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Analysis of G+35 Structure by Monolithic Construction Technique using Etabs Software

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ABSTRACT: In the cost and time effectiveness of buildings, Reinforced concrete wall or Shear wall act as a beneficial member of building compare to conventional structure system. The monolithic structure is important to reduce wall thickness, decreasing to foundation width and especially useful to reduce seismic effect. In this paper, we conclude the reviews and previous research of some research experts on the benefits over Conventional structure system to monolithic structure system. This study is to determine the suitability, adoptability and economic feasibility of monolithic structural system against conventional structural system. This topic is very useful to construction industry. In the seismic design of buildings, reinforced concrete structural walls, or shear walls, act as major earthquake resisting members. Concrete walls are provided for the additional gravity force resistant. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. In these paper conventional, monolithic with external walls structural systems and monolithic with internal wall system for G+20, G+25, G+35 storey was studied with the help of ETABS v 15 analysis and design. Additional Parameters like Lateral displacement, storey drift are calculated for both the structures. we concluded that there is drastic improvement in the monolithic structure as compared to conventional structure in term of strength as well as cost.

KEYWORDS: ETABS; Seismic Analysis; High-rise buildings, Monolithic structure

I. INTRODUCTION

Monolithic structure means the whole structure along with the slab is casted at a time. In order to construct a monolithic structure we required formwork for construction. In this project we discuss about the importance of use of monolithic construction work for high rise building. In accordance with the importance of time, it is feasible method for construction of the repetitive construction work as compared to conventionally applied method of construction. In this work we use aluminum formwork. Monolithic construction work is able to deliver good quality and durable structure in cost effective manner. It has been used in development of silos, residential building, schools, stadium, and roof of industries, nuclear reactors, pressure vessel, and auditorium. In monolithic structure we used formwork which provides proper alignment, smooth surface and good quality work. Due to use of formwork it increases the speed of construction as compare to conventional method.

The most basic form of monolithic architecture is a rock cut building (Single piece rock). The monolithic Churches of Ethiopia or the PanchaRathas (India). The first modern monolithic dome structure was built in Provo, Utah and opened in 1963. From many years, engineers have observed that there are Varieties in structural material and system which classified by construction material like concrete, masonry, steel, or wood. Some basic categories of structural systems are: Load Bearing wall systems like- masonry, concrete, Building frame systems like- concrete, steel, and wood. A well designed monolithic structure having shear wall may decrease the project cost. In the research two different structural systems were considered,

- (i) Beam-column structure (conventional system)
- (ii) Shear wall structure (monolithic system).

This structure provides safe shelter for the people area with hurricane, fires, bomb blast and earthquakes. Igloo is also a one kind of monolithic structure.

1.1. Tall structure

Tall structure can be define as the multistory building generally constructed by a various structural frames, and provided with high speed elevators and amenities provided with extraordinary height with ordinary room spaces such as low rise building. In short it is the expression of the city's power base, representing its private and public investments.

1.2. Monolithic structure

In Monolithic System; all walls, slabs, stairs, together with door and window openings are cast in place in one operation at site by use of specially designed formwork, easy to handle with less labour and equipment efforts modular form work made of Aluminum Plastic composite. In this system the lateral and gravity load resisting system consists of reinforced concrete walls and reinforced concrete slabs. Reinforced concrete structural walls are the main vertical structural elements with a dual role of resisting both the gravity and lateral loads.



(Fig1.1 Monolithic Structure With Aluminum Formwork)

II. LITERATURE REVIEW

These literature reviews are experimental work carried out by researchers on monolithic structure system.

Can Balkaya at el. (2004) they made that multistory Reinforced Concrete model and they put high stress concentration after all they tell it from the experiment Finite Element Method(FEM analysis) on it that, in monolithic Structure outer shell had shear wall; it was less prone to cracks in its structure. And also gives the best seismic performance with low cost compare to conventional building. (1)

NuzulAzamHaron at el. (2005) this study had come to know the cost comparison of conventional system and industrialized building system of formwork system (monolithic structure system). It provides to know that which one is cheaper and better among the conventional system and monolithic system. The data for research were collected from questionnaire survey and case study. From the statistical 't-test' they had derived that notable variance in cost saving for conventional structure over the formwork structure.(2)

H. Gonzales at el. (2011) this paper presents that the seismic assessment has been carried out for seven existing shear wall and average height buildings which are already in Peru. They have carried out static and dynamic nonlinear analyses for prescribed bodies. They came to the conclusion that the seismic strength of all the analyzed buildings is insufficient. Collapse Prevention is achieved first in the coupling beams. And some of feasible modifications in coupling beams make better seismic performance. (3)

N. H. Abdul Hamid et al. (2012) research slab-wall joint performance in RC wall construction during lateral loading. They prepare a slab-wall model and by using linear potentiometers and actuator they concluded that, stiffness of wall-slab joint started to decrease from 0.2% drift until 2.1% drift and lost its stiffness after 2.1% drift. (4)

Beatrice Belletti et al. (2013) this paper presents the seismic performance of multi-storey reinforced concrete structural building vertically joined with ordinary RC bar is analyzed and carried out different modeling made for pushover analyses. They came to end with that, through lumped plasticity model a reliable seismic response has been obtained, comparable to that one obtained with more remodified models. (5)

D. M. Wijesekara et al. (2012) formwork is one of the most important factors in determining the success of a construction project in terms of speed, quality cost and safety of work as it accounts about 40% of the total project cost of the structure. To minimize the costs the contractor needs to complete the project as soon as possible and the client wants the building to use the building as early as possible for the intended purpose. In high rise building construction the most efficient way to speed up the work is by achieving a very short floor cycle. That directly depends on the selected formwork type for the construction. This paper will present about the existing formwork types in Sri Lanka and the available new techniques in formwork erection. This paper will clearly present an analysis and comparison of costs and duration of projects when using different types of formworks. The main objective of this paper is to identify the least no. of typical storey required in a high-rise building construction project, to use aluminum panel system formwork. (6)

Deepak Suthar et al. (2014) the vertical growth is referred to a high-rise building, and a comparative analysis of dynamic loads are carried out on these high-rise structures using various International Standard Codes (American, European and Indian), with the inclusive of recently developed IS 1893:2016. (7)

Rajesh M. N. et al. (2014) reinforced concrete wall building model makeover and analyzed by 3D graphical analysis and design (SAP 2000's) pushover analysis by using layered shell elements. Various parameters such as aspect ratio of walls, RC detailing aspects and existence of openings are selected to study the seismic performance of reinforced concrete walled building. Finally up to end, by providing outer boundary component base shear capacity increases. (8)

H. G. Vivekprasad et al. (2015) comparative study of conventional, monolithic and precast construction techniques. The parameters for comparison majorly constitute of constructions materials and time required, cost incurred if the mass housing structure was constructed with conventional precast and monolithic methodologies. New and alternative approaches have been developed to compress the construction cost and reduce the overall time involved in the completion of the construction project. The alternate approach for the conventional method is fast track construction which involves monolithic and precast construction. (9)

Sajeet. S. B. et al. (2015) mivan wall System is one such new technology which has been used extensively across the world. MIVAN WALL technology is acceptable for constructing a huge number of buildings within minimum time by room size forms. In this system of formwork construction, cast-in-situ concrete wall and floor slabs are cast monolithically (Using only one material) in one continuous pour. (10)

Mr. N. B. Baraskar et al. (2015) analysis is carried out considering the various seismic and wind load condition for both systems of framing. Column beam conventional system and RC structural wall compared on the basis of various structural parameters. From analysis result, new structural parameter is represented which has the best performance in the worst loading. (11)

MatejSpak et al. (2016) the common concrete has a long history in precast elements production. The merits of precast construction are multiplied by combination of modern methods of concrete structures construction with advanced concrete technologies (HPC, UHPC). Therefore the use of advanced concrete technologies in precast construction has the significant potential to improve construction efficiency. On the other hand, HPC and UHPC technologies are utilizable also in monolithic concrete construction thanks to their technical and technological properties. Meaningful reduction in weight and volume of the structures leads to elimination of environmental impact resulting from lower material consumption. (12)

Harris M. Mal et al. (2016) in India generally monolithic construction system carried out only for lower rise buildings; if we contemplate this structural system medium height to sky scraper building then it may be more practicable, acceptable and economic comparing conventional structural system. In this structural system all elements are cast at site together. For analysis and design, Etabs software is used for both structural systems. (13)

Rahul B. Mojidra et al. (2017) in the seismic design of buildings, reinforced concrete structural walls, or shear walls, acts as major earthquake resisting members. Concrete walls are provided for the additional gravity force resistant. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. (14)

The following conclusions were carried out by researchers that, if monolithic structure will use than benefits are,

- [1] Accelerate the construction work.
- [2] Supreme surface finish.
- [3] Excellent Dimensional firmness.
- [4] Avoiding the time consumption taken by brickwork and plastering work.
- [5] Due to reduction of dead load, superstructure and foundation cost and size are minimized without compromising on strength.
- [6] Unparalleled strength against earthquakes.
- [7] Good water resistant surface quality.
- [8] Improve precise scheduling and quality control.
- [9] Reduce need of Manpower.

III. PROPOSED METHODOLOGY

For this study, a 20-storey, 25 storey and 35-storey building with a height of 3-meters for each storey is modeled. The sections of beam, column, shear wall is rectangular with common dimensions. The buildings are modeled using software ETAB v 15, three different models 1. Conventional Structural System (beam-column structural system) 2. Monolithic with only external wall structural system 3. Monolithic with external as well as internal wall structural system.

Dead load & live load calculation is as per IS 875, and Earthquake load calculation is as per IS 1893, wind load as per IS 875, taking EQ Zone-III by using static coefficient method. The data for these frames are given below.

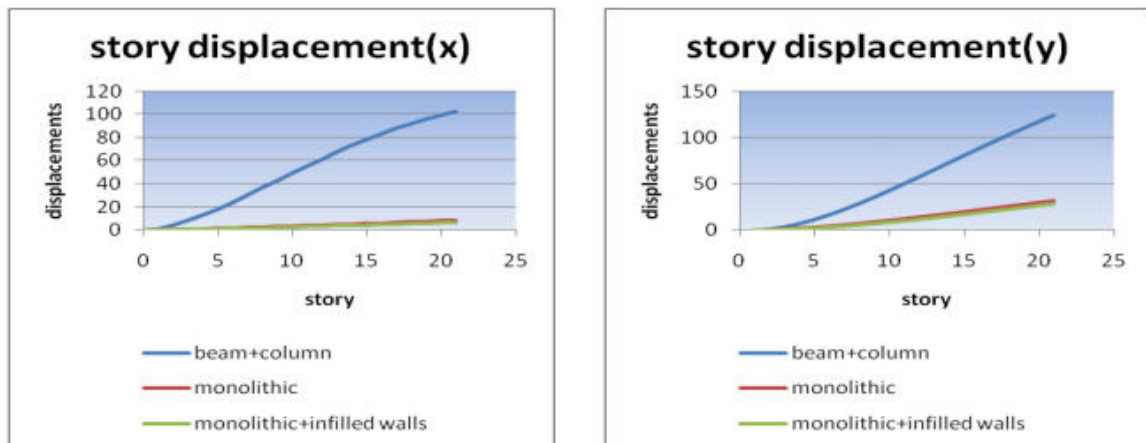
Seismic Zone – III, No of storeys – 1 to 20, 1-25, 1-35. Floor Height – 3m, Thickness of Shear wall – 300mm, Materials – M30, Fe 500, Depth of Slab – 150mm, Unit Weight of RCC – 25kN/m³, Type of soil – Medium. Size of beam 300x450 mm taken initially and increased as the design requirements.



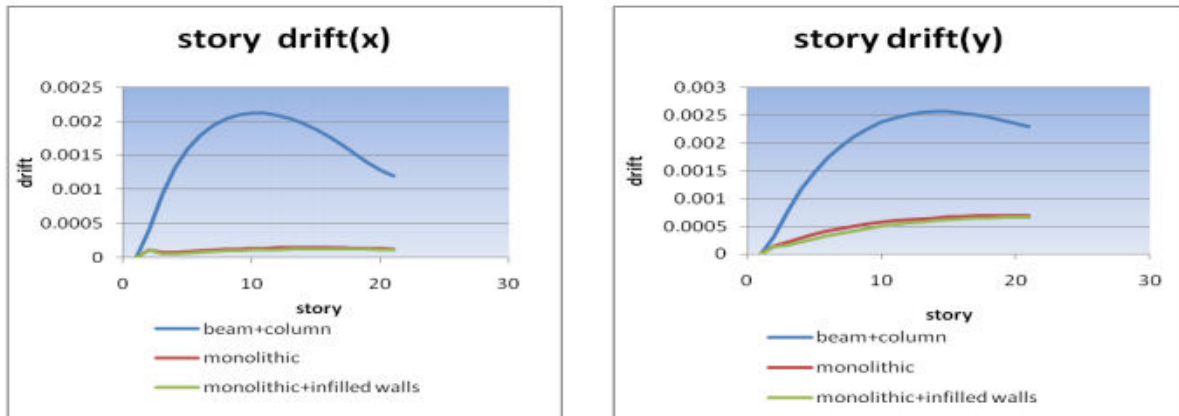
Fig. 3.1: architectural plan

IV. RESULTS

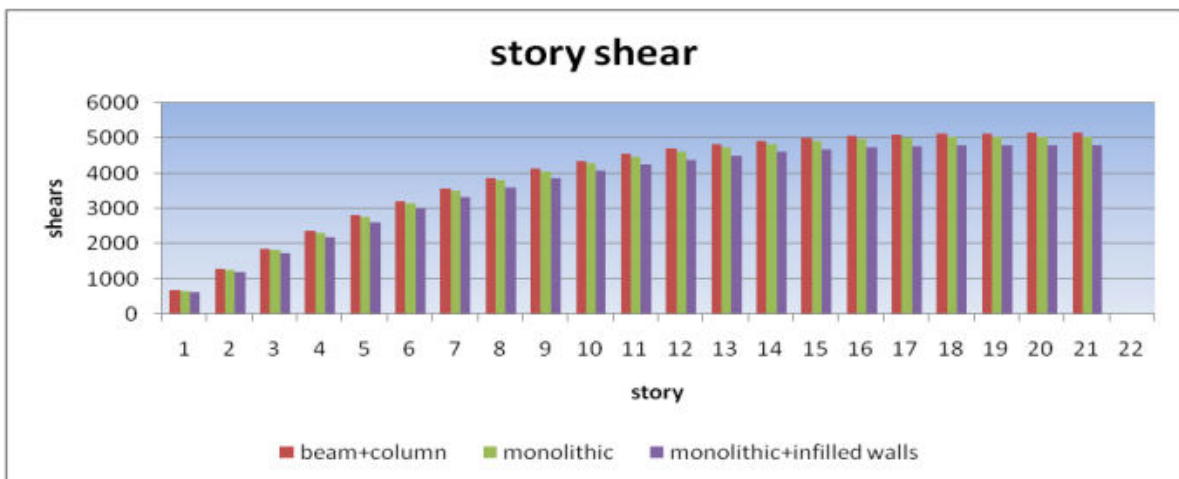
After analyzing and designing above plan, we have compared following parameters and cost of above mentioned three system for 20 storey, 25 storey and 35 storey. Comparisons are as follows.



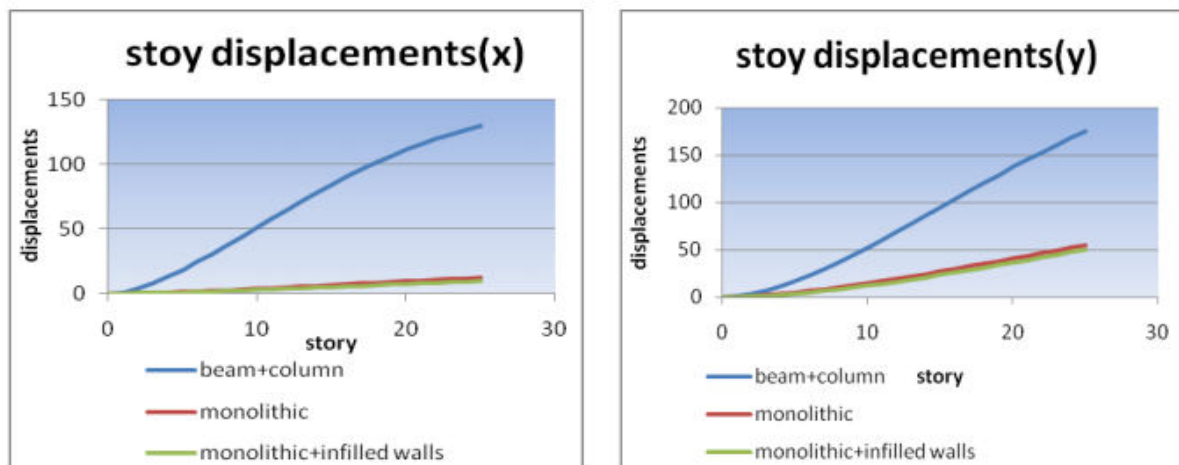
(Fig.4.1 :comparison of displacement in x direction for 20 storey, comparison of displacement in y direction for 20 storey)



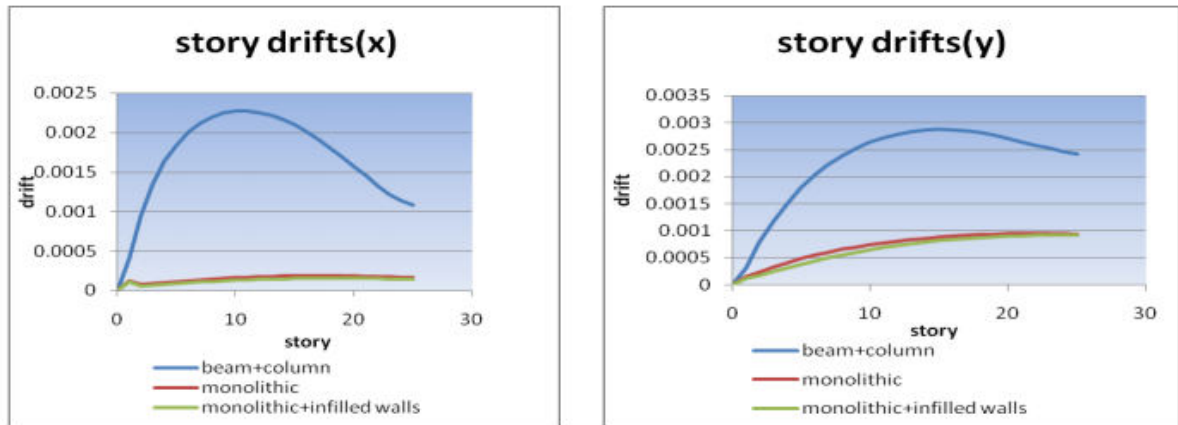
(Fig.4.2 :comparison of drift in x direction for 20 storey, comparison of drift in y direction for 20 storey)



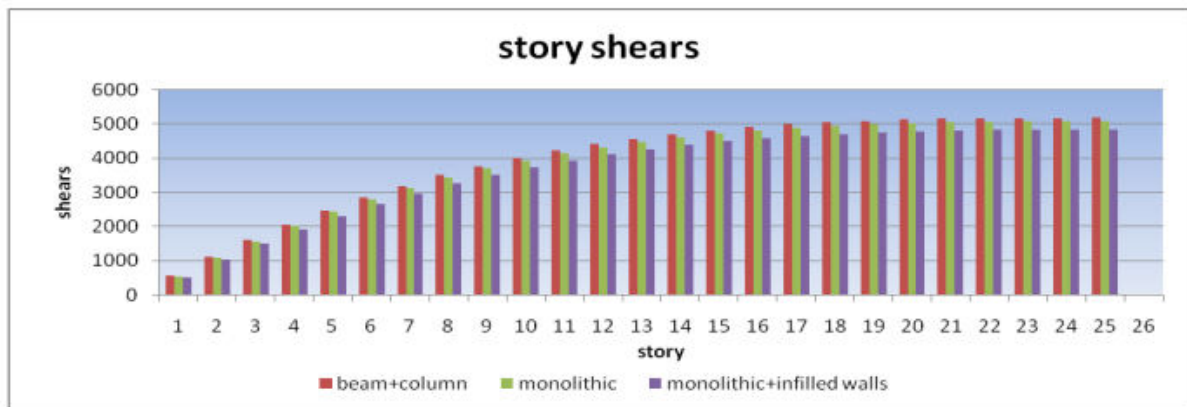
(Fig.4.3 :: comparison of storey shear for 20 storey)



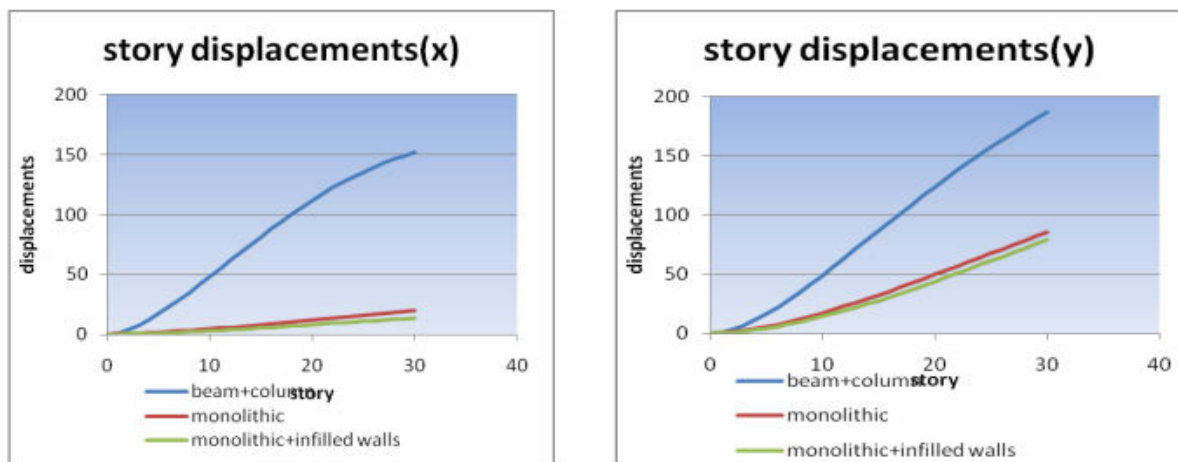
(Fig.4.4 :comparison of displacement in x direction for 25 storey, comparison of displacement in y direction for 25 storey)



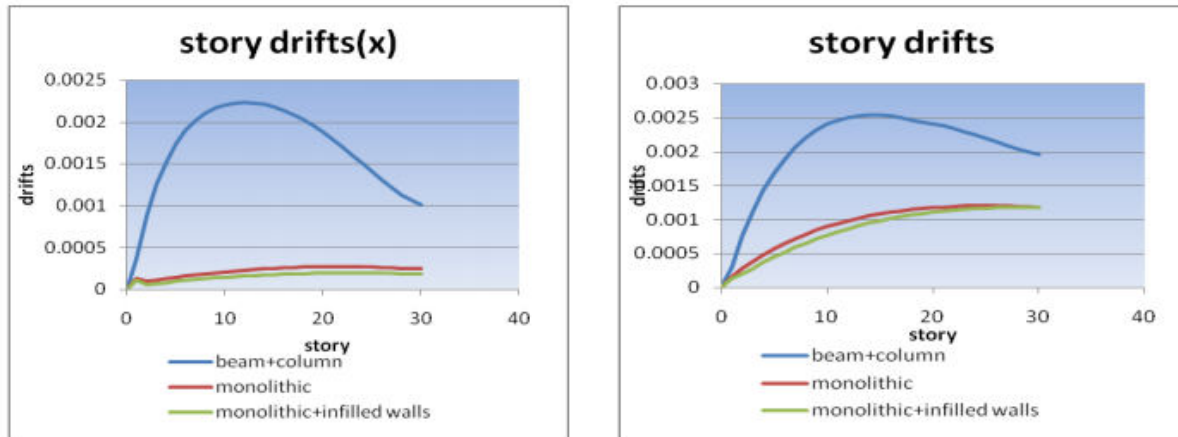
(Fig.4.5 :comparison of drift in y direction for 25 storey, comparison of drift in y direction for 25 storey)



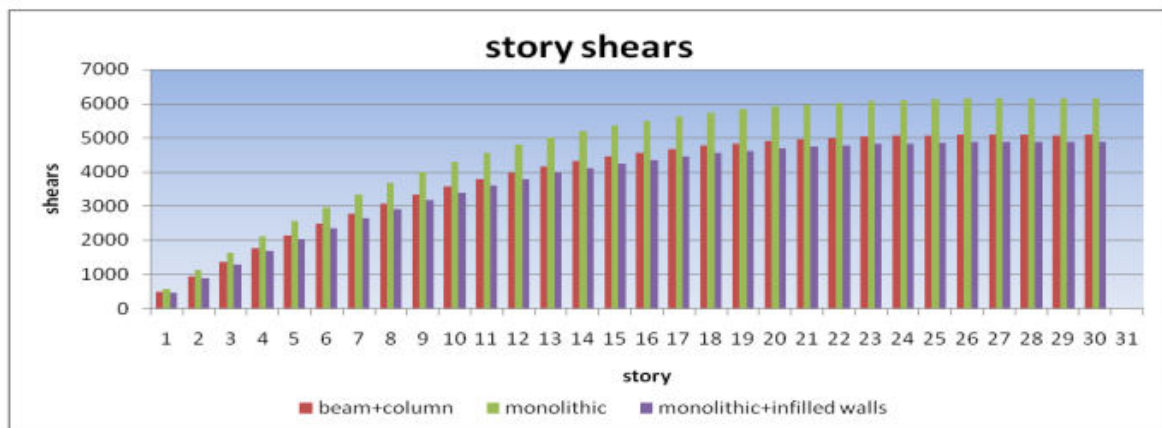
(Fig.4.6 :comparison of storey shear for 25 storey)



(Fig.4.7 :comparison of displacement in x direction for 35 storey, comparison of displacement in y direction for 35 storey)



(Fig.4.8 :comparison of drift in x direction for 35 storey, comparison of drift in y direction for 35 storey)



(Fig.4.9 :comparison of storey shear for 35 storey)

V. CONCLUSION

Comparison of strength parameter

For 20 storey

For monolithic with external walls system displacement reduced to 71% to 92% and drift reduced to 69% to 91% against conventional method.

For monolithic with internal walls system displacement reduced to 74 to 94% and drift reduced to 72 to 93%% against conventional method.

For 25 storey

For monolithic with external walls system displacement reduced to 65 to 85% and drift reduced to 65 to 84%% against conventional method.

For monolithic with internal walls system displacement reduced to 70 to 87% and drift reduced to 69 to 85%% against conventional method.

For 35 storey

For monolithic with external walls system displacement reduced to 59 to 89% and drift reduced to 55 to 87%% against conventional method.



For monolithic with internal walls system displacement reduced to 64 to 93% and drift reduced to 59 to 91%% against Conventional method.

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