SEISMIC EVALUATION OF RETROFITING TO REINFORCED CONCRETE BUILDINGS

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ABSTRACT :- Many reinforced concrete frame structures in India were designed and built previous to 2002. The seismic law IS 1893 was revised in 2002. Hence, structures built previous to 2002 don't comply with the codal demand. Further, some of the India structures built over the once many times indeed after 2002 are seismically deficient because of lack of mindfulness of builders regarding the seismic geste of structures. utmost of the being structures in this megacity are designed for graveness loads only. utmost of the structures which have infilled walls haven't considered infills in their design.

A large number of being structures in India need seismic evaluation due to colorful reasons similar as, resistance with the codal conditions, streamlining of law, poor design practice and change in the use of the structure. still, the being deficient structures in India some regions are in Zone III can be upgraded with some recuperation to sustain the anticipated performance position.

The study highlights the seismic evaluation of the existing hostel structure, grounded on the geste of G 2 reinforced concrete bare frame and infill frame structure subordinated to Zone- III position earthquake forces. The three dimensional reinforced concrete structures are anatomized by nonlinear static analysis(Pushover Analysis) using SAP2000 software. The analysis results showed the performance situations, geste of the factors, failure medium and sequence of hinge conformation of the structure.

INTRODUCTION

Inflexibility of ground shaking at a given position during an earthquake can be minor, moderate and strong. fairly speaking, minor shaking occurs constantly; moderate shaking sometimes and strong shaking infrequently.

The masterminds don't essay to make an earthquake evidence structure that won't get damaged indeed during the rare but strong earthquake; similar structures will be too robust and also precious. rather, the engineering intention is to make structures earthquake resistant; similar structures repel the goods of ground shaking, although they may get damaged oppressively but would not collapse during the strong earthquake. therefore, safety of people and contents is assured in earthquake-resistant structures, and thereby a disaster is avoided. This is a major ideal of seismic design canons throughout the world.

The consequences of damage have to be kept in view in the design gospel. For illustration, important structures, like hospitals and fire stations, play a pivotal part inpost-earthquake conditioning and must remain functional incontinently after the earthquake. These structures must sustain veritably little damage and should be designed for a advanced position of earthquake protection. The collapse of heads during earthquakes can beget flooding in the downstream rung, which itself could lead to a secondary disaster. thus, heads(and also, nuclear power shops) should be designed for a still advanced position of earthquake stir.

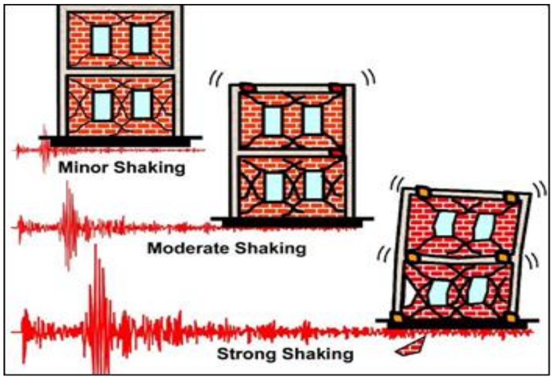


Figure 1 Performance of the Building

Objectives:- This study aims to investigate the effect of brick masonry infill wall on a reinforced concrete moment resisting frame conventionally designed as a bare frame, using available macro model .The specific objectives of the study are:

1. To study the effect of brick masonry infill wall on existing reinforced concrete moment resisting frame, subjected to earthquake induced by the lateral load.
2. To study the effect of an existing reinforced concrete moment resisting bare frame, subjected to earthquake induced by the lateral load.

RESEARCH METHODOLOGY

The research work had been carried out in three phases. In the First phase of the study is the creation and analysis of the model has to evaluate the performance of a typical selected deficient existing building having different types of lateral load resisting systems such as R.C. frame and In filled frame behavior with respect to seismic vulnerability. For this evaluation, a pushover analysis had been performed. The analysis result showed the performance levels, behavior of the components and failure mechanism of the building. It also provided the sequence of hinge formation. Based on the analysis the elements which needed retrofitting were identified.

The Second phase of the study involved the seismic strengthening of the existing bare frame structure based on the SAP 2000 analysis results. For strengthening of the existing building Glass Fiber Reinforced Polymer Composite (GFRP) was used extensively to address the strength requirements related to flexure and shear in the structural system. This phase highlighted the behavior and performance of composite beams by the moment – rotation relation and the ductility of the tested beams. The test result showed that the beams strengthened with GFRP wrapped exhibited better performance.

EVALUATION OF SEISMIC PERFORMANCE:- To select an appropriate retrofitting method, an accurate evaluation of the seismic performance and the condition of an existing structure is necessary. Based on this evaluation, engineers can choose the most effective retrofit technique among the various intervention techniques and optimize the improvement in seismic performance for an existing structure. Seismic deficiencies should first be identified through a seismic evaluation of the structure. The selection of an appropriate intervention technique based on the structural type and its deficiencies is the most important step in retrofitting. Seismic evaluation consists of gathering as-built information and obtaining the results of a structural analysis based on collected data. The Prestandard and Commentary for the Seismic Rehabilitation of Buildings – FEMA 356 (2000) provides guidance for evaluating the seismic performance of existing structures and determining the necessary retrofitting methods to achieve the performance objectives ASCE (2000).

DESCRIPTION OF THE FRAMED STRUCTURES:- The present study was to evaluate the behavior of G+2 reinforced concrete bare frame and infill frame building subjected to zone III level earthquake forces. The three dimensional reinforced concrete structures were analyzed by nonlinear static analysis (Pushover Analysis) using SAP2000 software. The analysis results showed the performance levels, behavior of the components and failure mechanism of the building. It also showed the sequence of hinge formation. Based on the analysis, the elements which need retrofitting were identified.

The three dimensional frame of the selected building having different types of lateral load resisting systems such as R.C. bare frame and Infilled frame were considered in this study. Figure 3.4 shows the plan of the building representing the X and Y direction used for analysis. Figure 3.5 shows a three dimensional line sketch of the frame in the X, Y and Z direction. Figure 3.4 shows a typical longitudinal bare frame (in the X direction in XZ plane). Figure 3.5 shows a configuration model of braces representing infills. Figure 3.6 shows an elevation of the existing study hostel building. The building exists in India and is a typical example of many such buildings in this region.

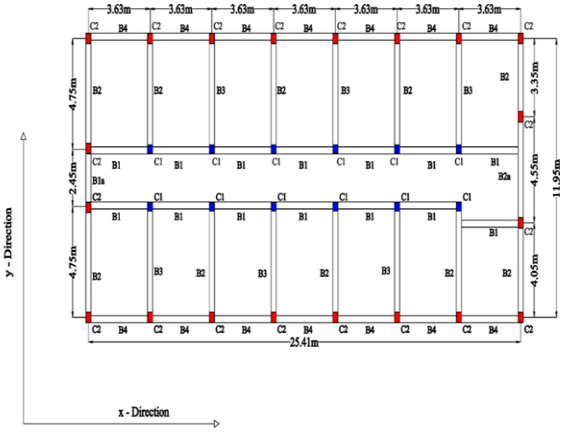


Figure 2 Plan of the Existing Hostel Building

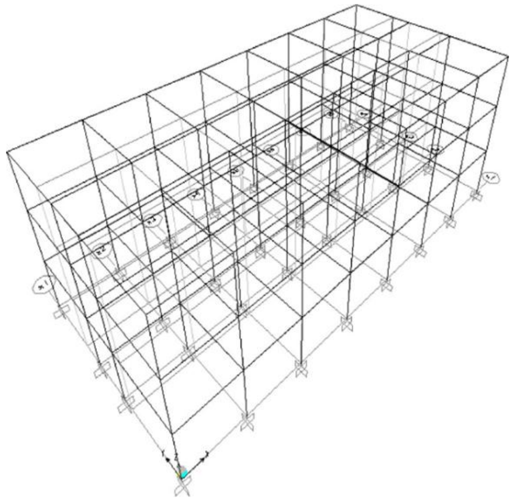


Figure 3 Three Dimensional View of the Bare Frame

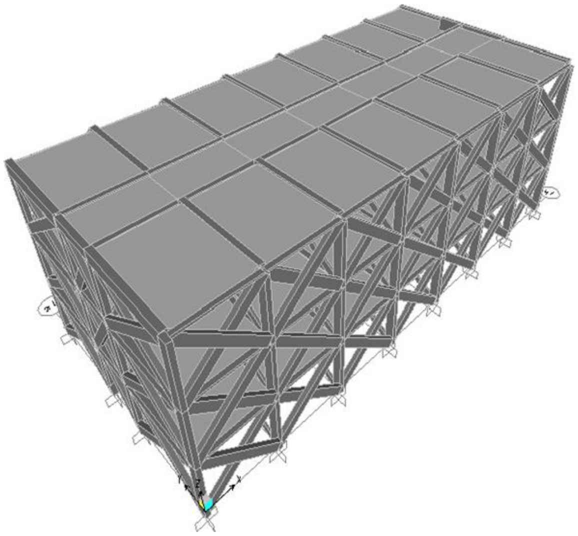


Figure 4 Three Dimensional view of the representing Infills Frame with Braces

Table 1 Seismic weight of the building for Bare Frame (W)

Floor No	Floor height from ground level (m)	Seismic weight (kN)
1	2.93	4463.474
2	5.86	4463.474
3	8.79	1039.470
Total seismic weight of the building (W)		9966.418

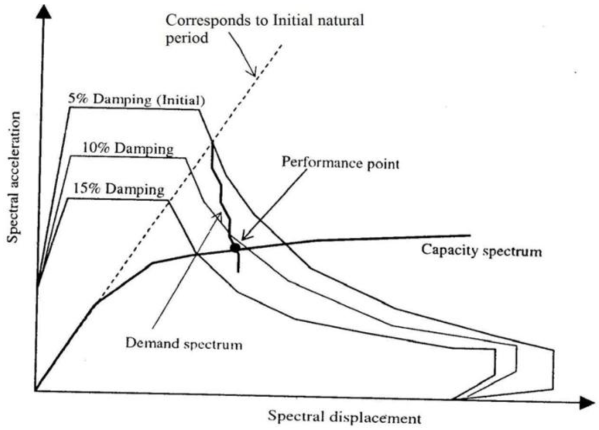


Figure 5 Demand and Capacity Spectra

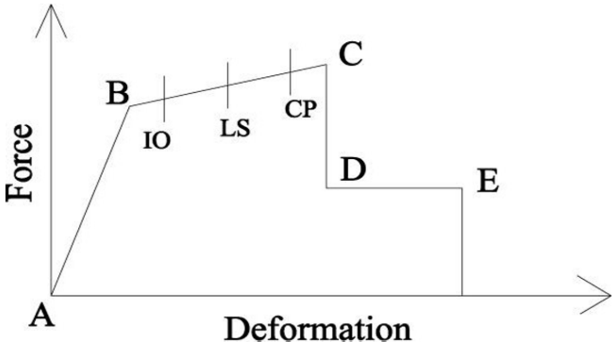


Figure 6 Different Stages of Plastic Hinge ATC 40

Pushover Analysis in SAP2000

The basic computer model (without the pushover data) in the usual manner was created. The graphical interface of SAP2000 makes this a quick and easy task.

The properties and acceptance criteria for the pushover hinges were defined.

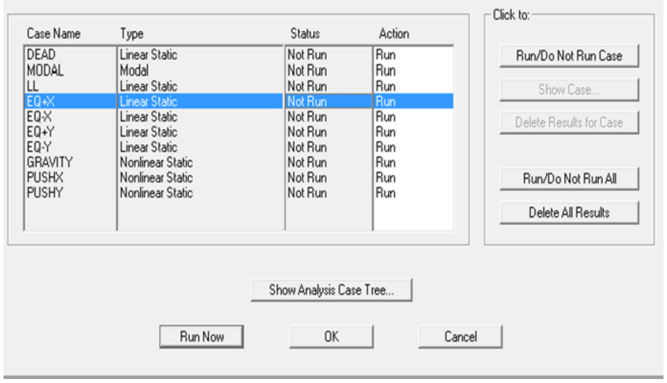
The program includes several built-in default hinge properties that are based on average values from ATC-40 (1996) for concrete members and average values from FEMA-273 (1997) for steel members. These built in properties were used for preliminary analyses but user-defined properties were used for final analyses.

The pushover hinges on the model were located by selecting the frame members and assigning them one or more hinge properties at hinge locations.

The pushover load cases were defined in SAP2000, where more than one pushover load case could be run in the same analysis. Also a pushover load case could be started from the final conditions of another pushover load case that was previously run in the same analysis. Typically the first pushover load case is used to apply gravity load and then subsequent lateral pushover load cases are specified to start from the final conditions of the gravity pushover. Pushover load cases can be force controlled, that is, pushed to a certain defined force level, or they can be displacement controlled, that is, pushed to a specified displacement.

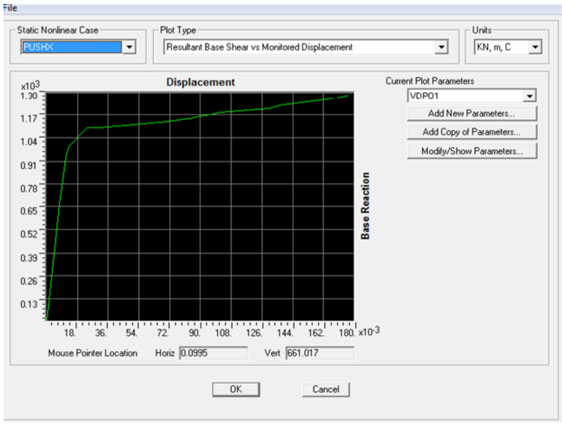
Typically a gravity load pushover is force controlled and lateral pushovers are displacement controlled. SAP2000 allows the distribution of lateral force used in the pushover to be based on a uniform acceleration in a specified direction, a specified mode shape, or a user-defined static load case.

Initially the basic static analysis was made to run in SAP 2000 and then the static nonlinear pushover analysis.



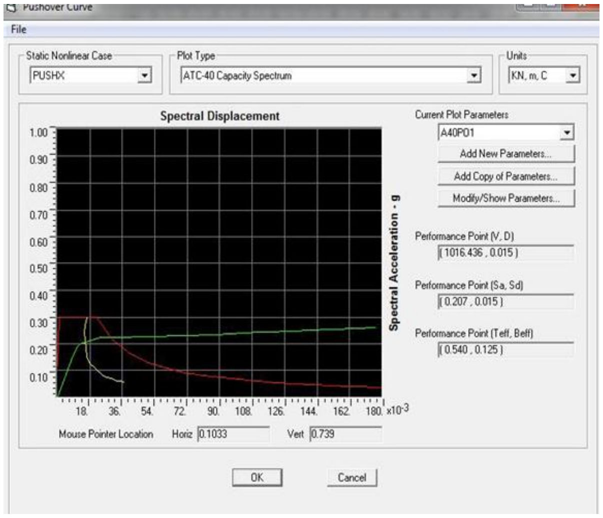
Case Name	Type	Status	Action
DEAD	Linear Static	Not Run	Run
MODAL	Modal	Not Run	Run
LL	Linear Static	Not Run	Run
EQ+X	Linear Static	Not Run	Run
EQ-X	Linear Static	Not Run	Run
EQ+Y	Linear Static	Not Run	Run
EQ-Y	Linear Static	Not Run	Run
GRAVITY	Nonlinear Static	Not Run	Run
PUSHX	Nonlinear Static	Not Run	Run
PUSHY	Nonlinear Static	Not Run	Run

Figure 7 Analysis Cases of the Frame



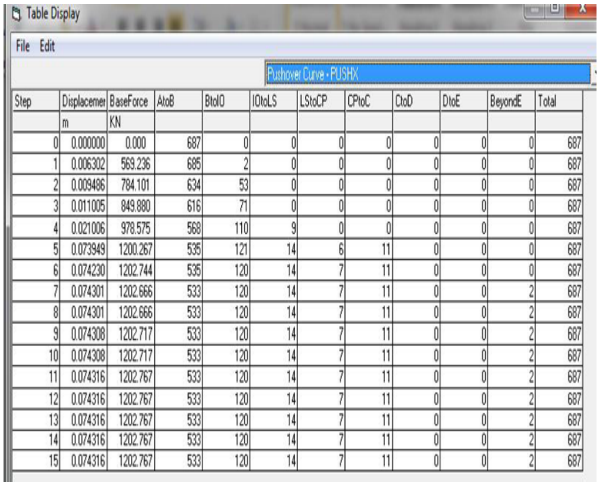
Static Nonlinear Case: PUSHX
Plot Type: Resultant Base Shear vs Monitored Displacement
Units: KN, m, C
Current Plot Parameters: VDPO1
Mouse Pointer Location Horiz 0.0995 Vert 661.017

Figure 8 Pushover Curve of the Frame



Static Nonlinear Case: PUSHX
Plot Type: ATC-40 Capacity Spectrum
Units: KN, m, C
Current Plot Parameters: A40PO1
Performance Point (V, D) (1016.436 , 0.015)
Performance Point (Sa, Sd) (0.207 , 0.015)
Performance Point (Teff, Beff) (0.540 , 0.125)
Mouse Pointer Location Horiz 0.1033 Vert 0.739

Figure 9 Capacity Spectrum of the Frame



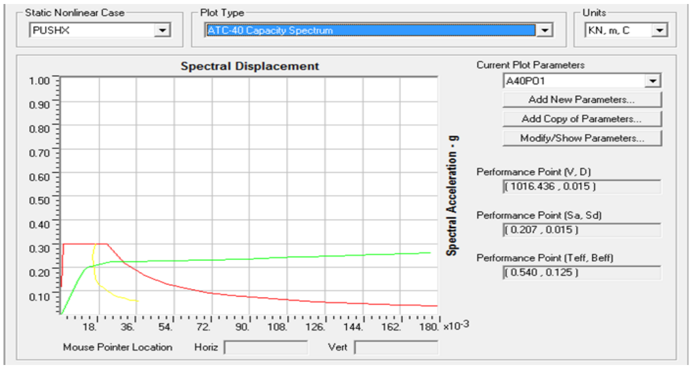
Pushover Curve - PUSHX

Step	Displacemer	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	0.000000	0.000	687	0	0	0	0	0	0	0	687
1	0.006302	569.236	685	2	0	0	0	0	0	0	687
2	0.009486	784.101	634	53	0	0	0	0	0	0	687
3	0.011005	849.880	616	71	0	0	0	0	0	0	687
4	0.021006	978.575	568	110	9	0	0	0	0	0	687
5	0.073949	1200.267	535	121	14	6	11	0	0	0	687
6	0.074230	1202.744	535	120	14	7	11	0	0	0	687
7	0.074301	1202.666	533	120	14	7	11	0	0	2	687
8	0.074301	1202.666	533	120	14	7	11	0	0	2	687
9	0.074308	1202.717	533	120	14	7	11	0	0	2	687
10	0.074308	1202.717	533	120	14	7	11	0	0	2	687
11	0.074316	1202.767	533	120	14	7	11	0	0	2	687
12	0.074316	1202.767	533	120	14	7	11	0	0	2	687
13	0.074316	1202.767	533	120	14	7	11	0	0	2	687
14	0.074316	1202.767	533	120	14	7	11	0	0	2	687
15	0.074316	1202.767	533	120	14	7	11	0	0	2	687

Figure 10 Output of the Pushover Analysis

RESULTS

Capacity Spectrum and Building Performance Level:- Capacity spectrum is the capacity curve transformed from base shear versus roof displacement co-ordinates into spectral acceleration versus spectral displacement (Sa Vs Sd) co-ordinates. The performance point is obtained by superimposing demand spectrum on capacity curve transformed into spectral coordinates. To have desired performance, every structure has to be designed for the spectral acceleration corresponding to the performance point.



Static Nonlinear Case: PUSHX
Plot Type: ATC-40 Capacity Spectrum
Units: KN, m, C
Current Plot Parameters: A40P01
Performance Point (V, D): (1016.436 , 0.015)
Performance Point (Sa, Sd): (0.207 , 0.015)
Performance Point (Teff, Beff): (0.540 , 0.125)

Figure 11 Capacity Spectrum for Bare Frame in X-Direction

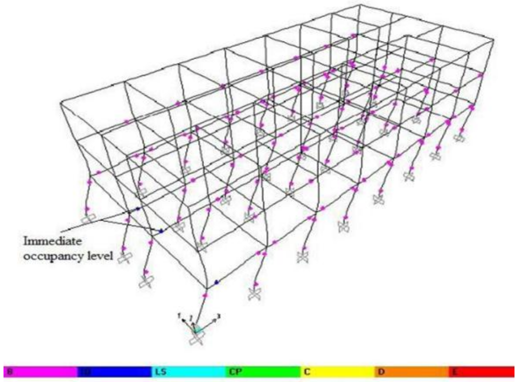
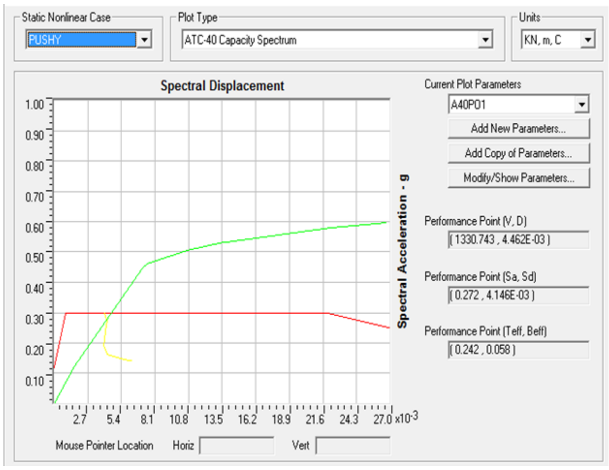


Figure 12 Hinges Formation in X- Direction at Performance Level



Static Nonlinear Case: PUSHY
Plot Type: ATC-40 Capacity Spectrum
Units: KN, m, C
Current Plot Parameters: A40P01
Performance Point (V, D): (1330.743 , 4.462E-03)
Performance Point (Sa, Sd): (0.272 , 4.146E-03)
Performance Point (Teff, Beff): (0.242 , 0.058)

Figure 13 Capacity Spectrum for Bare Frame in Y-direction

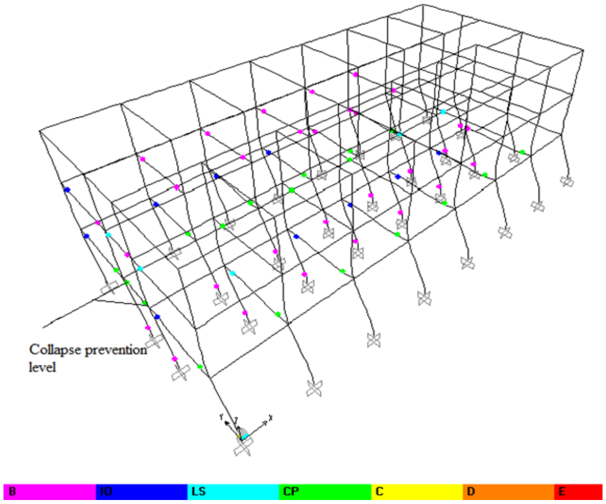


Figure 14 Hinges Formation in Y direction at Performance Level

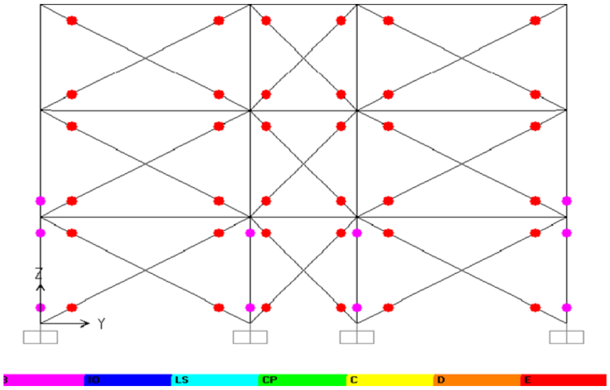


Figure 15 Sequence of Hinges Formation in Y- Direction

CONCLUSIONS:-

The structural designers of the India designed the buildings considering them as bare frame or bare frame with infill. In case of buildings designed as bare frame, when the first hinge occurs the beam collapse first in the event of an earthquake in the city. This is the case for the existing building selected for the research work.

The study involved the creation and analysis of the model and evaluation of the performance of a typical selected building which has different types of lateral load resisting systems such as R.C. bare frame and Infilled frame behavior with respect to seismic vulnerability. For this evaluation, a pushover analysis had been performed. The analysis results showed the performance levels, behavior of the components and failure mechanism of the building. It also showed the sequence of hinge formation. Based on the analysis the elements which needed retrofitting were identified.

The bare frame analysis predicts a beam failure mechanism first. In India many buildings have infills. Infill frame analysis predicts column to fail before beam failure. Therefore, the infill buildings had a weakness.

To avoid premature collapse of the column, the columns had to be retrofitted to have adequate strength so that at the performance point columns do not reach yield level.

Therefore weak columns in X and Y directions must be strengthened by using locally practiced strengthening techniques, before an earthquake.

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