. Mass housing can be possible with systematic

approach in building methodology and not necessarily particular construction type or design. If adopt right method at the right place by implementing partial precast technique we can succeed in getting solution over costly housing.

1.1 Previous study

Previously reinforced concrete walls in framed structure were considered as non-load bearing and as such limited research was done on these elements. Due to the recently gained popularity of tilt-up construction concrete walls have become just as important structural element as beams, slabs and columns. The recent gained popularity of reinforced wall as a structural element has spread to Australia, before to the 1990's limited experimental research was done on concrete panels. Since then a number of research projects focusing on the load capacity of concrete walls have been initiated in Australia.

Doh and Fragomeni (2012) [1] Have done an impressive work in the analysis of wall panel with and without opening in one way and two way action. In this paper they have tested reinforced concrete walls with and without openings in one-way and two-way action. The test panel with slenderness ratio of 30 is subjected to a uniformly distributed axial load with an eccentricity of thickness of wall/6. Typical failure modes and load-deflection behavior are also explained in detail. A simplified wall design equations given in the Australian Standard AS3600-01 and American Concrete Institute code ACI318-02 are intended only for solid load bearing walls supported at top and bottom (one-way action). These code provisions are unable to include the effects on load carrying capacity when to restraints on the side edges (two-way action).

J. G. Sanjayan (2000) [2] have studied on Load capacity of slender reinforced concrete walls governed by flexural cracking strength of concrete. His studies demonstrates comparative results using experimental results and theoretical derivations, found out that reinforced concrete walls may be able to carry much higher loads if the flexural cracking strength is considered in the calculation. Presented a theoretical derivation of formulae's for estimating the axial load capacities of reinforced concrete walls subjected to eccentric axial loads as well as uniform lateral loads.

Bob van Gils (2010) [3] has studied on Precast concrete shear walled structures, also called large panel systems, are a good solution for multistoried residential and commercial buildings. This paper describes the practical and economical aspects of designing and constructing these kinds of structures. The large panel systems are made of large precast walls and slabs that are connected to each other in vertical and horizontal direction. The precast wall panels should be load bearing members and shall be capable of carrying the vertical and lateral loads. The wall panels can be connected to each other in various ways and together with the floor diaphragm they will form box type structures. The external precast wall panels shall be a finished product and no cement plaster shall be required. The precast concrete structures with load bearing wall panels have several advantages compared to RCC frame structures.

1.3 Objective and scope of work

To perform structural analysis of RCC panel structure using the loading as specified in IS-875 in Etabs-2015.
To perform structural analysis of Conventional RCC framed structure using the loading as specified in IS-875 in Etabs-2015.

To compare seismic Structural response of conventional Frame structure with panel structure.

1.2 Concept of panel structure

Tilt up concrete shear walled structures, are a good solution for multistoried residential and commercial buildings. Efforts are to describe the practical and economical aspects of designing and constructing structures with the help of wall panel only. Precast wall panels should be load bearing members and shall be capable of carrying the vertical and lateral loads. The wall panels can be connected to each other in various ways and together with the floor diaphragm they will form box type structures. Panel structure is analogical to the wooden box made of wooden strip as shown in figure-1. In panel structure same wall panels is used in slab which are used as a vertical load bearing wall.

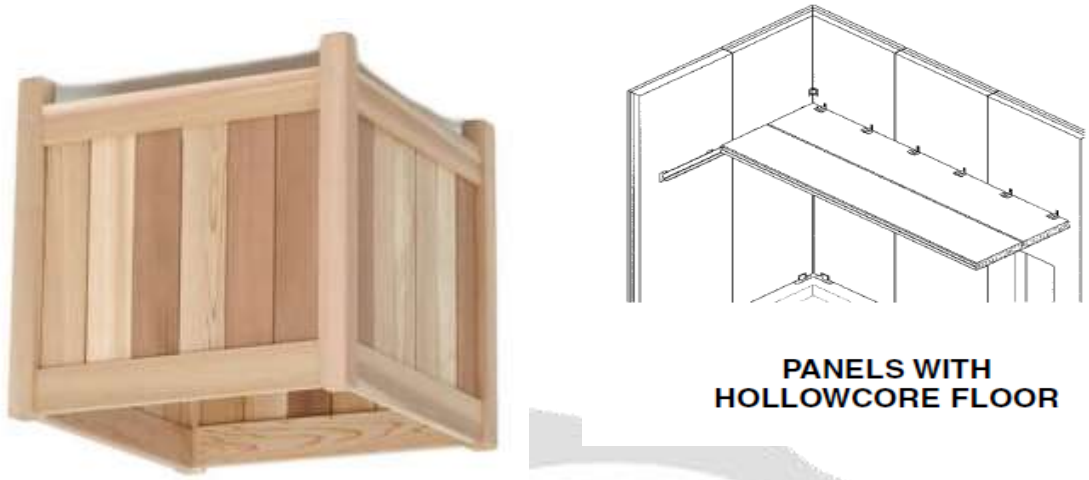

Fig -1 Analogy of panel model to wooden plate box

2. METHODOLOGY

For the analytical purpose a residential building proposed to have in Pune is considered. This structure consists of G+1 floor levels having Floor to floor height of building is 2.85 m shown in figure-2. Load application and load combination are as per specified in Indian standard codes. The objective is to analyze structure with structural configurations of building with conventional Beam Column Frame structure and load bearing RCC precast tilt up wall panels also used in slab. Work is to determine the comparative results between conventional frame and panel structure in seismic stimulation. Comparative analysis includes base shear time period and displacement.

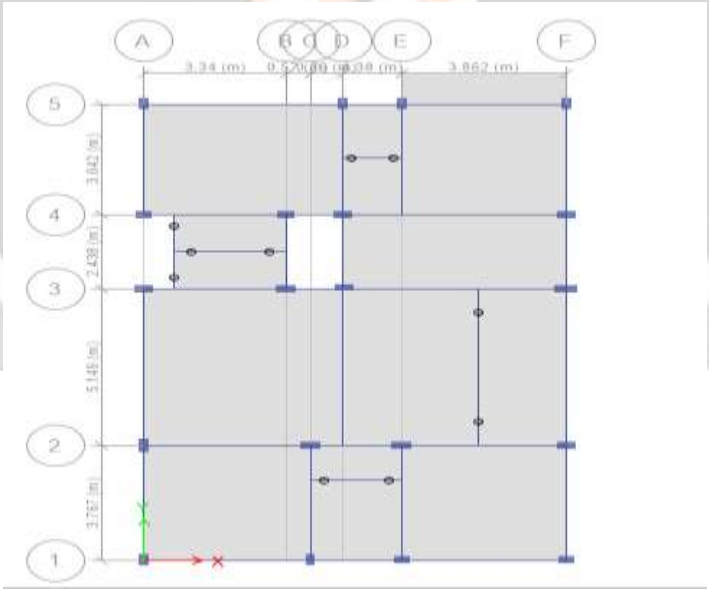

Figure-2 Residential building plan used in modellig

Material properties and sections used in conventional RCC model, wall panel model are tabulated in table 1 through table-3

Table -1- Material property used in model

MATERIAL USED	STRENGTH (kN)
Precast wall	M30
Structural elements	M30
Reinforcement	Fe500

Table -2 Section of beam column used in RCC frame model

STRUCTURAL ELEMENTS IN RCC MODEL	SIZES
Column 1	230*380
Column 2 (C2)	230*450
Beam 1 (B1)	230*450
Beam 2 (B2)	230*530

Table -3 Section of wall panel used in RCC Panel model

WALL ELEMENTS USED IN PANEL	THICKNESS
WALL PANEL 1 (W100)	100
WALL PANEL 2 (W150)	150

2.1 Analysis Philosophy

Before we proceeds further to results lets understand the terms used in analysis of results. Analysis of structure includes for vertically downward force and lateral forces coming on to the building.

Vertical Forces- Dead load due of the structural elements, Live Load on the Structure, Superimposed dead load

Lateral forces includes- Seismic, Wind etc.

As vertical loads are not significant in stability comparative analysis of structure on this base are not in the scope of this paper, discussion in this paper is in regards to earthquake analysis and lateral load due to wind is neglected.

3. RESULTS AND DISCUSSION

Results discussed here are on the comparative seismic analysis on RCC panel Vs RCC conventional frame with identical conditions.

Base Shear- As base shear is the direct function of the seismic weight therefore naturally base shear is more in the case of RCC panel structure. In RCC framed structure the base shear seems to be less and hence required design will not be heavy. Base shear in panel structure is approximately 24% more than framed structure. The reason behind this is that self weight of panel structure is comparatively more than framed structure. As shown in figure-3 below.

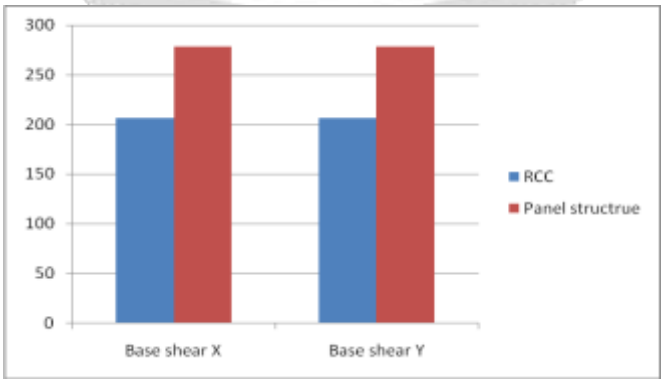

Figure-3 Comparative Results of base shear

Time period- Time period of first mode in RCC framed structure is 0.676 sec and in that of panel structure it is 0.06 sec which is that is 10times less.As all the walls of panel structure act as a shear wall structure is bound to be rigid. Hence panel structure can be termed as rigid structure Figure-4 shows a graph of modes to time period.

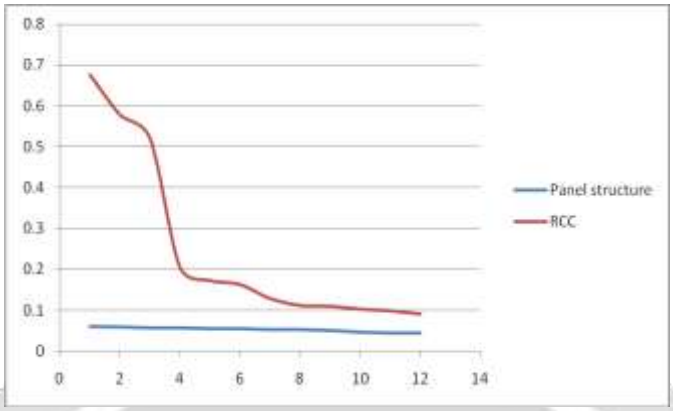

Figure-4 Comparative Results of time period

Displacement- While comparing the storey displacement of all storeys, RCC structure is having significant variation at top storey compare to Panel structure. Displacement of panel is within the code limit but too small as compare to Conventional RCC structure. Maximum joint displacement comparison between RCC framed structure and panel structure, it can be clearly recognized that the displacement in panel structure is negligible and the structure is stiff in all four extreme joint of building. Maximum displacement in RCC structure is found to be 4.6mm and in panel structure it is 0.03726 Figure-5 shows the variation in the displacement against the storey height.

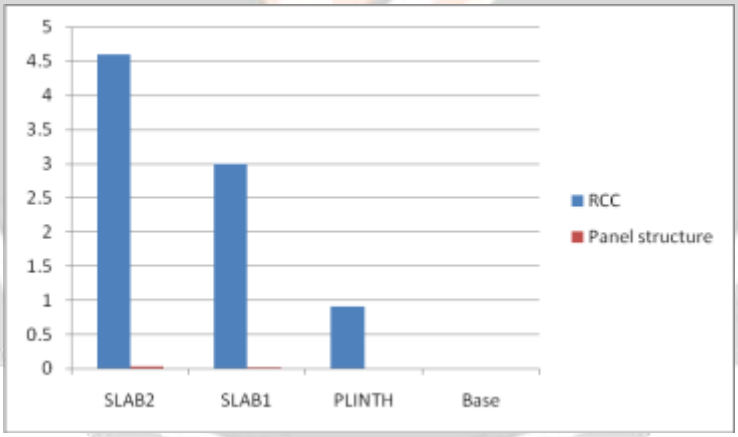

Figure-5 Comparative Results of Displacement in X-Direction

3.1 Observation

From the results it has been observed that displacement in panel model is very small and time period of structure too is very short hence the structure can be termed as rigid structure, there should be some code provision in height to width ratio of building so that the building should resist overturning effect.

4. CONCLUSIONS

1) Base shear seems to be more in the RCC Panel structure and majored as 26% more when compared with RCC framed structure.
2) The significant variation which is more than 36% is seen in the fundamental time period in between RCC and panel structure in the first mode.
3) The time period in the panel structure is seen to be more as the self weight of the structure is increased.
4) The displacement in X and in Y direction for panel structure for earthquake is seen to be less as wall panel acts as a shear wall and resist the lateral load.

5) Panel structure is stiffer and rigid compare to framed strucrure as the time period and displacement is found to be less.
6) Cost benefits can be achieved on secondary cost of construction as the construction method is easy and rapid.

5. OBSERVATION AND FUTURE SCOPE

- Connection designing of wall panel elements.
- Standardization of wall panel element to use as a thumb rule in designing.
- Establishing a codes provision in geometric parameters like height, width and length ratios.
- Innovative design of connections to provide some degrees of freedom to release stress if required.

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