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The Effect of Lateral Connection in Moment Carrying Capacity Frames of Low-Rise, Mid-Rise and High-Rise RC Structures by Perfoming Pushover Analysis

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Abstract **– Now a day's Special Moment Resisting Frames (SMRF) were used as an earthquake resisting structure in Reinforced Concrete structure which are made to stand without any fail or to resist the earthquakes. The Beam-Column Joints, Columns, and Beams in the moment frames are proportioned and detailed as well to resist the shearing, an axial, and flexure which became in result as a construction sways via many ground shaking intense earthquake. The proper proportioning & detailed needs will make a frame capable of resisting strong earthquake without any major loss of strength or stiffness. These Frames which are Resisting the Moment develop due to seismic force are known as "Special Moment Resisting Frame." (SMRF) because of this kind of an extra need, this help to resist seismic force in comparison with much less ductile detailed "Ordinary Moment Resisting frame." (OMRF). The "SMRF" building designing criteria is provided in IS (13920-2002). In this thesis, the buildings are made as "OMRF" and "SMRF" also, and the functionality of these buildings are differentiated. For this purpose, the nonlinear static also known as pushover analysis is carried out by ETABS software on the buildings that modelled. The pushover curve are made from the outcomes of the analysis and also the behaviour of designed structures that are inspected for different end conditions and also for different Infill conditions.**

Key Words**: Pushover Analysis, ETABS, Response reduction factor, SMRF, OMRF.**

I. INTRODUCTION

Now a days the Earthquake became a worldwide thing. Because on regular basis occurrence of earthquake now it is not more considered as act of God. Throughout the earthquake ground tends to move in both vertical and horizontal direction in uncontrolled manner that makes structure to vibrate and generate inertial forces within them. The Analysis of destroys occurred in moment resisting RCC framed structure put through previous earthquake shows what could be the problems we face because of use of concrete which is not having adequate resistance capability, soft storey, beam-column joint mishap for inapposite anchorage or weak reinforcements, column failure leads to the storey mechanism. Beam-column brace is mostly found as weaker part of structure whenever a system is put through seismic loading. Figures of the column-beam joints and failure collapses in previous seismic activity are shown in Figure 1.1. Thus this kind of column and joint disaster needs to be provided attention.

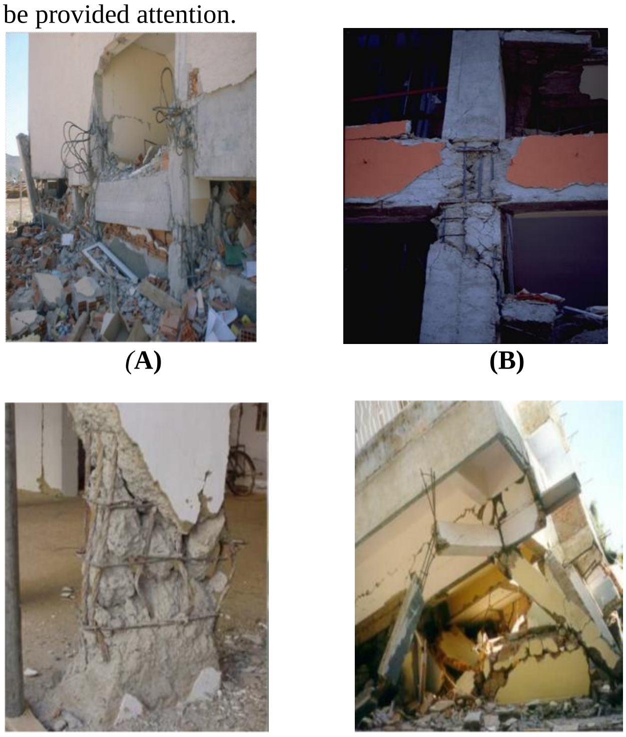

Figure I.1: Storey mechanism failure of buildings in past earthquakes: - Figure (A) shows the failure of column with eccentric connection during turkey earthquake, 2003. Figure (B) shows the failure of column and beam-column joint during turkey earthquake, 2003. Figure (C) & (D) shows the failure of building due to column storey mechanism during Bhuj Earthquake, 2001.

THE USE OF SMRF STRUCTURE- The moment resist frames are generally adopted because of their ability to resist the seismic force when there is flexibility in architectural planning. When concrete frames are choose for structures that are mentioned in Seismic Zone Categories III, IV or perhaps V, the design of the reinforced concrete moment frames should be different by considering the safety through the working period of structure. Proportioning & detailing required for a unmatchable moment frame will grant the frame to easily experience considerable deformations which are expected to be in these seismic layout groups. Specific second frames might be utilized in Seismic Design Categories I or perhaps II, although this might not result in the cheapest design. Both power and stiffness have to be viewed in the design of unique moment frames. Based on IS 13920-2002, specific moment frames are allowed to be designed for a force reduction factor of “R = 5”. Moment frames are adoptable lateral systems; thus, by minimizing base shear equations of the codes the need of the strength might be managed.

II. PROBLEM STATEMENT

Present study focus on different aspects associated with the functionality of SMRF buildings. The primary goal of current study will be the analysis of relative functionality of OMRF and SMRF frames, designed as per IS Codes, utilizing nonlinear analysis. The greater realistic performance of the SMRF and OMRF building necessitates modelling the stiffness along with strength of the infill walls. The variations in the kind of the infill walls utilizing in Indian constructions are considerable. Based on the modulus of elasticity and also the strength, it could be classified as weak or strong. The 2 extreme cases of infill walls, weak and strong are thought by modelling the stiffness as well as power of infill wall space as accurately as you possibly can in the current study. The behavior of structures depends on the kind of soils. Determined by the foundations resting on medium soils, the displacement boundary conditions in the bottom part of foundations may be looked at as hinged or maybe fixed. As the modelling of soils isn't in the range of the research, 2 boundary conditions, fixed and hinged, which symbolize 2 extreme conditions, are considered.

III. METHODOLOGY

BUILDING CONFIGURATIONS AND DESIGN DETAILS

The maximum 12 numbers of structural frames are design with different numbers of storey also two different quantity of bays and two kinds of infill wall configurations. A detailed illustration of all the types of frames made in this study is given in Table 3.1. The height of storey is 3.5m and width of bay is 4m that is same for rest of the frames. Each frame was design as “SMRF” and “OMRF” by considering response reduction factor as 3 for OMRF and 5 for SMRF. The IS 13920-1993 code suggests that a response reduction factor according to the type of frame. The way of the performance of the frames is by conducting linear static analysis of bare frames as well as considering for all of the load combinations recommended by IS 1893-2002. Two end conditions like fixed and hinged support conditions are taken in account in the research. For easy understanding presentation of results, a well naming is followed. [3S3B-SMRF-B-F] this 3storey & 3bays with a No Infill wall frame, designed as Special Moment Resisting Frame (SMRF) with fixed support conditions. [9S6B-SMRF-I-H] 9storey & 6bays is an Infill walled frame, designed as Special Moment Resisting Frame (SMRF) with hinged support conditions.

Table III.1Details of all the fixed support bare frames

SR No	Frame Name	Frame type	No. of storey	No. of bays	R	Frame Type	Support condition
1	3S3B	Bare	3	3	5	SMRF	Fixed & Hinged
2	6S3B	Bare	6	3	5	SMRF	Fixed & Hinged
3	9S3B	Bare	9	3	5	SMRF	Fixed & Hinged
4	9S6B	Bare	9	6	5	SMRF	Fixed & Hinged
5	12S6B	Bare	12	6	5	SMRF	Fixed & Hinged
6	15S6B	Bare	15	6	5	SMRF	Fixed & Hinged
7	3S3B	Bare	3	3	3	OMRF	Fixed & Hinged
8	6S3B	Bare	6	3	3	OMRF	Fixed & Hinged
9	9S3B	Bare	9	3	3	OMRF	Fixed & Hinged
10	9S6B	Bare	9	6	3	OMRF	Fixed & Hinged
11	12S6B	Bare	12	6	3	OMRF	Fixed & Hinged
12	15S6B	Bare	15	6	3	OMRF	Fixed & Hinged

Material properties and Geometric parameters assumed

SR No.	Design Parameter	Value
1	Unit weight of concrete	25 kN/m^3
2	Unit weight of Infill walls (Brick) strong masonry	20 kN/m^3
3	Unit weight of Infill walls (AAC Blocks) weak masonry	7 kN/m^3
4	Characteristic Strength of concrete	25 N/mm^2
5	Characteristic Strength of Steel	415 N/mm^2
6	Damping ratio	5%
7	Modulus of elasticity of steel	2e5 N/mm^2
8	Slab thickness	150 mm
9	Wall thickness	230 mm

Seismic Design Data assumed for Special and Ordinary Moment Resisting Frames

SR No.	Design Parameter	Value
1	Seismic Zone	V
2	Zone factor (Z)	0.36
3	Response reduction factor (R)	5
4	Response reduction factor (R)	3
5	Importance factor (I)	1
6	Soil type	Medium soil
7	Damping ratio	5%

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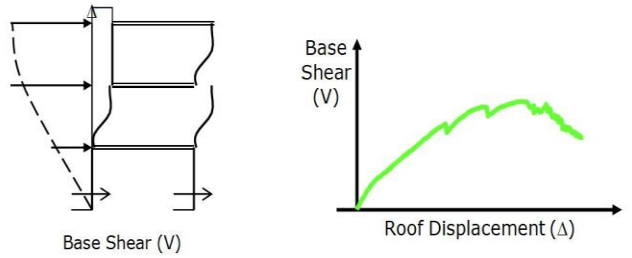
PUSHOVER ANALYSIS

An examination of functionality of the created frames are done by conducting nonlinear static i.e. pushover analysis. The modelling and analysis performing part of the frames for examination is done in the ETABS software.

The Pushover has a fixed line of action to analyze a structure where loading on a structure is incrementally enhanced by utilizing a predefined pattern (i.e., inverted triangular or maybe equal). A nonlinear aftermath are modeled and the structure pushed till a collapse mechanism is formed. By increasing intensity of a lot, weak back links & failure modes of the structure are located. At each and every steps, the structure is pushed till an enough hinge forms to get a curve between base shear and roof displacement of the structure widely known as pushover curve. At every phase, the entire base shear and the relative roof displacement are plotted to have this particular pushover curve at each different phases. It provides us a conception of the maximum base shear that the structure can constructively resist and also the related inelastic drift. For common building structures, it also provides an estimation of the global strength and stiffness in terminology of displacement and force of the building structure. A typical designed frame & a regular pushover curve diagram is shown in fig 3.2 below:



Typical Pushover Curve

IV. RESULT

A. *COMPARISON OF SMRF AND OMRF: BARE FRAME, FIXED SUPPORT*

In this type of comparison, the performance of ordinary moment resisting frame particular with fixed support circumstances are deemed. The base shear when compared with roof displacement at each analysis step is obtained. The pushover curves are made in each situation.

The Figure 4.1 shows pushover curve for 3Storey&3Bays bare frames intended as both OMRF and SMRF, with fixed support conditions. At first the starting shears increases linearly combined with the roof displacement. Right after achieving a certain base shear the structure yields.

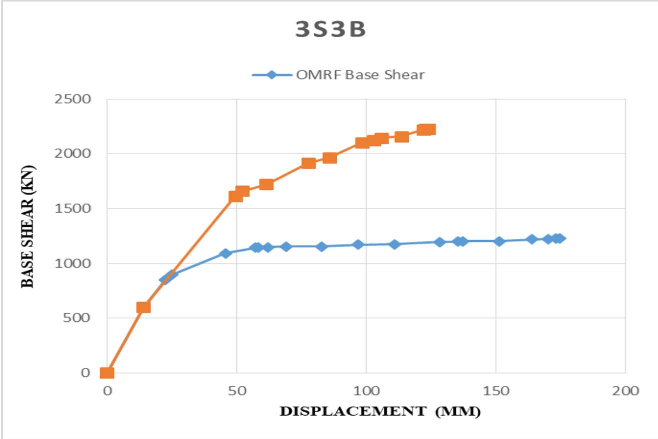


Figure IV.1 Shows the pushover curves of 3S3B OMRF AND 3S3B SMRF with fixed support condition and no infill.

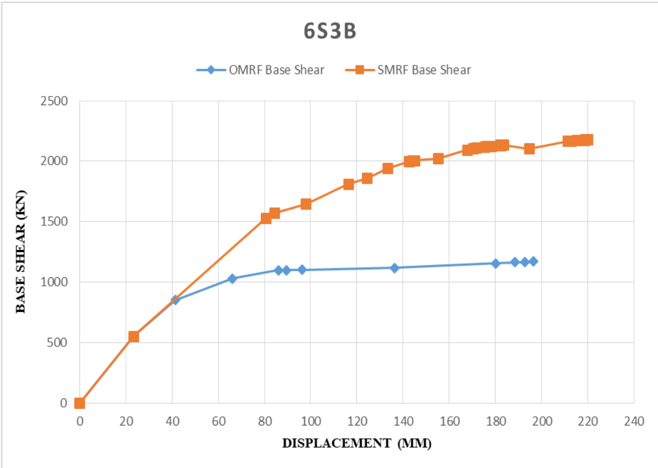


Figure IV.2 Shows the pushover curves of 6S3B OMRF AND 6S3B SMRF with fixed support condition and no infill.

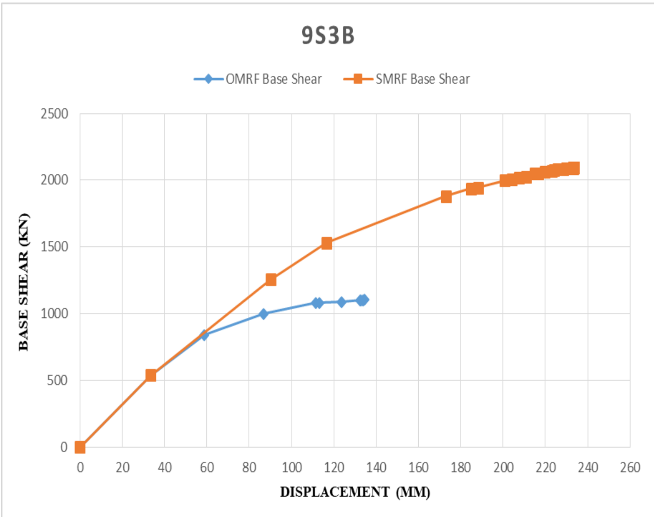


Figure IV.3 Shows the pushover curves of 9S3B OMRF AND 9S3B SMRF with fixed support condition and no infill.

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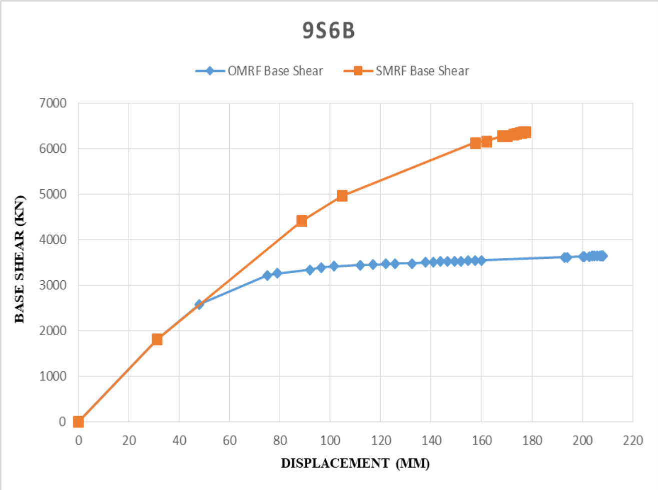

Figure IV.4 Shows the pushover curves of 9S6B OMRF AND 9S6B SMRF with fixed support condition and no infill

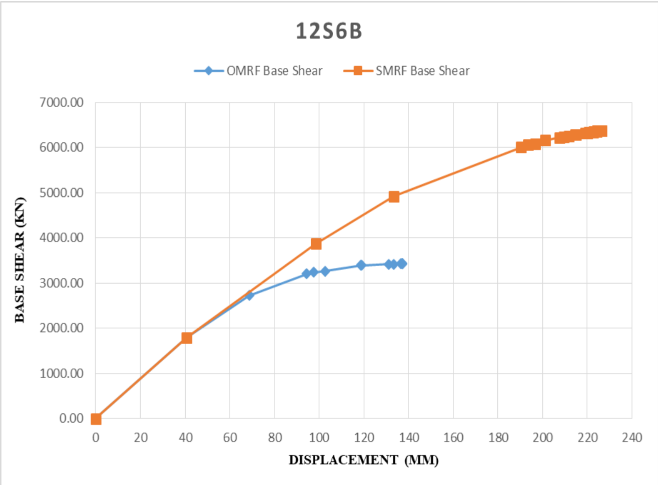

Figure IV.5 Shows the pushover curves of 12S6B OMRF AND 12S6B SMRF with fixed support condition and no infill.

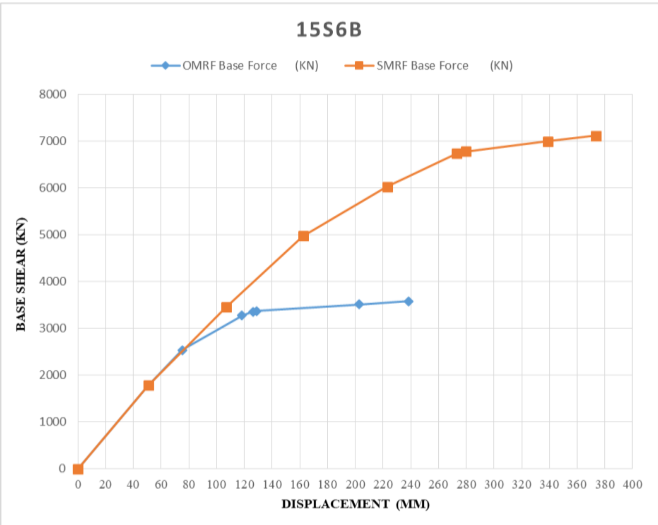

Figure IV.6 Shows the pushover curves of 15S6B OMRF AND 15S6B SMRF with fixed support condition and no infill.

B. *COMPARISON OF SMRF AND OMRF: BARE FRAME, HINGED SUPPORT*

In this particular comparison, the functionality of ordinary moment resisting frames with hinged support situations are deemed. The pushover curves for various configurations of components are plotted and the building effect is observed. The pushover evaluation of the frames mentioned in the previous areas is conducted. The base shear when compared with roof displacement at each analysis step is obtained. The pushover curves are furnished in each circumstance. Figure 4.7 shows pushover curves of 3S3B bare frames meant as both OMRF and SMRF, with hinged support conditions. At first the starting shear improves linearly combined with the roof displacement. Right after attaining a certain base shear the structure yields.

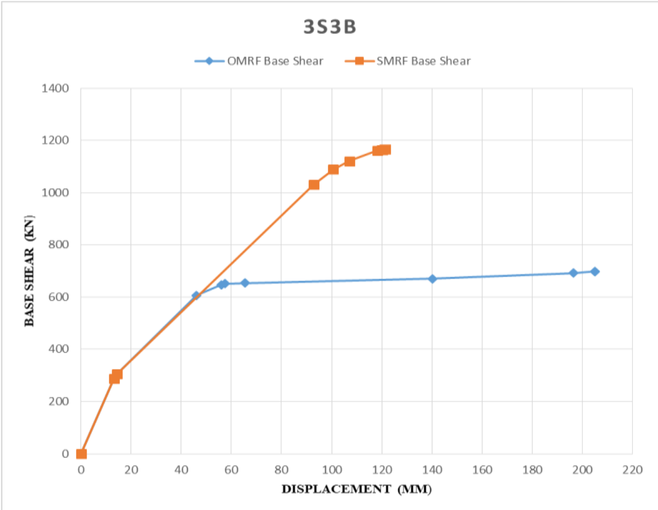

Figure IV.7 Shows the pushover curves of 3S3B OMRF AND 3S3B SMRF with hinged support condition and no infill.

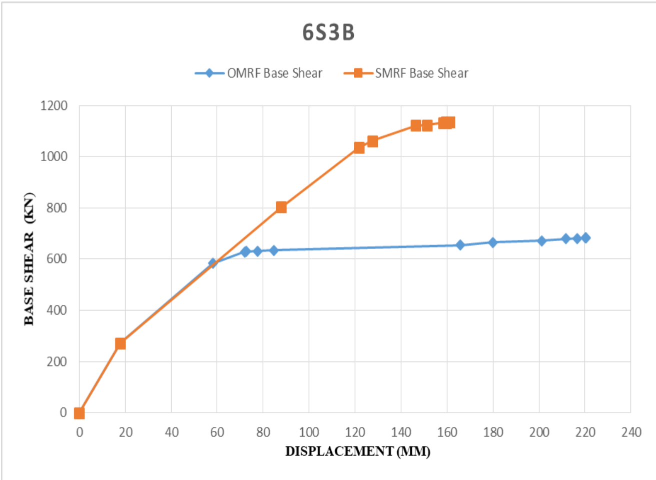

Figure IV.8Shows the pushover curves of 6S3B OMRF AND 6S3B SMRF with hinged support condition and no infill.

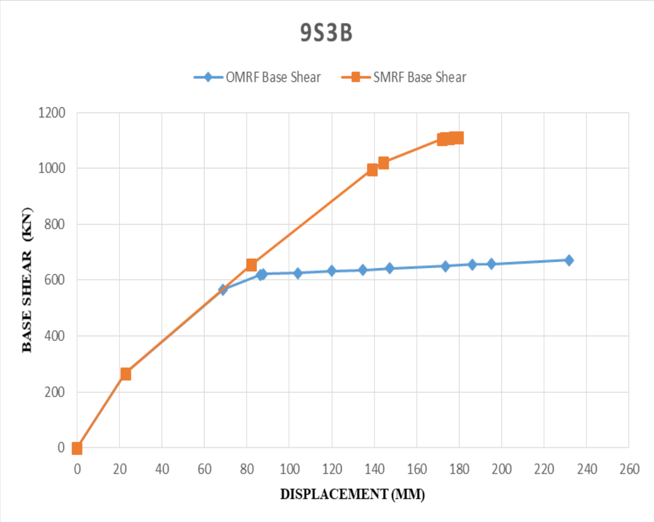

Figure IV.9 Shows the pushover curves of 9S3B OMRF AND 9S3B SMRF with hinged support condition and no infill.

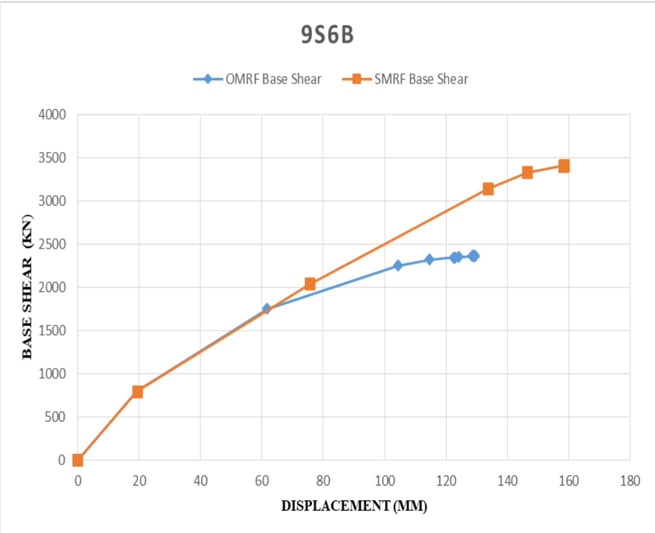

Figure IV.10Shows the pushover curves of 9S6B OMRF AND 9S6B SMRF with hinged support condition and no infill.

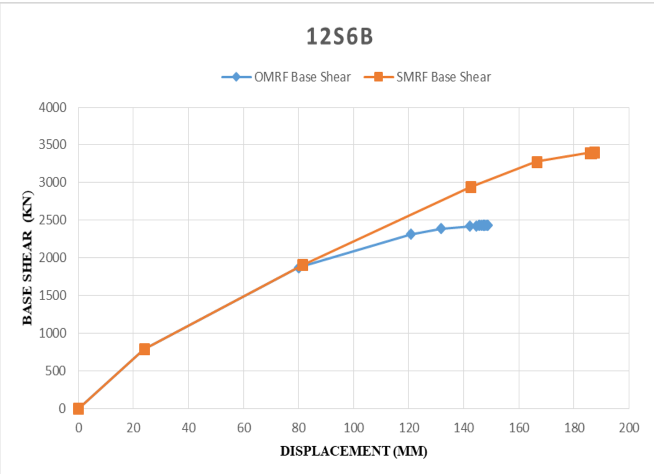

Figure IV.11Shows the pushover curves of 12S6B OMRF AND 12S6B SMRF with hinged support condition and no infill

Figure IV.12 Shows the pushover curves of 10S7B OMRF AND 10S7B SMRF with hinged support condition and no infill.

C. STOREY WISE COMPARISON OF SMRF BUILDINGS

The structures with the very same amount of bays are seen in this particular comparative study. The buildings considered are 9S6B SMRF, 12S6B SMRF and 15S6B SMRF structure with fixed support condition is taken all having 6 bays. These structures are taken to see the behavior of the structures after analysis in comparison with each other. The pushover curve is shown in figure 4.13.

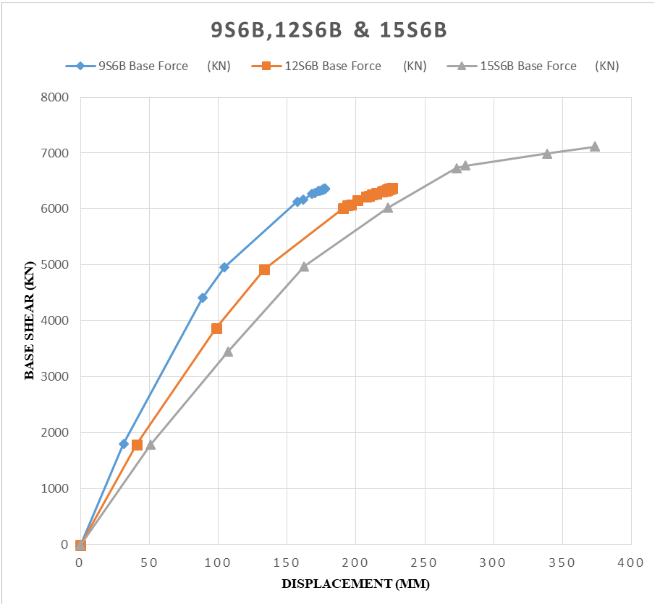

Figure IV.13 shows the storey wise comparison of SMRF buildings with fixed support conditions and no infill

D. BAY WISE COMPARISON OF SMRF BUILDINGS

The structures with the very same amount of storeys are seen in this particular comparative study. The buildings

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considered are 9S3B SMRF and 9S6B SMRF, are having nine storeys With fixed support condition is taken to make a comparative study by performing the pushover analysis to find the behavior pattern of these structure in compare with each other the figure 4.14 shows the result of the structures.

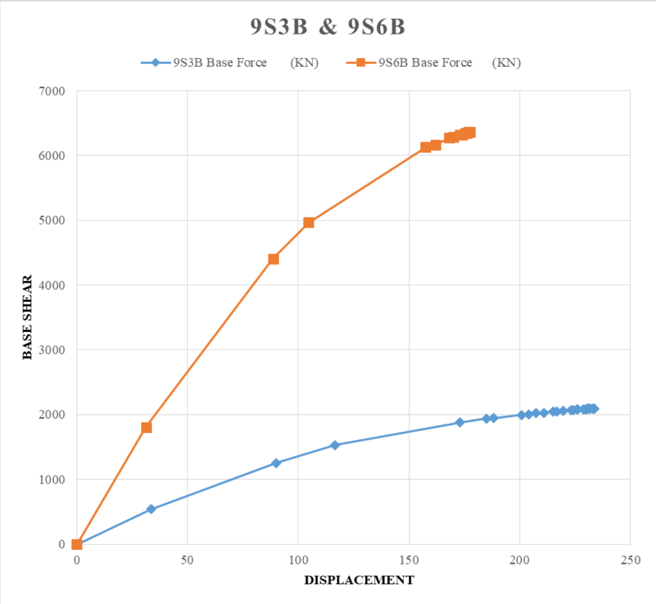

Figure IV.14 shows the BAY WISE COMPARISON of SMRF BUILDINGS with fixed support conditions and no infill.

E. COMPARISON OF SMRF BUILDINGS WITH STRONG AND WEAK INFILL: FIXED SUPPORT CONDITION.

In this specific analysis, the functionality of SMRF buildings with strong and weak infill with the fixed support condition is compared. In Fig 4.16, the fixed pushover curve of 9S6B SMRF building with weak and strong infill is shown. Similar behavior is discovered for 12S6B SMRF and 15S6B SMRF buildings in Fig 4.17 and Fig 4.18.

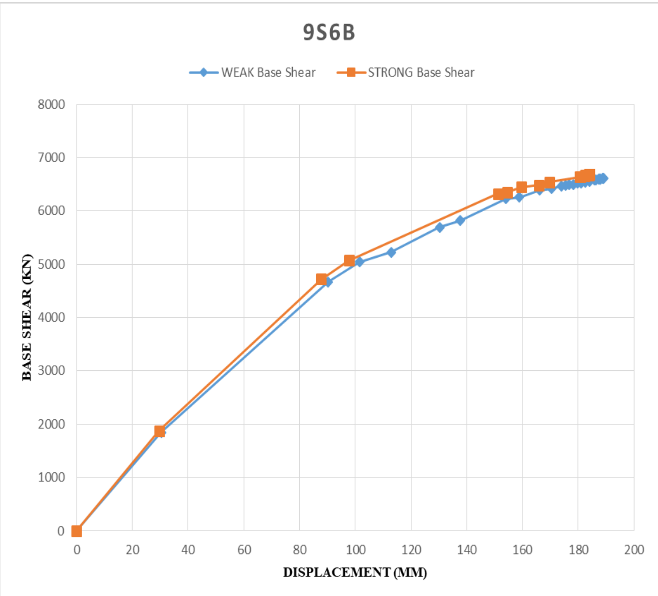

Figure IV.13Shows the comparison of 9S6B SMRF BUILDING with Strong and Weak infill and fixed support conditions.

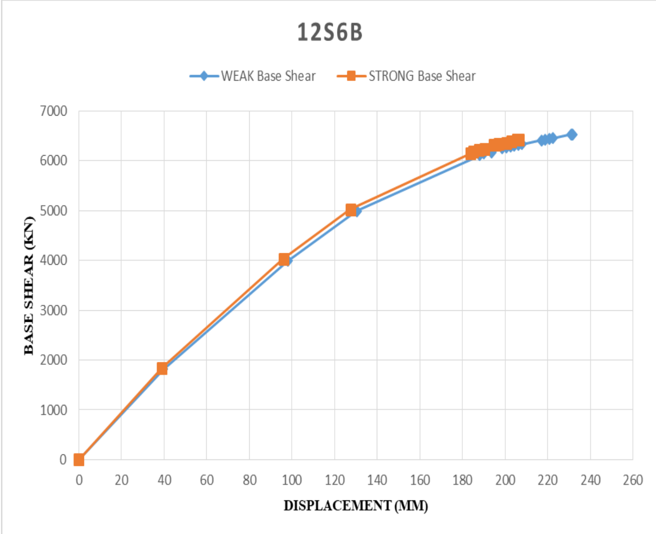

Figure IV.14 Shows the comparison of 6S2B SMRF BUILDING with Strong and Weak infill and fixed support conditions.

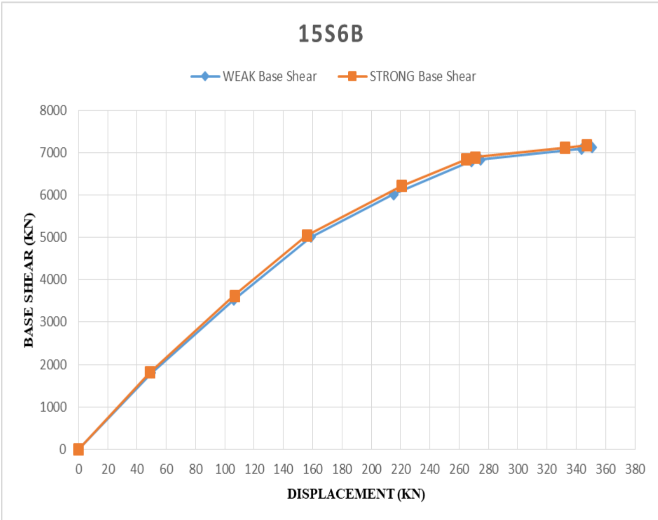

Figure IV.15 Shows the comparison of 10S7B SMRF BUILDING with Strong and Weak infill and fixed support conditions.

V. CONCLUSION

The efficiency analysis of buildings designed as Special Moment Resisting Frame (SMRF) Ordinary Moment Resisting Frame (OMRF) is analyzed for a number of building configurations, infill problems in addition to help conditions. The buildings are meant and in addition modelled utilizing computational software. Nonlinear analysis is completed on these buildings and the response are monitored. A pushover curve with Base Shear versus Roof Displacement is plotted for each frame while utilizing evaluation data. Several comparative scientific tests are carried out to understand the behavior of SMRF and OMRF.

- It is observed that for OMRF & SMRF as the height of the building increases the Base Shear increases.
- For fixed support The Base Shear of SMRF building of 3 bays is more than OMRF building of 3 bays. The

percentage increase in Base shear for SMRF is from 81 % to 90 %.

- For fixed support The Base Shear of SMRF building of 6 bays is more than OMRF building of 6 bays. The percentage increase in Base shear for SMRF is from 75 % to 99 %.
- For fixed support when the bay width and storey height is nearly equal, the roof displacement decreases for SMRF structure and when the storey height and bay width are unequal then roof displacement increases.
- For Hinged support the increase in Base Shear for SMRF structure is nearly same for all height of buildings having same number of bays.
- For Hinged support The Base Shear of SMRF building of 3 bays is more than OMRF building of 3 bays. The percentage in Base shear for SMRF is from 68 % to 65 %
- For Hinged support The Base Shear of SMRF building of 6 bays is more than OMRF building of 6 bays. The percentage in Base shear for SMRF is from 44 % to 39 %.
- For Hinged support The Roof displacement of SMRF structure of 3 bays decreases from 23 % to 27 %. & for 6 bays it increases from 23 % to 27 %.
- In comparison of SMRF structure for FIXED & HINGED support it shows that the Base Shear and Roof Displacement for FIXED support is better than HINGED support.
- In the storey wise comparison of SMRF structure with fixed support conditions and no infill it is found that 15S6B SMRF is better than the 9S6B & 12S6B SMRF structure.
- In bay wise comparison of SMRF structure with fixed support conditions and no infill it is found that 9S6B SMRF is better than 9S3B SMRF structure.
- In comparison of SMRF structure with Strong and Weak Infill for FIXED support condition. The base shear & roof displacement for Strong and Weak infill wall structure does not affect that much, so we can say that the type of infill walls does not affect the base shear & roof displacement.
- However for the better and correct results our input details should be correct, any wrong inputs of the details may lead to the wrong results.
- Also while performing such analysis on the software proper knowledge of the software is require any wrong input given may lead to the wrong results that will affect the study of the structures.

Although pushover analyses offers an insight about nonlinear behavior imposed on structure by seismic activity, pushover analyses were not in a place to reasonably make neither the actual sequence of hinging nor the places of theirs in cases that are many. So, seismic evaluation process and also style have to be performed by constantly keeping in the mind of yours that specific degree of variation generally prevails in seismic demand prediction of pushover analysis.

Lastly, a lot more systematic and finish parametric scientific tests, looking at several times, power proportions, and earthquake ground motions, nonetheless, will be expected to create specific standards for efficient design of reinforced concrete specific moment resisting frame system.

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