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Seismic Retrofit using ETABS

Peerzada Waris Ahmad[1], and Brahamjeet Singh [2]

[1]M.Tech Scholar, Department of Civil Engineering, RIMT University, Punjab, India
[2]Assistant Professor, Department of Civil Engineering, RIMT University, Punjab, India

Correspondence should be addressed to Peerzada Waris Ahmad; waris9596@gmail.com

ABSTRACT-In India, Multi-storied structures built are deficient of land and have to carry maximum load. Earthquake could be a circumstance which might result in the failure of the structure. Buildings are to be created so that they are safe to live in and the structure before failure should possess ductile property. To prevent structures from failing and from serious damages the structures before construction should be analyzed for its seismic performance along with support reactions and wind calculations both are to be included in the design of an earthquake resistant structure. The primary objective of present study is to make earthquake resistant structure by retrofitting its columns and the process is known as column jacketing. The retrofitted structure is analyzed in the E-tabs software. For this purpose, a retrofitted G+5residentialbuilding is considered. Calculations are done for an earthquake in seismic zone V. To guarantee the safety of the structure all the forces acting on the structure including the lateral loads due to wind and seismic excitations are considered. Because of the jacketing the column strength and the overall stability of the structure will increase. By using IS Code (IS 15988-2013), the jacketing will be done in E-tabs software. After the jacketing the various responses including bending moment, shear force of existing building will be studied under various loads for an earthquake in seismic zone V.

KEYWORDS-Multi-Story building, Retrofitting measures, Column Jacketing, ETABS v18, Section Designer, Modelling, Story Drifts, Maximum story displacement

I. INTRODUCTION

Earthquakes of the past has made us realize the importance of earthquake resistant structures i.e., the buildings that are made after the analysis and detailed study of various parameters should only be adopted for construction purposes. Earthquake like Gujrat earthquake in 2001, Kashmir earthquake in 2005, Sikkim earthquake in 2011 had made us realize the importance of building codes for earthquake resistant structures. In present paper the effect of column jacketing on the performance of the building during an earthquake in seismic zone V is studied using E-tabs software. In various past studies it was found that the percentage of about 22% -39% of buildings were vulnerable to earthquake due to flexural deficiency and about 84%-54% were deficient in shear. Failure of column due to shear can lead to collapse of a building. Therefore, many structures in seismic zone V are highly vulnerable. So proper use of retro fitting techniques and building codes in construction of buildings is highly recommended.

The objectives of the study are as follows:

- To select and design appropriate retrofit scheme for the building.
- To evaluate the seismic capacity of the building under consideration using E-tabs.
- To study the seismic performance of the retrofitted building using E-tabs.

II. LITERATURE REVIEW

Structural safety and architectural preservation are the two important considerations in retrofitting of historical buildings. In order to select the appropriate retrofit technique and the best possible building codes, the mechanical properties such as compressive strength, shear strength, Elastic modulus, shear modulus, unit weight of materials etc., are needed to be found. The different types of technique for finding mechanical properties of masonry have also been described here using past research works.

- Malyszko, L. (2005) conducted triplet test, diagonal compression test, direct tensile strength tests on clay brick masonry specimen to find the in-plane shear strength and tensile strength. Scaled model was tested in the laboratory to evaluate the seismic performance of the structure.
- Aguilar et al. (1989) performed a detailed study on the repair and fortification of 114 residential building made of reinforced concrete using the method of retrofitting particularly column jacketing and study its seismic [1] performance.
- Bett et al. (1988) studies the effect of column jacketing on the strength of columns both with and without supplementary cross ties and found that the retrofitted

[2] columns were extra hard and firm then the original columns without jacketing.

- Bousias and Fardis (2003) proved that the disadvantageous effect of lap splicing on flexure capacity [3] even for short lap length can be effectively removed by using the method of column jacketing.
- Ersoy et al. (1993) Deduced that a retrofitted column behaved better when the column jacketing[4]was done after unloading the column.
- Valluvan et al. (1993) Tested various specimens having lap splicing of the longitudinal bars [6] and was found that removing concrete cover for adding new ties is not an effective method for strengthen the splice location as it results in micro cracking of the concrete core. External reinforcement around the splice region significantly improves the confinement of the concreteand the overall strength of the concrete. Steel dowels were inserted at the face of the original columns for better transfer of shear at the interface of the old concrete and the jacketed column and thus increase the seismic [5] performance of the building.
- Austin et al. (1999). Studied the strength of concrete [7] bond using tensile pull out test. The bond between old structure and the new repair material was studied and presentation of failure envelope was done using Griffith and Mohr column theory

III. MODEL USED FOR STUDY

In this present paper, a hypothetical Five story reinforced concrete building is considered as shown in figure-1.Thisbuilding represents a structure assumed to be built before the seismic codes were adopted or implemented. This structure hence had been designed for gravity loads with the considerations of wind loads and it lies in zone V. The columns are retrofitted by jacketing technique and plane view of the retrofit columns is shown in figure-2. Some of the notable specifications of the building are given in table 1 and are as follows:

Table 1: Salient Features of proposed building

Particulars	Values
Type of building	Multi story building
Height of each story	3.6m
Size of beam	300mm*400mm
Size of column	400mm*400mm
Total height of building	18m
Concrete grade	M15
Concrete grade for Jacketing	M30
Seismic zone	V
Thickness of slab	150mm
Column size after Jacketing	550mm*550mm
Load on Beams	3KN/m
Load on column	7.56KN/m
Dead Load on slabs	3.75KN/m2
Live load on slab	3KN/m2
Earthquake load on structure	1.5KN/m2
Wind pressure Coefficient, Cp	0.86
Wind Speed	35m/s

The Floor plan for base is shown in figure-3, Floor plan for story 5 is shown in figure-4,3D view of the building and the plan view of retrofitted columns of the building used for the modelling is shown below:

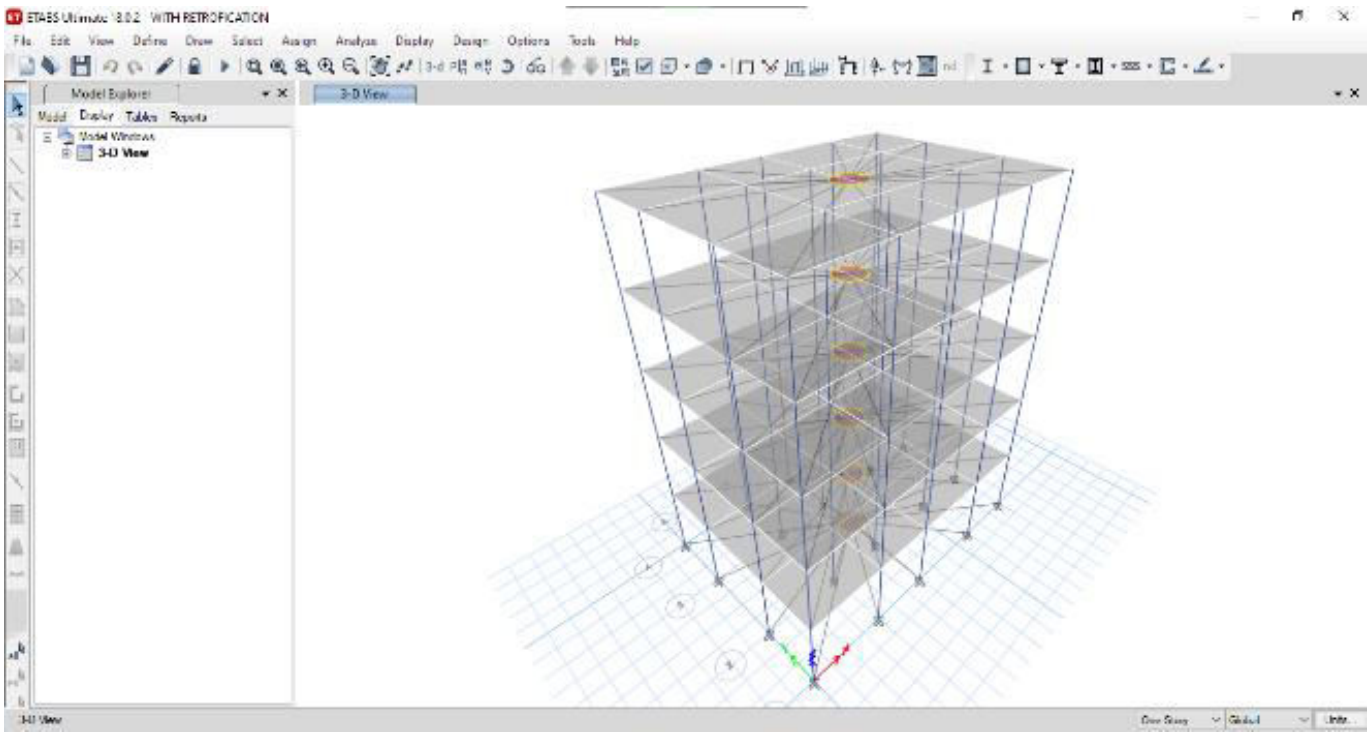

Figure 1: 3D view of G+5 Building

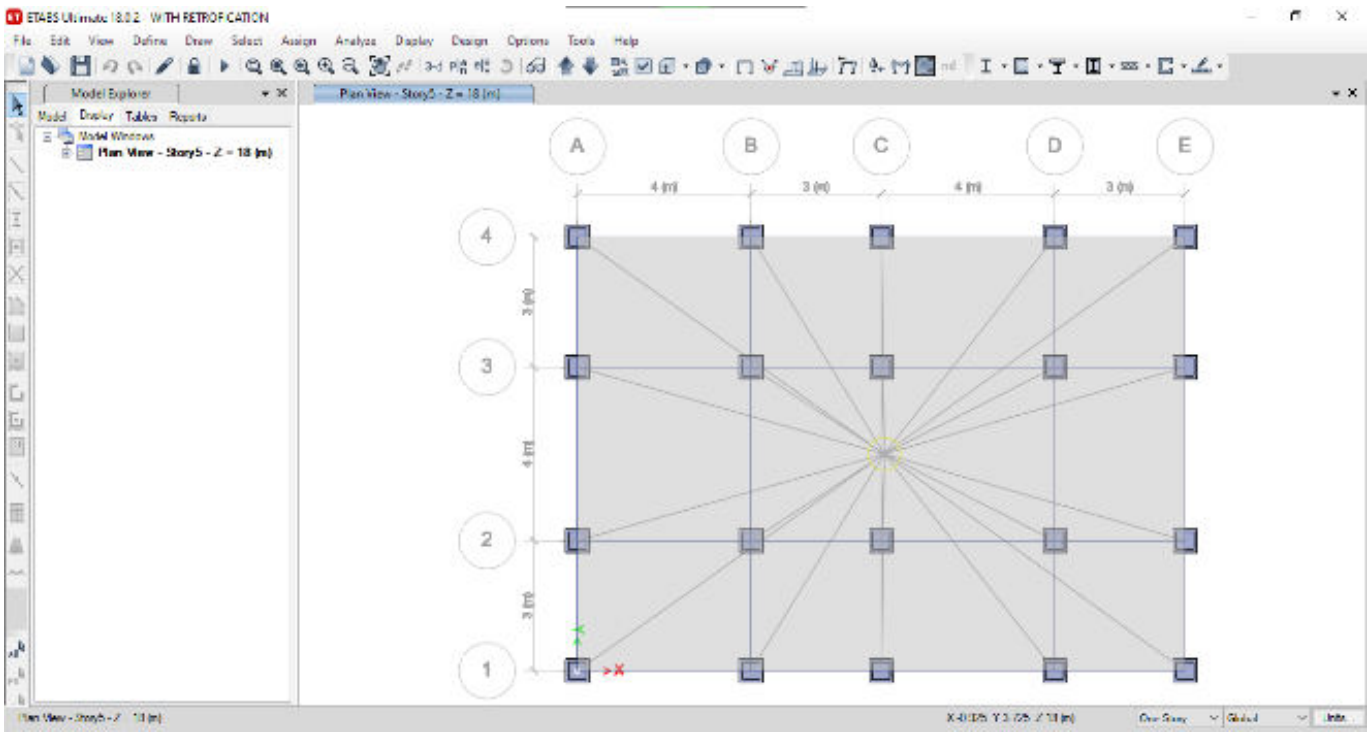

Figure 2: Plan view of retrofitted column

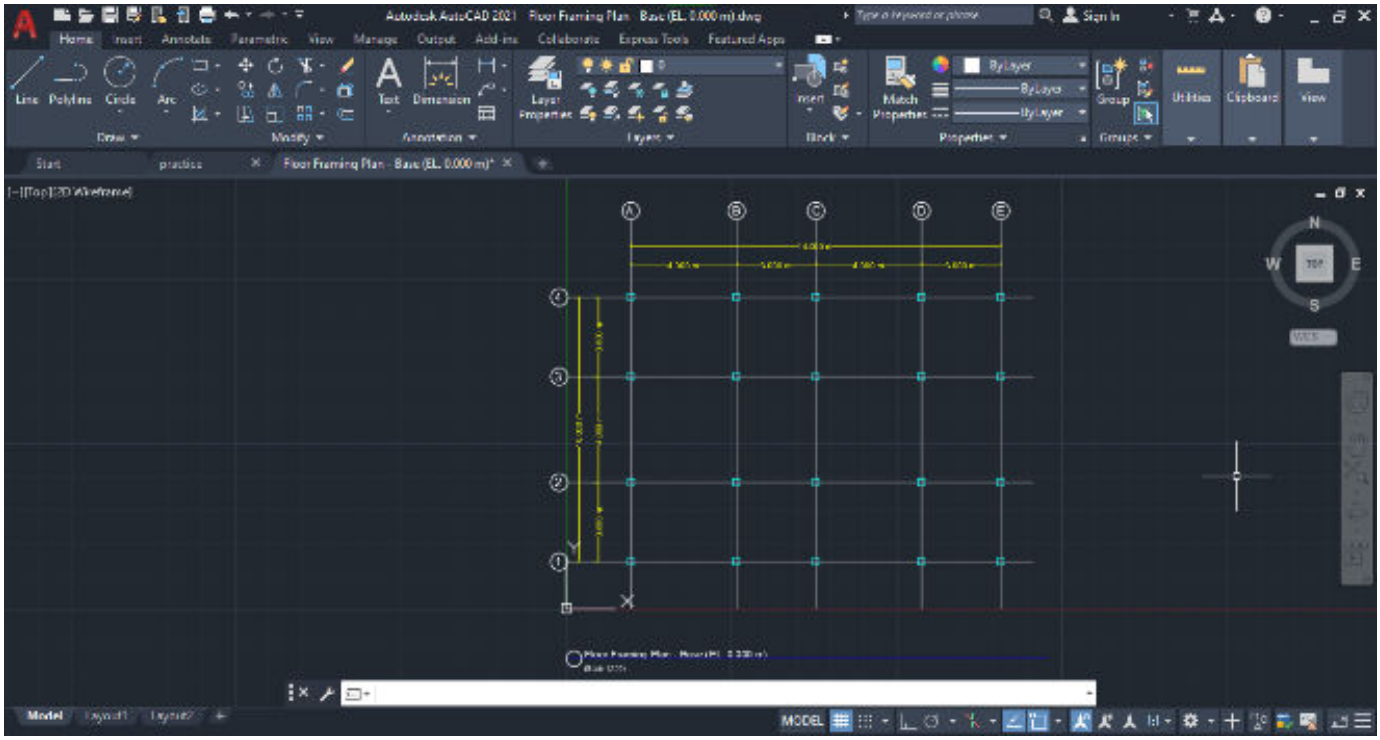

Figure3: Floor plan for base

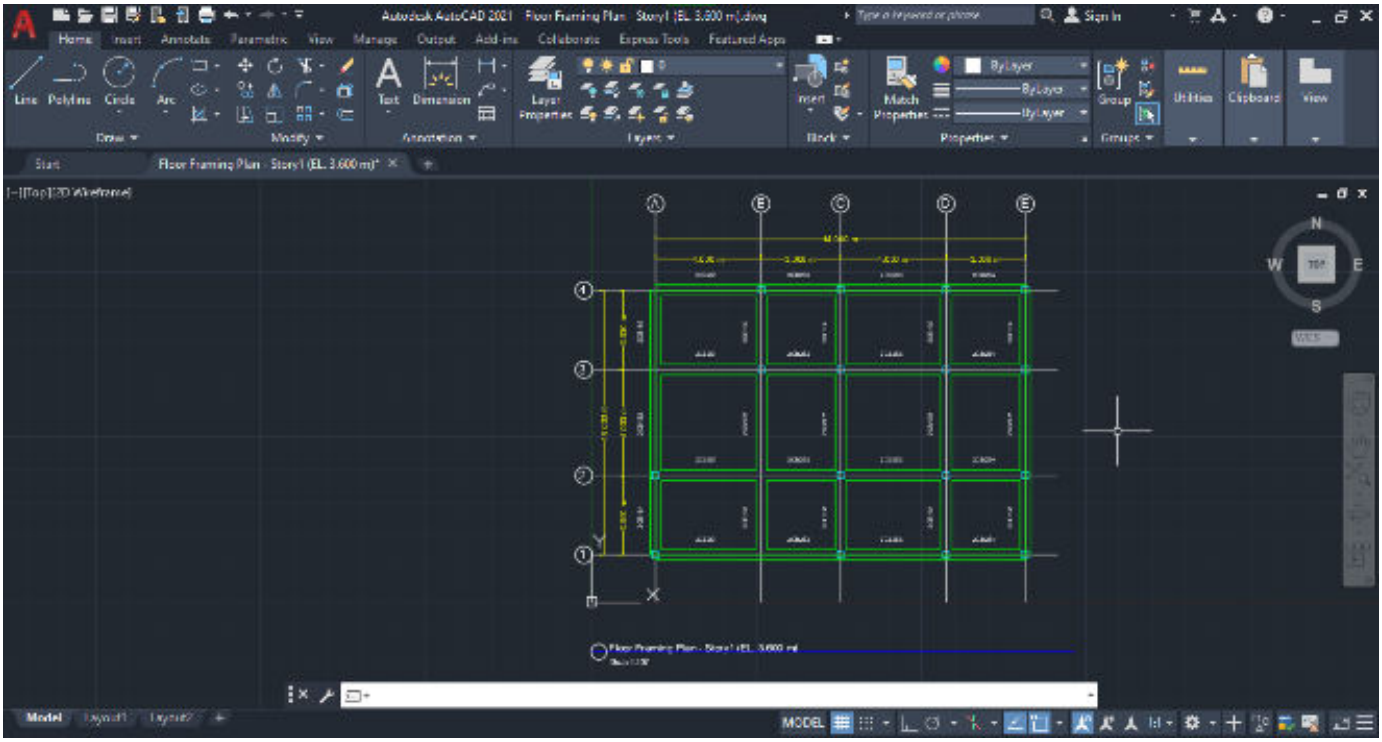

Figure 4: Floor plan for story 1

A. Modelling of Concrete Jacket InEtabs

Section designer as shown in figure-5 is used for modelling of the column jacket in E-tabs software and is an important process for modelling and analysis of the structure. The E-tabs software can be used to model and analyze the structure for various loads and study the seismic performance of the structure. The use of E-tabs software should be widely used for modelling and analysis, which will decrease the chances of structural failure. The various steps for modelling the structure are described as follows:

- Go to draw section and draw the old concrete column of concrete grade M15.
- Then go to rebar section and select the reinforcement of size 12 mm in diameter.
- Then go to draw section again and define the column jacket size and concrete grade of M30.
- Then Reinforcement of size 16 mm for the column jacket is defined.

This completes the modelling of the concrete Jacket. The figure of the section is shown below:

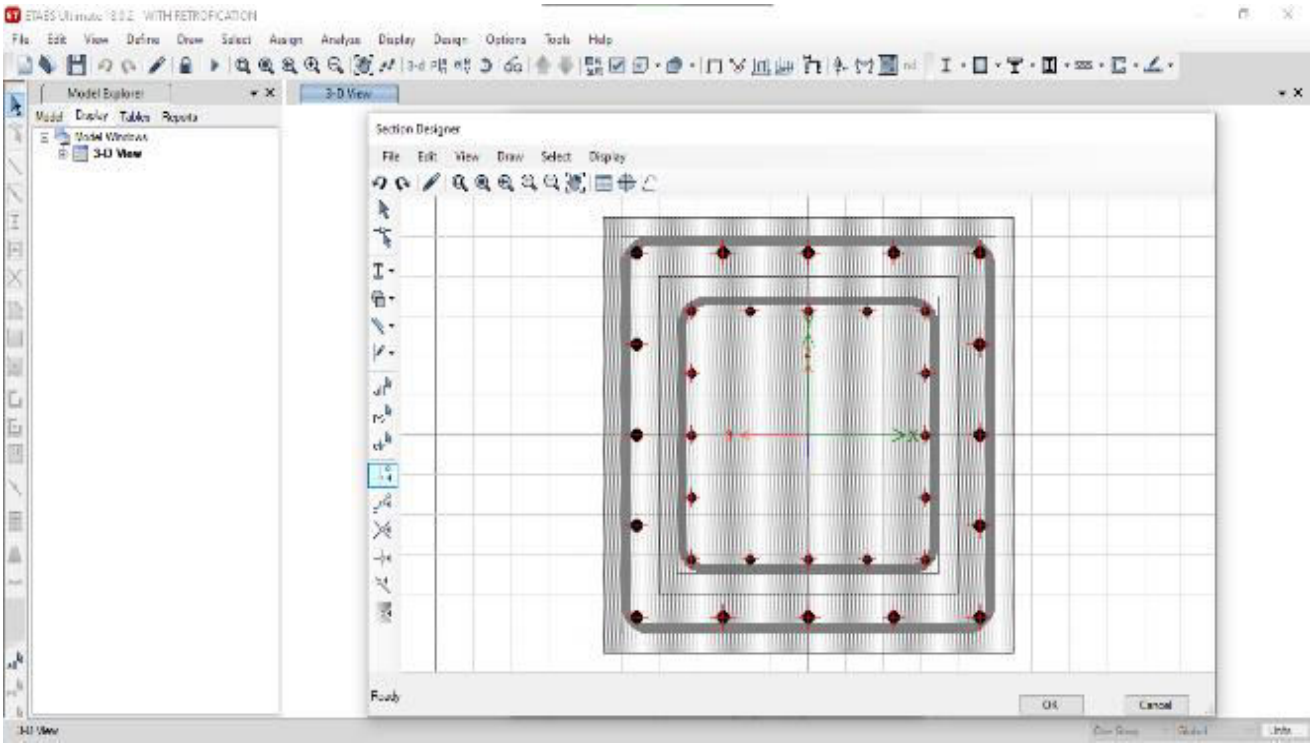

Figure 5: Section Designer

IV. RESULT

A. Drift values

After the modelling of the building the drift values of the building before any column is retrofitted are shown in table-2 and after the columns are retrofitted the drift values better results and can be used as a retrofit measure for the necessary structure are shown in table-3 and we can see in table 3 that the drift values are decreasing from story 5 to story 1 and we can safely assume that the column jacketing technique is giving

.Table 2: Drift values for building without retrofitted column

Story Drifts

File Edit Format-Filter-Sort Select Options

Units: As Noted
Filter:

Story Drifts

Story	Output Case	Case Type	Direction	Drift	Label	X m	Y m	Z m
Story5	EQX	LinStatic	X	0.001984	17	14	0	18
Story5	EQY	LinStatic	Y	0.002148	4	0	10	18
Story4	EQX	LinStatic	X	0.003387	17	14	0	14.4
Story4	EQY	LinStatic	Y	0.003595	4	0	10	14.4
Story3	EQX	LinStatic	X	0.004652	17	14	0	10.8
Story3	EQY	LinStatic	Y	0.004894	4	0	10	10.8
Story2	EQX	LinStatic	X	0.005397	17	14	0	7.2
Story2	EQY	LinStatic	Y	0.005642	4	0	10	7.2
Story1	EQX	LinStatic	X	0.003768	17	14	0	3.6
Story1	EQY	LinStatic	Y	0.003916	4	0	10	3.6

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Table 3: Drift values with retrofitted column

Story Drifts

File Edit Format-Filter-Sort Select Options

Units: As Noted

Filter:

Story Drifts

Story	Output Case	Case Type	Direction	Drift	Label	X m	Y m	Z m
Story5	EQX	LinStatic	X	0.002001	17	14	0	18
Story5	EQY	LinStatic	Y	0.002109	4	0	10	18
Story4	EQX	LinStatic	X	0.002763	17	14	0	14.4
Story4	EQY	LinStatic	Y	0.00289	4	0	10	14.4
Story3	EQX	LinStatic	X	0.003354	17	14	0	10.8
Story3	EQY	LinStatic	Y	0.003493	4	0	10	10.8
Story2	EQX	LinStatic	X	0.003298	17	14	0	7.2
Story2	EQY	LinStatic	Y	0.003424	4	0	10	7.2
Story1	EQX	LinStatic	X	0.001738	17	14	0	3.6
Story1	EQY	LinStatic	Y	0.001801	4	0	10	3.6

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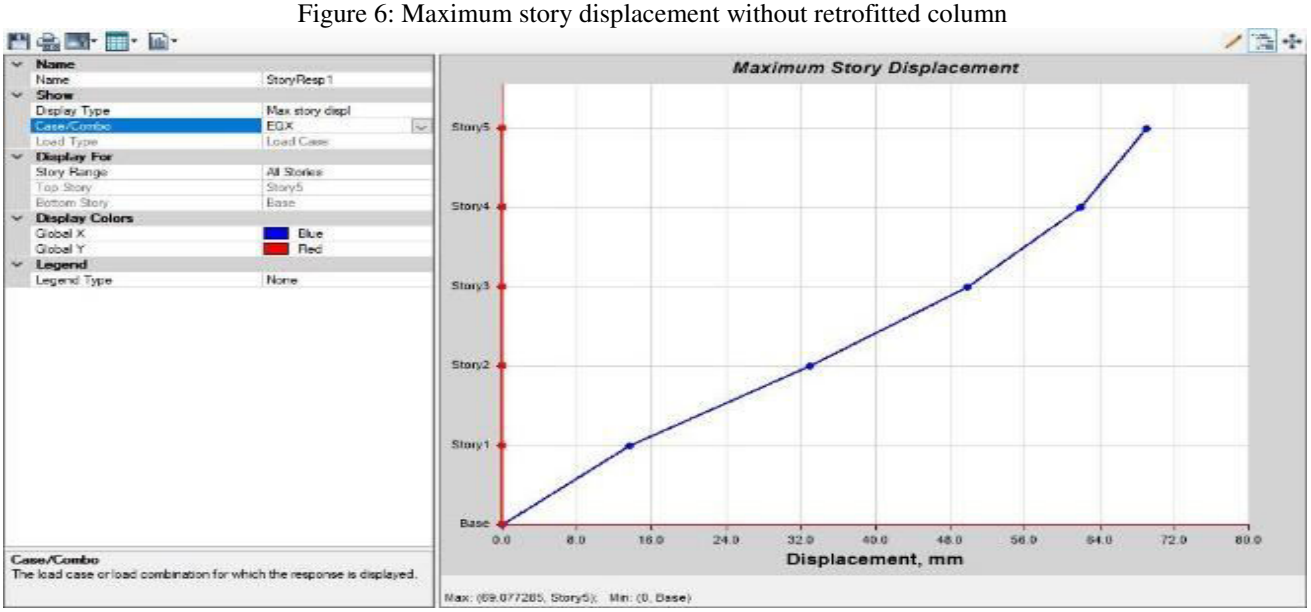
B. Story response plot

The story displacement plots which are shown in figure-6 and figure-7 clearly shows that the maximum displacement value for story 5 is decreased after the building is retrofitted with column jacketing technique.

After seeing all these results, we cansee the importance of E-tabs software for modelling and analysis of the structure under consideration.Therefore, E-tabs software should be used for the modelling and analysis before any structure is built.

Figure 6: Maximum story displacement without retrofitted column



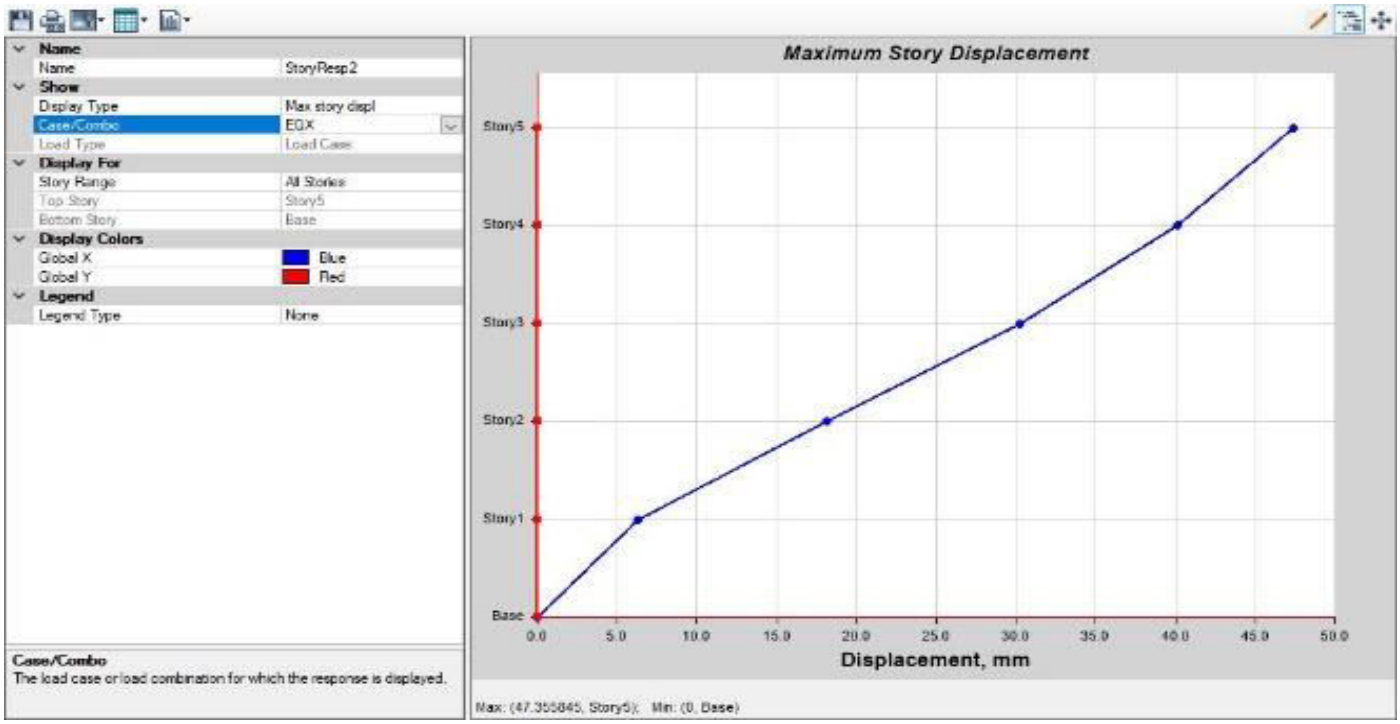


Figure 7: Maximum story displacement with retrofitted column

V. CONCLUSION

The guideline intended to be used in seismic evaluation and strengthening of existing buildings is provided in the IS 15988 (2013), Software's are hardly used in India for modeling and analysis of structure before its construction or for retrofit analysis.In this current study the attempt had been made to interpret and use the guidelines to design a suitable concrete jacket and model it using E-tabs.

The modelling and analysis of the whole retrofitted member on ETABS had been very less used, it is very crucial to model the jacketing on ETABS and the analysis performed gives more reliable and precise results. The results shown here are similar to the results that we get in actual practice and provides close resemblance to the realistic response of the jacketed column. The result obtained is acceptable and can be used as a basis for analysis purpose.

The reinforced column jacketing technique helps to increase the stiffness and strength of the building under cyclic loading. The resilience of the original column is also enhanced. Therefore, this rehabilitation process does not require trained work manship. On the basis of above data Column Jacketing is considered an obvious choice of retrofitting for structural rehabilitation.

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