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A STUDY BEHAVIOR OF SOFT STORY BUILDING CONSIDERING DIFFERENT SUPPORT CONDITIONS

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ABSTRACT:-Now a day's in RCC (Reinforced Cement Concrete) structure as an open first storey is generally provided for social and functional need in multistory building. They are used for parking, communicaton halls, intercourse hall or any other purposes. In RCC framed multistory building the walls are not considered as a part of structures, but from recent studies it shows that partition wall by using different infill materials helps to improve the strength of building against lateral load. An infill material provides stiffness to the RCC framed structures. Soft storey at different levels of multistory building is constructed. Investigations of past and recent earthquake damage have illustrated that the building structures are severe damage or collapse during moderate to strong ground motion. In this paper reviews various research works carried out by several researchers on seismic behavior of multi-storied buildings provided with different infill materials with soft storey.

Keywords:- Multistory building, infill materials, seismic behavior, RCC frame.

I. INTRODUCTION

In a recent construction multistory building the soft story provided at base of building. A multistory building with soft storey, one or more floors are "soft" due to structural design. Soft story buildings are characterized by having a story in which lot of open space such as parking, communication hall or large spaces or floors with a lot of windows [1] in which lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of three storey above in buildings [2]. Generally buildings are constructed in recent times considering a special feature - the ground storey is provides open for the purpose of parking, i.e. columns in the ground storey without any partition walls (of either masonry or RC) between them. Such buildings called as open ground storey buildings [3]. Upper stories have brick infill wall panel and open ground storey is provided in building is called as stilt building and the open storey is called as stilt floor or soft storey. A soft storey also known as weak storey [4]. The important reason behind the need is the buildings are designed to existing design codes well performance in earthquakes with respect to safety of human life, loss of economy, usage and extent of damage to structures. The repairing cost of for damaged structures is very high [5]. These soft storeys buildings are collapsed due to irregularities introduced in RC frame buildings. These irregularities are primarily because of uneven distribution of mass [6].

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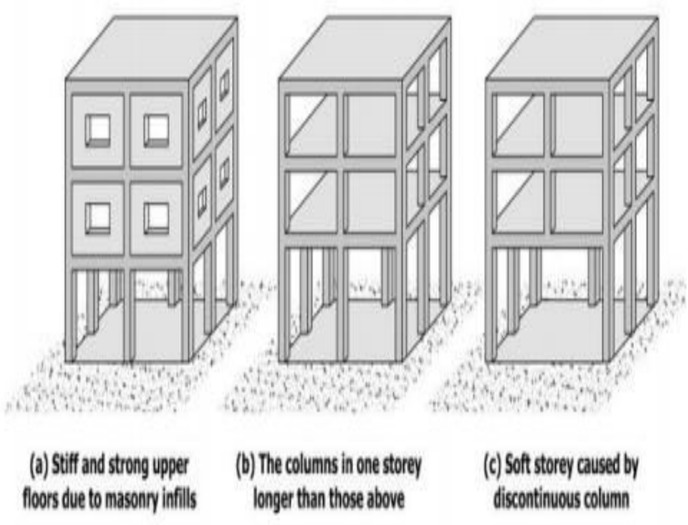

Multistory building with soft storey

II. METHODS

The selected 3 and 6-story frame buildings are regular 20m by 16 m in plan as shown in Figure 1 below. They have 5 bays by 4m along X direction and 4 bays by 4m along Y direction (Figure 1). Typical floor height is 3m. The location of masonry infill walls in plan is shown by the hatch of beams (Figure 1). The selected buildings have the plan view as shown in Figure 1:

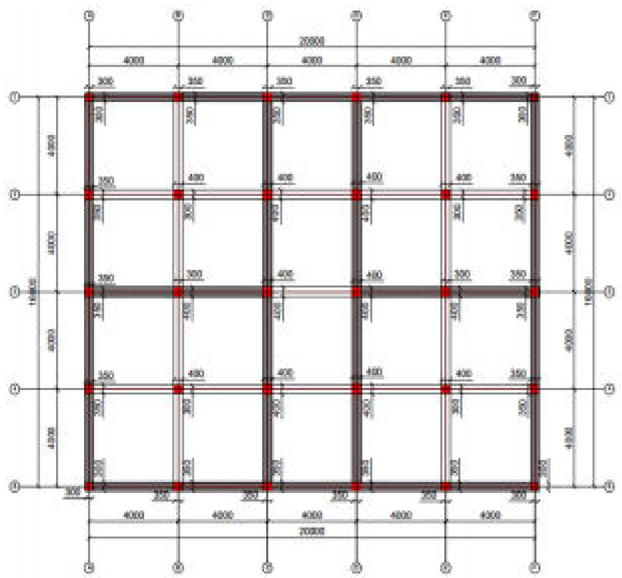

Figure 1 Structural Plan view of 3, 6-Story frame (units in mm)

Beam and column dimensions of the reference buildings represent the most common frame elements for low and mid-rise frames in Albanian construction practice. The 3-story frame consists of 300mm x 300mm corner columns and 350mm x 350mm outside columns, identified as C1 and C2 respectively, 300mm x 400mm, 400mm x 300mm and 400mm x 400 mm inside columns, identified as C5,C4 and C3 respectively, as shown in Figure 2. Beams have all the same section for the 3- story frame which consists of 300mm x 400 mm, Figure 4. The 6-story consists of 400mm x 400 mm corner columns and 500mm x 500 mm outside columns, identified as C3 and C6 respectively, and 600mm x 600mm, 500mm x 400mm and 400mm x 500 mm inside columns, identified as C7, C8 and C9 respectively, as shown in Figure 3 and the beams have all the same section 300mm x 400 mm, Figure 4. Material properties are based on most common materials used in Albanian construction practice; it is assumed 20 MPa for the concrete compressive strength and 355 MPa for the yield strength of reinforcement. Then in order to get the effect of soft story structural irregularity in reinforced concrete structures the selected buildings are modified to have above-mentioned structural deficiency, soft story. The cases which will be analysed are: 1- Reference regular building, infilled frame, (Ref), Figure 5a 2- Reference regular building without masonry infill walls, bare frame, (RefWW), Figure 5c 3- Soft story due to increased ground story height (3 m to 4.5 m) (SSH), Figure 5e 4- Soft story due to absence of walls at ground story (SSW), Figure 5b 5- Soft story due to increased height and absence of walls at ground story (SS-H-W), Figure 5d

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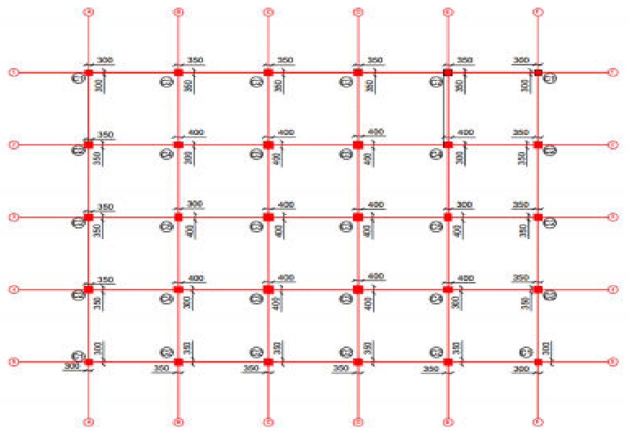

Figure 2 Column plan view of 3 Story frame (units in mm).

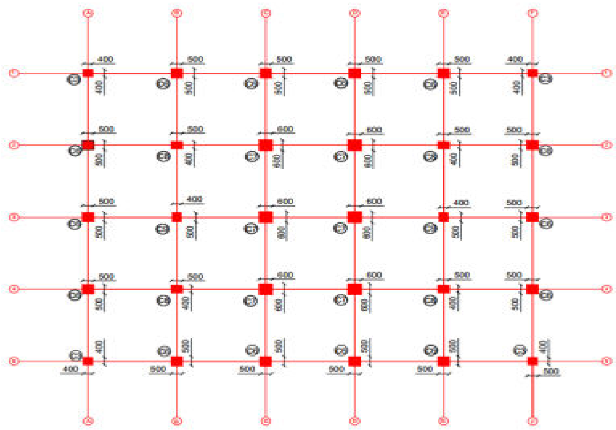

Figure 3 Column plan view of 6 Story frame (units in mm)

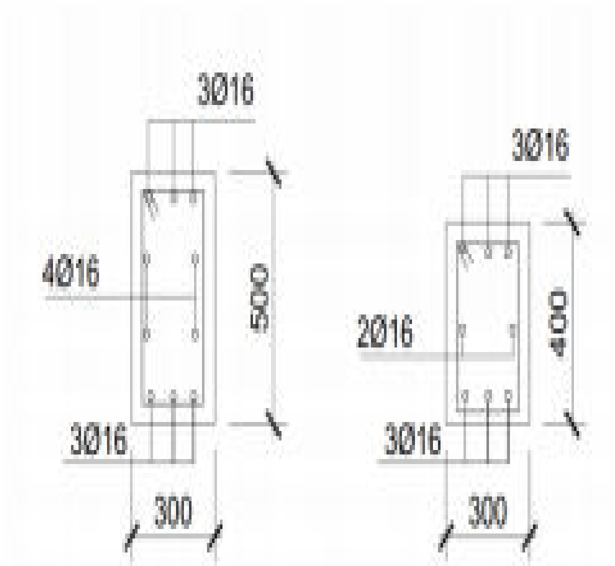

Figure 4 Beam Sections (units in mm)

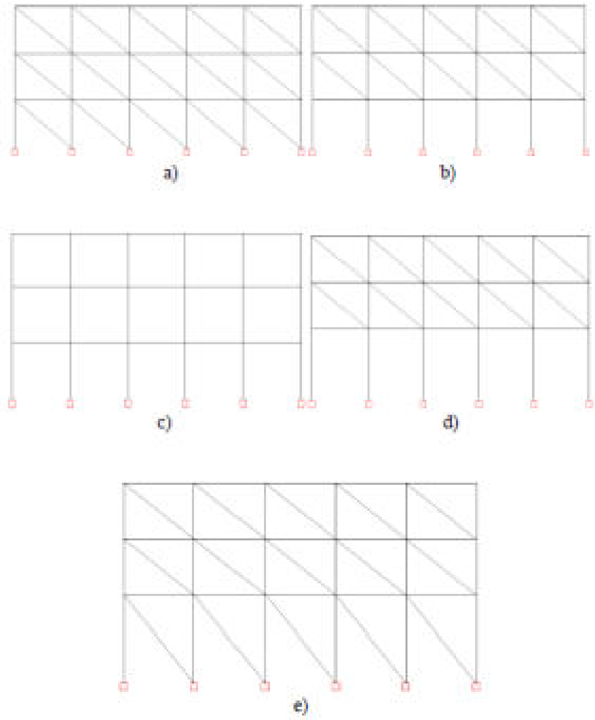

Figure 5: Elevation view of building models a) Ref, b) SSW, c) RefWW, d) SS-H-W, e) SS-H

III. RESULTS

Pushover analysis has been conducted for the 10 building models. The material nonlinearities are assigned as hinges; M3 flexural hinges for beams and PM2M3 flexural hinges for columns. Infill panels are modelled by one nonlinear strut elements, which only has compressive strength. Then each lateral load pattern is applied and static pushover analyses results of the case study buildings are generated. Behaviour of the structure is represented by capacity curves that represents the base shear force and displacement of the roof. Figures 7-10 illustrates capacity curves obtained from the pushover analysis of the 3 and 6-story frames. In x-axis is shown the roof drift ratio that is roof displacement normalized by the building height and in y-axis is shown the shear strength coefficient that is the base shear force normalized by the seismic weight.

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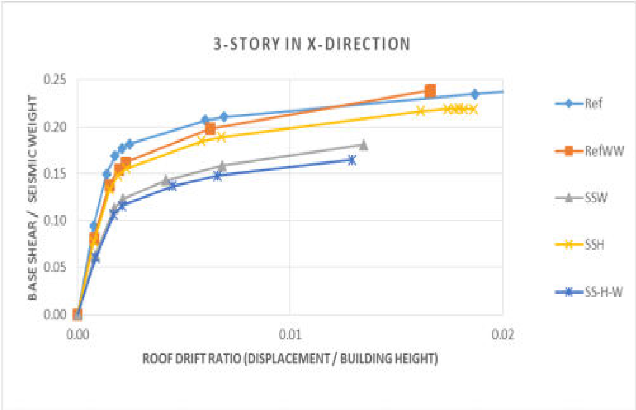

Figure 7 Capacity Curve of 3- story Frame, X-direction

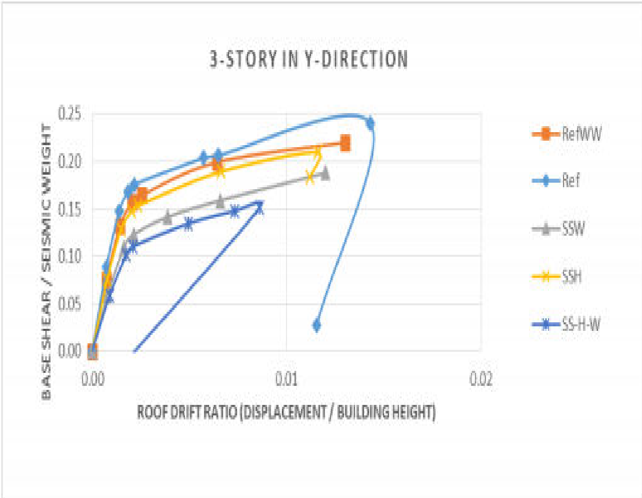

Figure 8 Capacity Curve of 3- story Frame, Y-direction

From the normalized graphs (see Figures 7-10) is showed that presence of masonry infill walls for both frames increases both stiffness and strength of the frames. Infilled (Ref) frame has shown approximately a stiffness of 1.4 and strength of 1.2 that of bare frame for the 3 story case and a 1.2 strength and 1.3 stiffness of the bare frame for the 6 story case. From the normalized graphs, presence of soft story irregularity effects the seismic performance of the frame, it both weakens and softens the system as shown in Figures (7- 10) below. Soft story due to absence of masonry infill walls at the ground story is found to be more damaging than the soft story due to greater height of the ground story in both cases low and mid-rise buildings, 3-and 6-story respectively. Soft story due to absence of infill has shown approximately 1.2 lower strength than soft story due to higher story height and 1.4 lower strength than the Ref building.

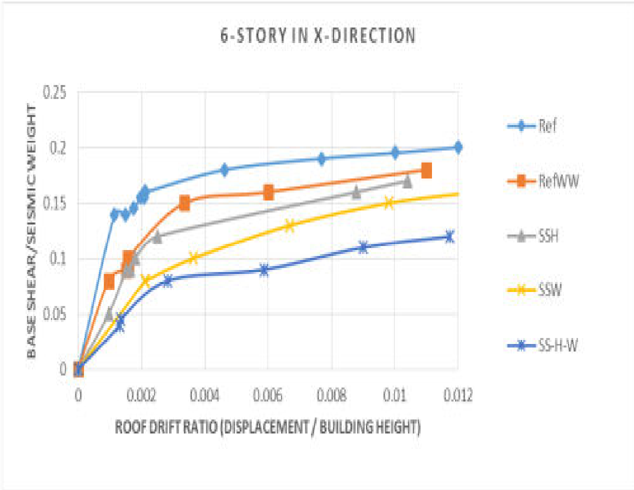

Figure 9 Capacity Curve of 6- story Frame, X-direction

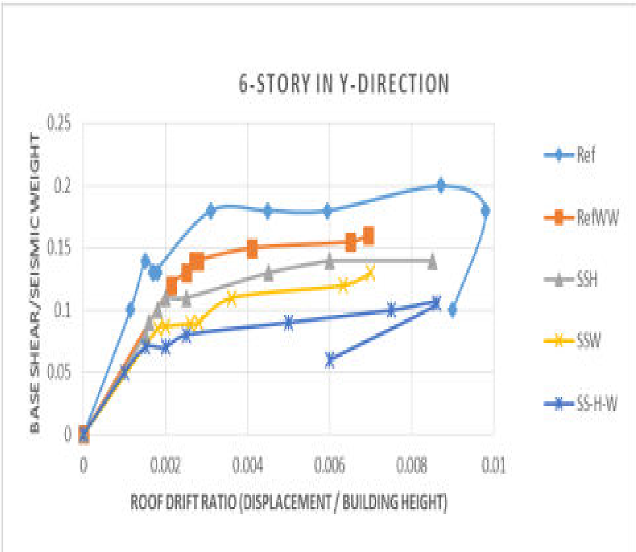

Figure 10. Capacity Curve of 6- story Frame, Y-direction

But the most unfavourable case is soft story due to both absence of infill walls and higher height of the ground story. The capacity curve of 6-story SS-H-W building has shown approximately 1.7

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lower strength and 1.2 lower stiffness than Ref building, and capacity curve of 3 story SSH-W building has shown 1.6 lower strength and 1.9 lower stiffness than capacity curve of Ref building. The drift ratios obtained in this study (see Figure 7-10) obviously show that the demands of 3- story buildings are higher than those of 6-story ones

IV. DISCUSIONS

There are many researches have been carried out to know seismic behaviour of multistorey building for different infill materials to find out the different parameters of building against different conditions. Storeys of buildings that are significantly weaker or more flexible than adjacent storey are known as soft storey buildings, these are characterized by having a story which has a lot of open space. While the unobstructed space of the soft story might be aesthetically or commercially desirable. Soft-storey is also called as flexible storey. A large number of buildings with soft storey have been built in recent year, but it showes poor performance during earthquake. Structural capacity will reducing under lateral loads. Displacement and relative story drifts are affected by the structural regularities [1]. A large number of buildings with soft storey show weak performance during earthquake. The provided strength and stiffness to the building frame by modified soft storey provision in two ways, (i) By providing stiff column & (ii) By providing adjacent infill wall panel at each corner of building frame. The displacement and force demands (i.e. BM & SF) in the first storey columns are very large for building with soft ground storey. The configuration of infill in the parking frame changes the behavior of the frame [3]. Stiffness irregularity in vertical direction affects the behavior of building. Lightweight infill is very effective in reducing the stiffness irregularity and storey drift. Cross bracings significantly increases the first storey stiffness [4]. A seismic design is based on different performance objectives and related earthquake hazards [5]. Study is carried out to find out the performance of a building with soft storey at different level along with at ground level (GL). Nonlinear static pushover analysis is carried out. It obtains poor seismic performance of building with soft storey at different level along with soft storey at ground level. Displacement reduces when the soft storey is provided at higher level [6,7]. Concluded that when RC framed buildings having brick masonry infill on upper floor with soft ground floor is subjected to earthquake loading, base shear is more than twice to that predicted by equivalent earthquake force method with or without infill [8, 9,10]. Effects of nonstructural masonry infill on the earthquake response of reinforced concrete structure are investigated by considering reinforced concrete structures with different configuration of masonry infill to find the effects of irregular infill masonry structural performance. The diagonal strut model is adopted for modeling masonry infill. Numerical analysis is performed. The lateral stiffness of the soft story frame is large compared to bare frame and infilled frame [11]. Five reinforced RC framed building with brick masonry infill were designed for the same seismic hazard, in accordance with IS code. RC frame structures behavior with various arrangement of infill when subjected to dynamic earthquake loading providing infill below plinth improves earthquake resistant behavior of the structure when compared to soft basement. Provision of infill wall improves the performance of building in terms of displacement control, storey drift and lateral stiffness [12]. Infill in RCC structures play important role in enhancing the lateral stiffness of complete structures. The effect of infill wall is to change the predominantly a frame action of a moment resisting frame structure towards a truss action. Lesser base shear result gives lesser lateral forces. The response of a structure in terms of bending moments is greatly improved in an infill

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model. The bending moments is reduced greatly by the introduction of infill panels [13]. A structure combining the frame with the infill within the frame gives better lateral resistance potential. The walls may act as vertical bracing to transfer the lateral loads to the ground while the floors provide horizontal bracing to transfer the lateral loads [14]. The behaviour of RC frame with G+6 storey with different masonry infill such as complete filled (CF), Bared frame (BF), Soft storey (SS), Partially Infilled (PI) were analysed. The total multistirey building with soft storey for infilled materials. It shows that the filled frame gives least displacement at top and bottom, Soft Story give largest displacement [15]. Response reduction of cases ordinary moment resisting frame and special moment resisting frame values with deflection diagrams in static and dynamic analysis. The special moment of resisting frame structured is good as compare to ordinary moment resisting frame (OMRF) structure in resisting the seismic loads. Displacement in static analysis of OMRF values are more compared to that of dynamic analysis values of same columns [16]. The earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software. Gradually increases value of lateral forces from bottom floor to top floor [17]. First soft story of building in which the columns were unable to provide adequate shear resistance during the earthquake therefore shear walls and steel bracings at the first storey is required to provide. Inter-storey drift is minimum for shear

V. CONCLUSIONS

1. Based on the studies literature so far carried out by several researchers following conclusions can be drawn. 1) Infill materials increase the seismic resistance to the building.
2. Lightweight infill is very effective in reducing the stiffness irregularity and storey drift.
3. Infilled frame gives least displacement at top and bottom, Soft Story give largest displacement.

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