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Retrofitting of Industrial building for Increased Imposed loads

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ABSTRACT: The major structural elements such as beam and column needs retrofitting whenever they are subjected to increased imposed loads. Due to the change in building usage, the structures with increased imposed loads must be retrofitted to satisfy the standards. To study the effect of retrofitting, it is important to numerically model the sections of the structural elements against the revised imposed loads. In this study, a finite element model of a building is used and it is subjected to increased imposed loads. The structure is subjected to the modal analysis and response spectrum analysis to examine the safety of structural elements under elastic loads. Further, a time history analysis with a return period of 200 years is used by scaling and selecting a site specific accelerogram. A displacement-controlled pushover analysis is performed against the maximum displacement as per the time-history analysis to study formation of plastic hinges. The structural elements failing by the formation of plastic hinges are retrofitted with new sections, to impart the safety against the increased imposed loads.

KEYWORDS: Retrofitting by push-over analysis, section-designer.

I. INTRODUCTION

For this study, a 5-storey residential building is used which is to be retrofitted to be used as an industrial building. The structural elements, initially designed for residential loads are to be used for industrial loads. The building is safe against the imposed load of 2.5 kN/m^2 and the safety against the increased imposed load of 5 kN/m^2 as per IS 875 1987(Part-2) is required to be checked by performing modal and response spectrum analysis. Further, suitable retrofitting is provided based on the non-linear dynamic time history analysis and static pushover analysis.

II. METHODOLOGY

1. Numerical modelling of the residential building with structural elements as per the details.
2. Performing dynamic response spectrum analysis to obtain the base shear.
3. Designing the concrete structure as per IS 456 2000 and checking for any failure due to the increased imposed loads.
4. To check the feasibility against the extreme earthquake loads, a nonlinear time-history analysis is performed to get the maximum displacement. .
5. The displacement obtained is used to perform the displacement- controlled static push-over analysis and the probable hinge locations are determined.
6. A new section of column is defined with proper jacketing around the column using numerical modelling technique

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III. RELATED WORK

A G+5 structure with imposed load of 2.5 kN/m^2 is analyzed and designed to check all members passing the design check.

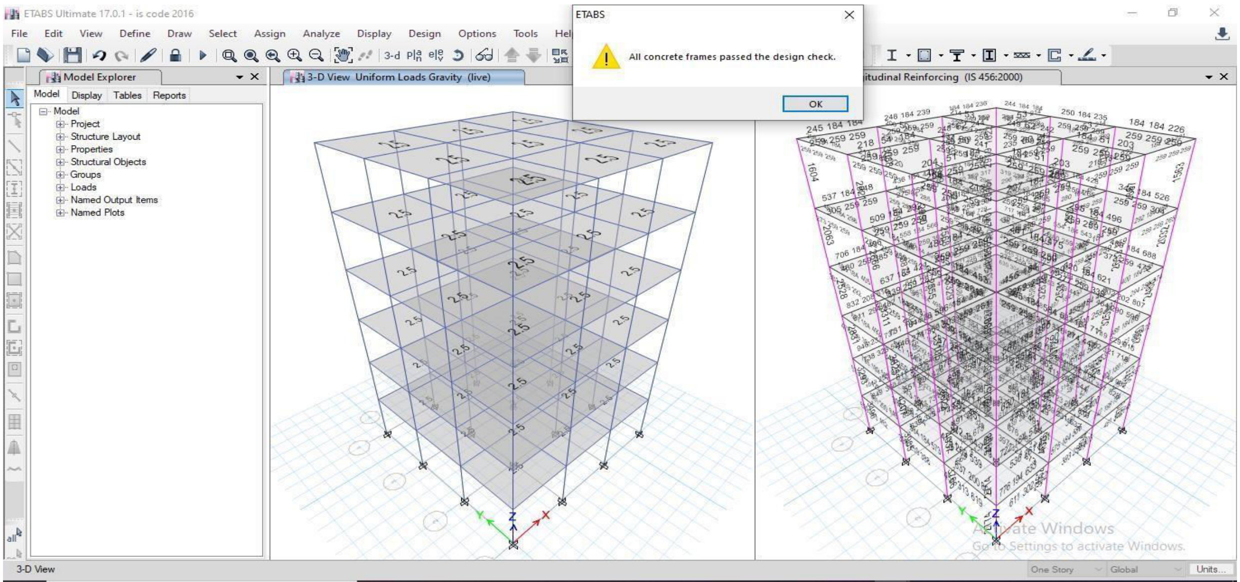

Fig.1 G+5 building with 2.5 KN/m^2 imposed load

IV. CHECK FOR RETROFITTING REQUIREMENT

The building shown in Fig. 1 will be checked for the increased imposed load and extreme earthquake loads by Non-linear pushover analysis. In fig. 2 the structure failed to the imposed loads itself. There are 2 concrete frames members, failed under the increased imposed loads. Further a Non-linear Time History (FNA) analysis was done to get the maximum displacement from the ELECENTRO Time History function to perform Nonlinear Pushover Analysis. Fig 3 shows the maximum displacement obtained from the Nonlinear Time History analysis. Since the building is symmetrical, the maximum displacement obtained in both the directions will be same. The maximum displacement was found to be 61mm at top storey

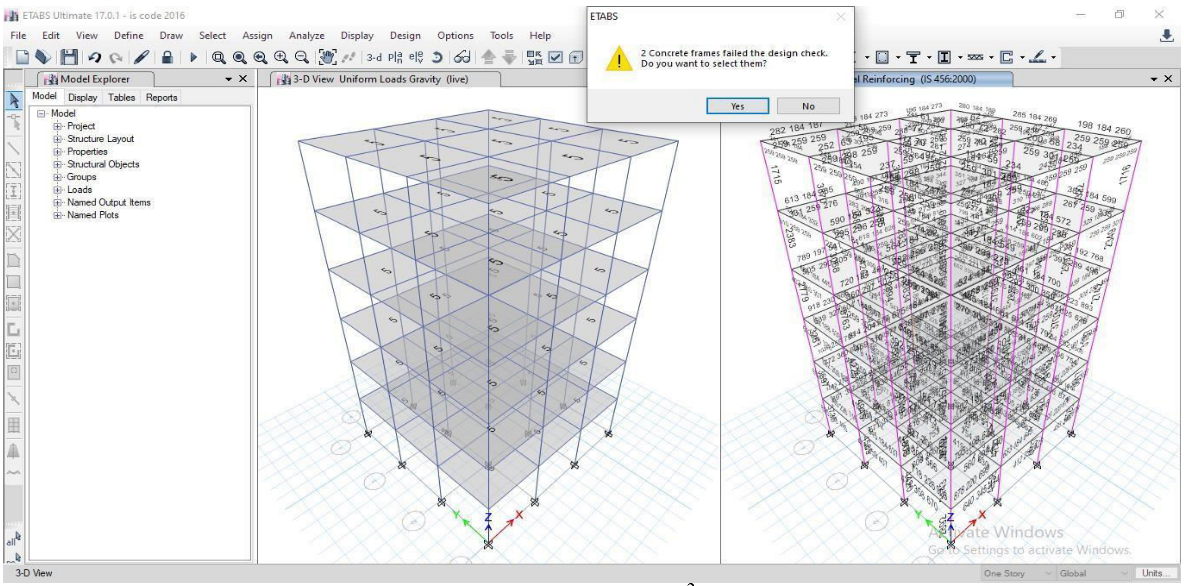

Fig.2 G+5 building with 5 KN/m^2 imposed load

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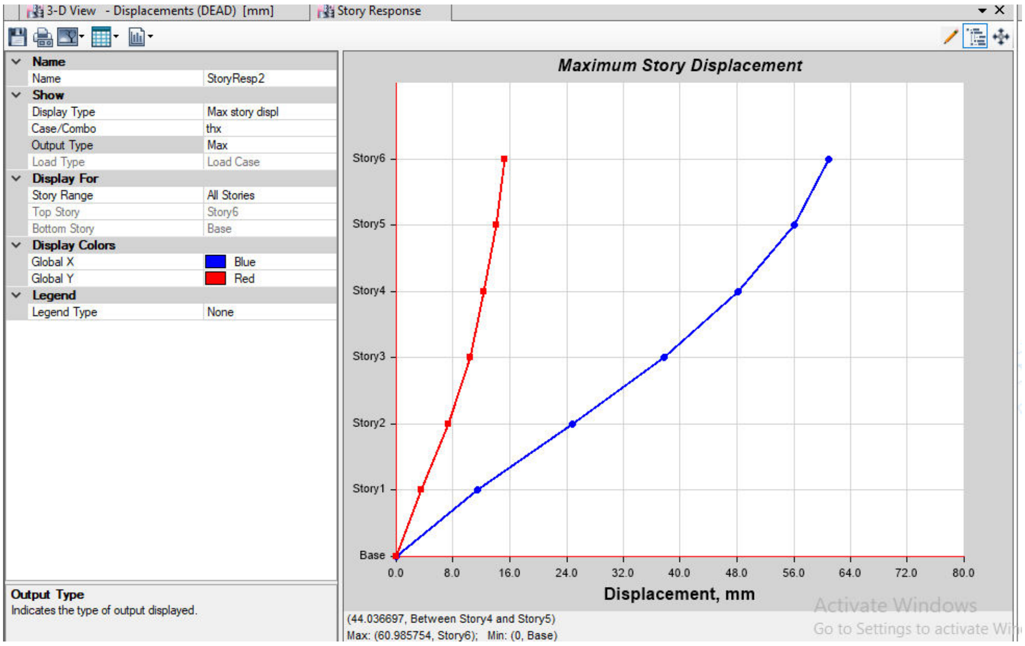
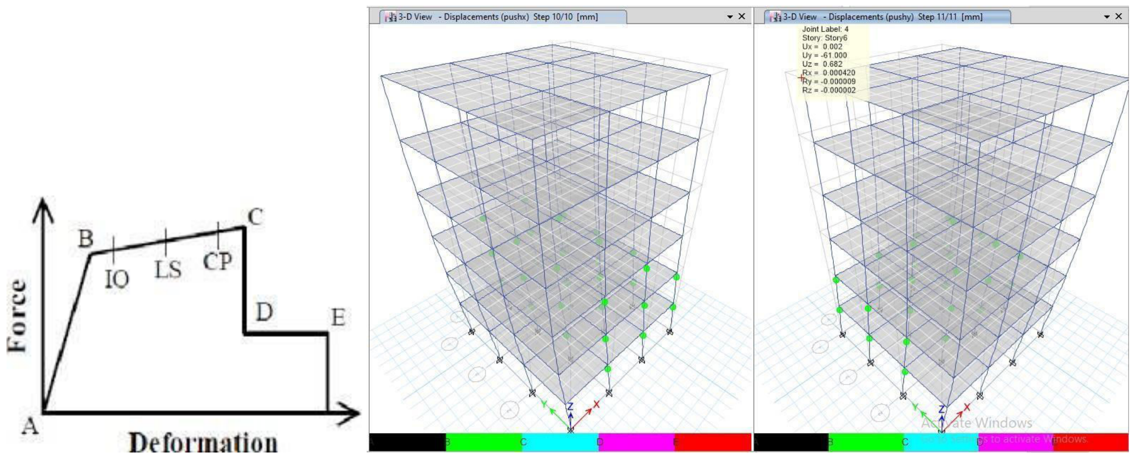


Fig.3 maximum displacement from Nonlinear Time History analysis (FNA)



(a) (b)

Fig.4 (a) State of hinge for loaded members (b) Probable hinge locations

Nonlinear static pushover analysis is done for both the directions and a force Vs deformation curve is adopted to define the state of hinge at any point. The results for the nonlinear static pushover analysis in both the directions with the displacement of 61mm is shown in the fig 4(b). Since plastic hinge formations lies between B and C region green. It is now clear that the hinge formed is within the elasto-plastic region and no damage will be possible if earthquake load equivalent to the intensity of ELECENTRO earthquake is applied. Hence the structure is safe against the earthquake load but unsafe for the increased imposed load. To make the structure safe against the increased imposed loads the failed columns need to be retrofitted.

V. PROCEDURE FOR RETROFITTING

To retrofit the failed columns as shown in fig. 2 a new section of the column is defined to take the extra load. This new section of the column can be defined in ETABS with the help of section designer. An extra jacketing cover is provided to the original column section with reinforcement. The fig 5 shows the new section of the column defined in section

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designer in ETABS. The initial size of the column has dimension of 450mmx300mm. The dimension of the section was increased to 500mmx350mm i.e a 50mm thick jacketing around the column was provided with reinforcement. The dark concrete in fig 5 represents the new concrete which is reinforced with 4-16mm dia bars at the corners and 8-12mm dia bars at the face as shown in the figure.

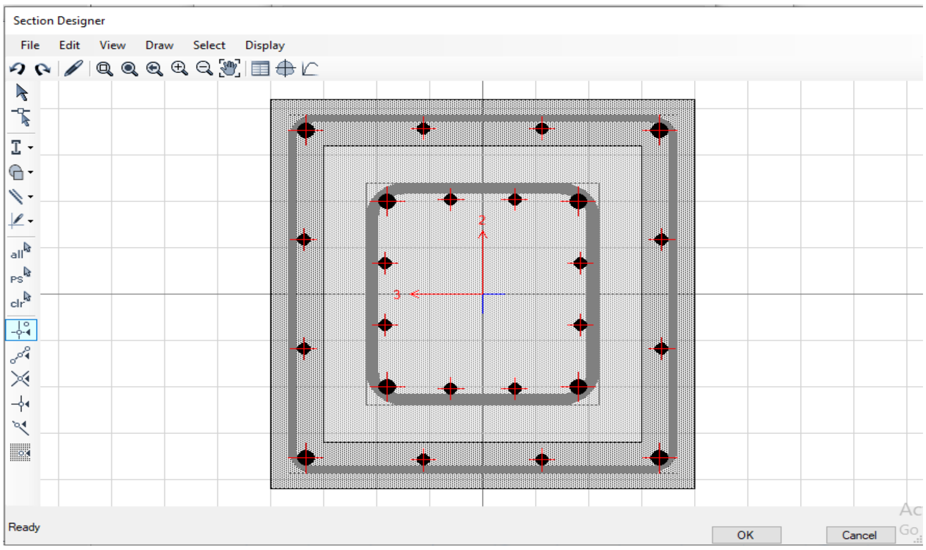

Fig.5 New section defined in section designer

The failed columns were retrofitted with the section shown in the figure 5. The structure is now analyzed and designed to check the failed column section to be safe against the applied increased load. The fig 6 shows the columns retrofitted with the new sections are now safe against the increased imposed load.

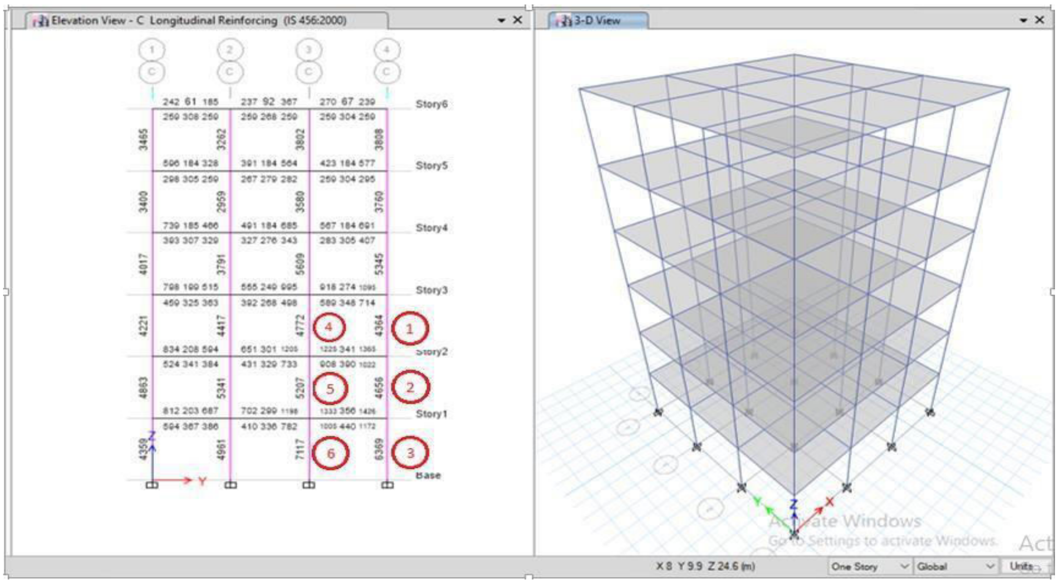

Fig.6 new section defined in section design

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