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Parametric study on seismic analysis of column jacketing by using etabs

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Abstract: Retrofitting can increase a building's structural qualities, including its strength, stiffness, ductility, and stability. Due to the probable design problems in the current columns and the increasing strain the building will receive as the number of retailer's increases, the bottom story may experience the greatest amount of column failure. As a result of the jacketing process, the columns will become stronger and the jacketing will be constructed to sustain the greater load in accordance with IS code, reducing the number of columns that fail (IS 15988:2013). The structure may rise to the aforementioned floors because the strengthened columns' bigger surface area can withstand a heavier load. The software will model every unsuccessful column. A common refit technique is concrete jacketing. The concrete junketing's design and computer-aided modeling are crucial components of the retrofitting procedure to be used on an existing structure. Particularly in India, there aren't enough laws and norms governing retrofitting. Use the structural engineering tool ETABS to analyze multi-story buildings for seismic loads, and then present retrofitting options to reduce the building's overall displacement and raise the frequency of seismic vibrations.

1. INTRODUCTION

Strengthening a structure's seismic resilience is the junketing's primary objective. Depending on the kind of jacketing used, increasing strength, stiffness, ductility, or a combination of them, can be accomplished. There are numerous techniques to jacket a structural element. Usually, a jacketing of reinforced concrete formed of welded wire fabric or concrete fortified with longitudinal steel and links is placed over the existing part. Infrastructure sustainability is gaining importance as time goes on. The capacity to strengthen and repair reinforced concrete columns can raise structural performance to the standard required by current design rules. Retrofitting is a technological intervention in the structural system of a building that increases its resilience to earthquakes by increasing strength, ductility, and seismic loads. The strength of the structure as a whole is influenced by the size, composition, amount, and shapes of its structural components. The building's strong materials, excellent detailing, level of seismic resistance, etc. all contribute to its durability. The earthquake load is affected by a number of factors, including the seismicity of the location, the mass of the buildings, their historical significance, their level of seismic resistance, etc. The variability of building structural characteristics makes it difficult to formulate common principles for retrofitting. Each building uses a different approach depending on its shortcomings. Engineers must therefore plan and develop the retrofitting strategies. When creating a retrofitting strategy, the engineer must follow the building codes. The results of the chosen retrofitting methods must satisfy the minimum requirements specified in the building regulations, such as those relating to deformation, detailing, strength, etc.

Concrete jacketing is one of the most often employed methods for strengthening weak columns. This technique has improved the properties of the member and the structure as a whole. There aren't many established guidelines or rules for designing and implementing retrofitting in India. Structural engineers primarily resort to the rules of other countries when developing retrofit plans and designing an appropriate retrofit for the structure under investigation. The main code requirement in India that stipulates general guidelines for retrofit design is IS 15988:2013. This code is intended to provide standards for the development of a few important retrofit procedures as well as advice for evaluating existing structures.

A structural analysis tool offers a variety of analysis methods. For performance-based structural analysis, a hierarchy of structural analysis may be developed. Higher level processes offer a more accurate method of estimating how well a building will actually perform under earthquake loads, but it is more challenging and time-consuming to interpret the results.

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Description of software used ETABS a list of the software used List of the software programs used in ETABS. Developed integrated building design software called ETABS, also referred to as CSI. This program may be the most useful in the field of structural engineering for designing structures and towers. Structural engineers can use a collection of tools given by ETABS when designing multi-story buildings, whether they are working on single-story buildings or the tallest commercial skyscrapers and towers. The modeling tools and templates, code-based load prescriptions, analysis methods, and solution approaches all take into account the grid-like geometry that is unique to this type of construction. Simple or complicated systems can be analyzed with ETABS under static or dynamic circumstances.

The impact of CFRP strengthening on the general behavior and failure modes of the strengthened RC columns have been the subject of numerous investigations. Deficient RC columns that had been retrofitted with external CFRP jacketing exhibited stable flexural response, higher ductility, and superior energy dissipation capacity, according to Ma et al. [24], because the jacketing prevented brittle shear failure. Ye et al. [25], who discovered that the CFRP sheets can increase the shear strength of RC columns that have insufficient transverse reinforcement, discovered results that were similar to theirs. Additionally, it was found that the CFRP sheets' shear resistance mechanism is similar to that of reinforcing hoops, where it started working once concrete developed diagonal shear cracks.

- Column jacketing has a purpose.
- Column jacketing serves two key purposes.

1. Increasing the shear capacity of columns (design with strong columns and weak beams).

2. To increase the flexural strength of the column.

After a thorough analysis of the existing structure has been carried out, defective elements are discovered. Calculated and indicated on the list are the available and required reinforcements. Each of these components needs to be strengthened in order to increase their ductile strength. Therefore, to reinstall these members, jacketing is utilized. It also increases the building's strength, load-bearing capacity, and seismic resilience without the need for any demolition. It enhances the lateral load capacity and ductile behavior of the construction. Additionally, the building gains rigidity and strength.

2. LITREATURE REVIEW

1. Umesh Dhargalkar's 2002 article [16] mainly focused on seismic assessment for seismic retrofitting of buildings built with or without consideration for seismic effects. Possible retrofitting plans can be evaluated using the data gathered by modeling an exact replica of the structure. Based on implementation case and cost, the best suitable approach is chosen.

2. The subject of G. Appa Rao, M. Mahajan, M. Gangaram, and Rolf Eligehausen's 2008 [19] article [19] was how to reinforce RC column junctions that were not seismically constructed to withstand seismic stress. In pre-seismic design, typical reinforcement details of joints have been described. Review of the strengthening technique, as well as its benefits and test results; have been examined in relation to the rehabilitation of RC structures. Therefore, the advantages and disadvantages of joint strengthening have been discussed in this work.

3. Rodrigues et al. (2018) [1] investigated a few existing structures in Nepal and suggested appropriate retrofit solutions, such as adding shear walls, concrete jacketing for weak columns, and steel bracing. They have made an effort to highlight these measurements' effectiveness in terms of strength and ductility.

4. In his article from 2013, Ismail (2013) examined the effectiveness of different jacketing employing steel, CFRP, and concrete as retrofit approaches. He assessed the structural members' lateral displacement and strength with and without retrofitting an existing G+9 building. He came to the conclusion that the concrete jacketing procedure significantly increases both lateral strength and stiffness.

5. In their research, Riyad et al. (2016) assessed the effectiveness of CFRP and shear walls as retrofitting solutions. He thought about a Moroccan-coded, eight-story RC structure. He came to the conclusion that CFRP increased the structure's ductility and stiffness.

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3. OBJECTIVES

• To use E-TABS software to carefully analyse and design the structure to produce a 3D model.
• To comprehend the essential ideas behind the Indian Standard Codes-based architecture.
• Being aware of the slab, column, beam, and other structural elements' design requirements.
• To look at the temporal development of the structure during earthquake ground motions.
• To use response analysis to choose the best construction configuration.

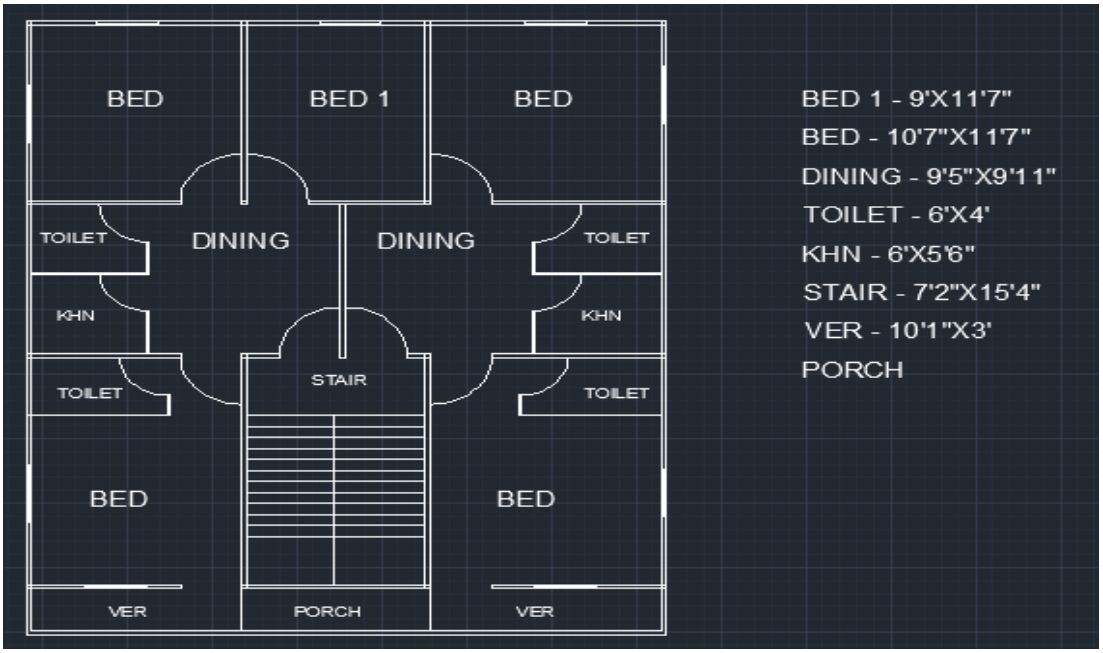
4. METHODOLOGY

• A G+6 story building is modelled and put through a time history study using ETAB's software.
• IS 456-2000 and SP16 must be followed while using the material (13330- 2017).
• The axial load and moment seismic loads are calculated based on the analysis' conclusions. The creation of the concrete jacket followed IS 15988:2013.
• The concrete jacket part was created and sculpted in ETABs using section designer.
•16mm bars that are 400mm square and 150mm apart are used to jacket concrete.

5. RESULT AND DISCUUSION

5.1 AUTO CAD PLANNING

AutoCAD is a computer-aided design (CAD) tool used for two- and three-dimensional drafting and design. AutoCAD, developed and offered by Autodesk Inc., was among the first CAD programs to function on personal computers. CAD software is used to design objects like the electronic circuit boards found in computers and other devices.



5.2. MODELING PROCEDURE

- Create a New Model
- Set both the story dimension and the grid dimensions.
- Select the Bottom Fixed Restraints
- Frame Sections
- Define Slab Section

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5.3MODEL APPLIED IN THE STUDY

The building model is a 3D model of an existing building. Without any particular earthquake resistance characteristics, it was constructed to endure gravity in accordance with Indian standards. For the objectives of the study, a hypothetical four-story school structure is taken into account. This building represents a construction that was likely built before seismic codes were adopted or put into force. This zone V building was therefore designed to support only gravity loads. Some of the more prominent features of the building are listed below.

Beams are 300 mm x 300 mm, and the column section is 400 mm x 400 mm.

Floor height is 3.15 m.

150 mm thick for the slab.

M20 is the concrete grade.

Fe 415 steel rebar grade.

IS 456: 2000, the Building Design Code

Below are the seismic data that were utilized for modeling:

A seismic zone of V, a soil type of 2, a response reduction factor of 5, an importance factor of 1, and an amount of damping of 5%.

The following wind data were utilized in the modeling:

a. Wind speed: 44;

b. Terrain category: 2;

c. Importance factor: 1;

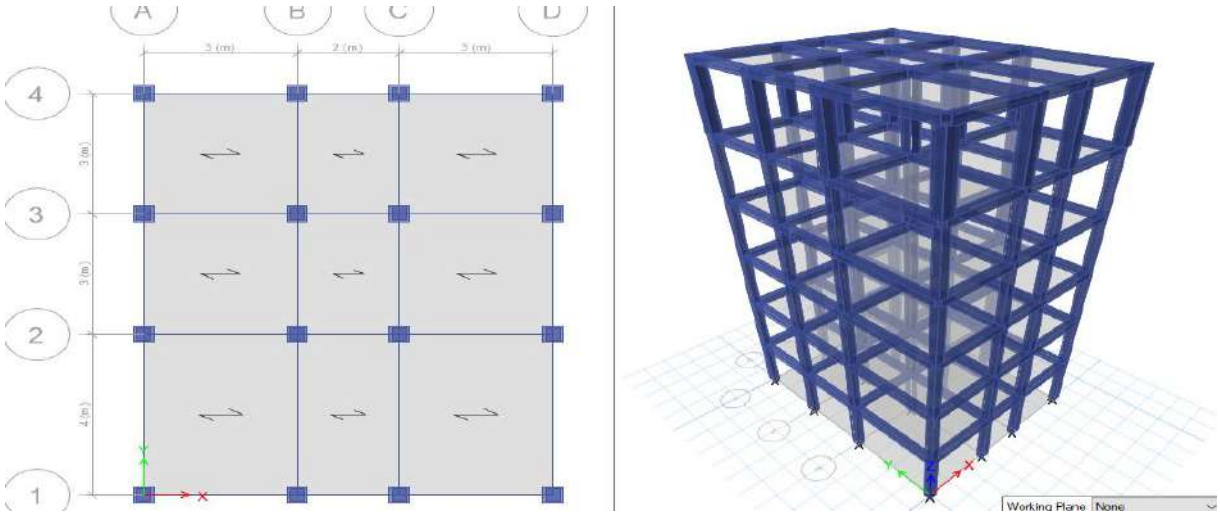
d. Risk coefficient: 1;

e. Topography: 1;

f. Windward coefficient: 0.8;

g. Leeward coefficient: 0.5;

h. Degree of direction: 90



5.4 COLUMN JACKETING

A retrofitting method known as column jacketing improves the ductility and strength of weak beams and columns at the member level. The absence of any weak column components is essential since they could trigger failure mechanisms during earthquakes. Since the columns are governed by axial load, shear, and flexural strength, column jacketing is seen to be an acceptable local strengthening. Column jacketing involves enclosing pre-existing columns with concrete, longitudinal reinforcement, and transverse reinforcement. Jacketing may be added to one, two, three, or four sides of the

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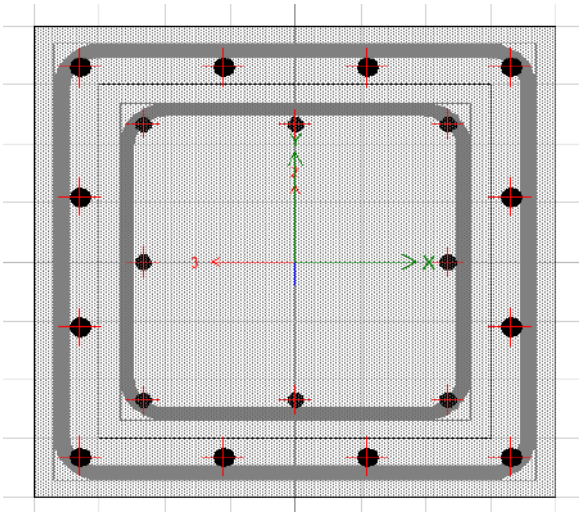
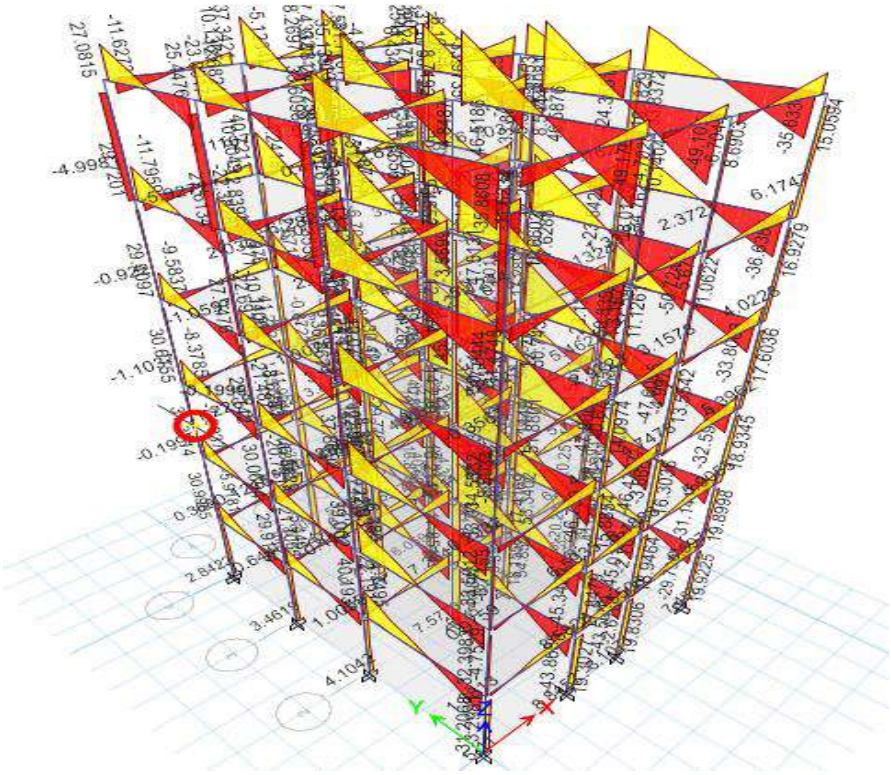
member, depending on the circumstances of the space that is available around the columns. We provided the 150 mm center-to-center spacing for the 16 mm bars.



5.5 Bending force (Shear force)

A shear force resists an offset force that works in the opposite direction by being applied perpendicular to a surface. A shear strain is the outcome of this. In other words, while some of the surface is being pushed in one way, other portions are being pushed in the opposite direction. Shear strain is frequently produced by shear force, which is the result of shear tension acting over a surface.



5.6 Flexible moment (Bending moment)

The algebraic sum of moments on either the left or right side of the section is referred to as the "bending moment." A structural element (such a column or beam) bends and eventually fails when an external force is applied to it. The bending

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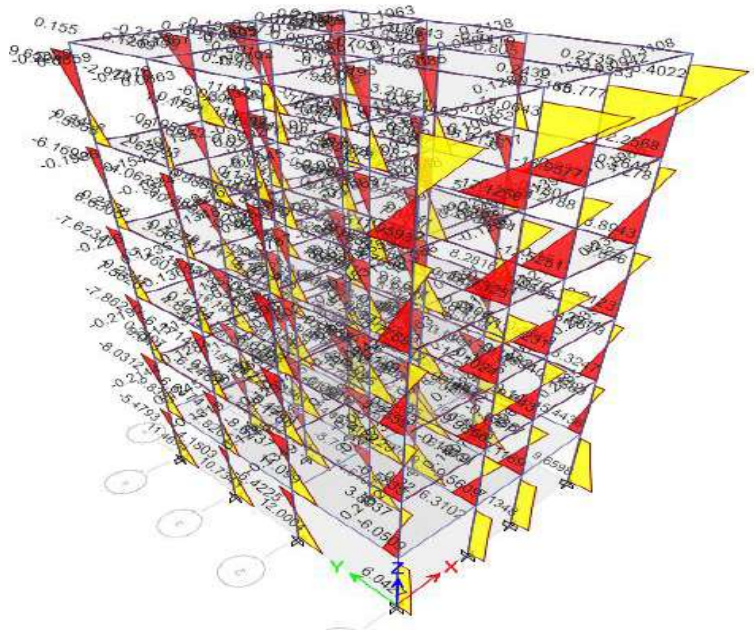
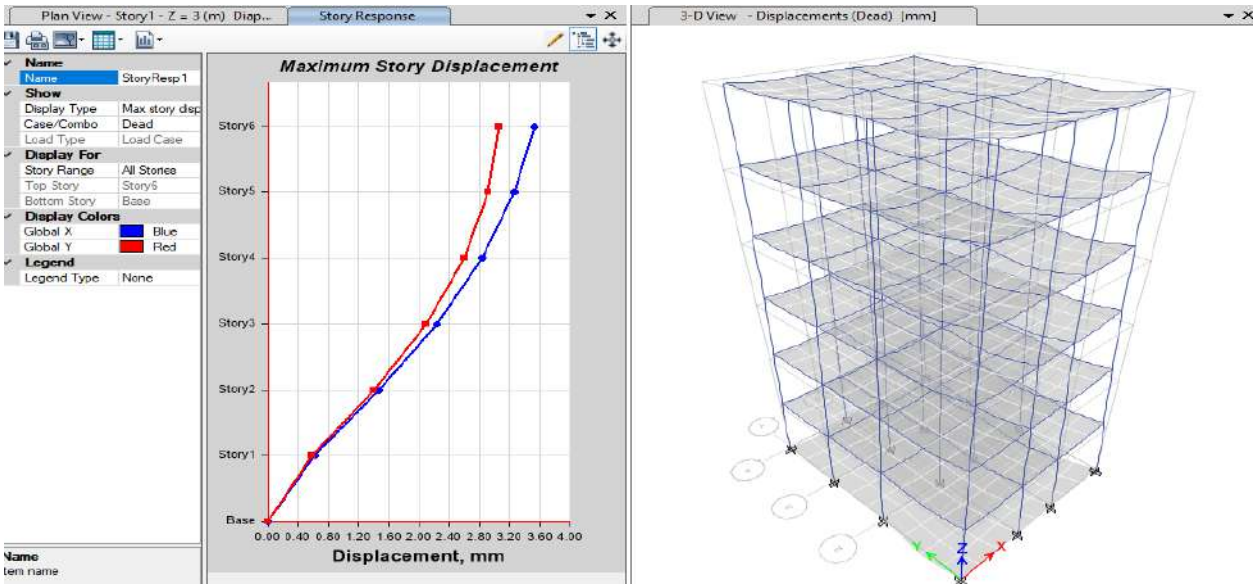
moment happens at this point. Think of a load-bearing beam with straightforward support: The maximum bending moment in the beam occurs at the point of greatest stress, just before it breaks. This idea is essential when building structures for optimal structural integrity. There are two distinct kinds of bending moments, depending on the direction of the bending:



5.7 Displacement

The definition of displacement is the modification of an object's position.



5.8Analyzing historical time

Time history analysis is used to assess a structure's dynamic response to a given loading that could change over time in small stages. It is feasible to predict how a structure will respond seismically to dynamic loading from a representative earthquake through time history analysis. With the aid of time-history analysis, the dynamic structural response to loads can be assessed linearly or nonlinearly, depending on the time function chosen.

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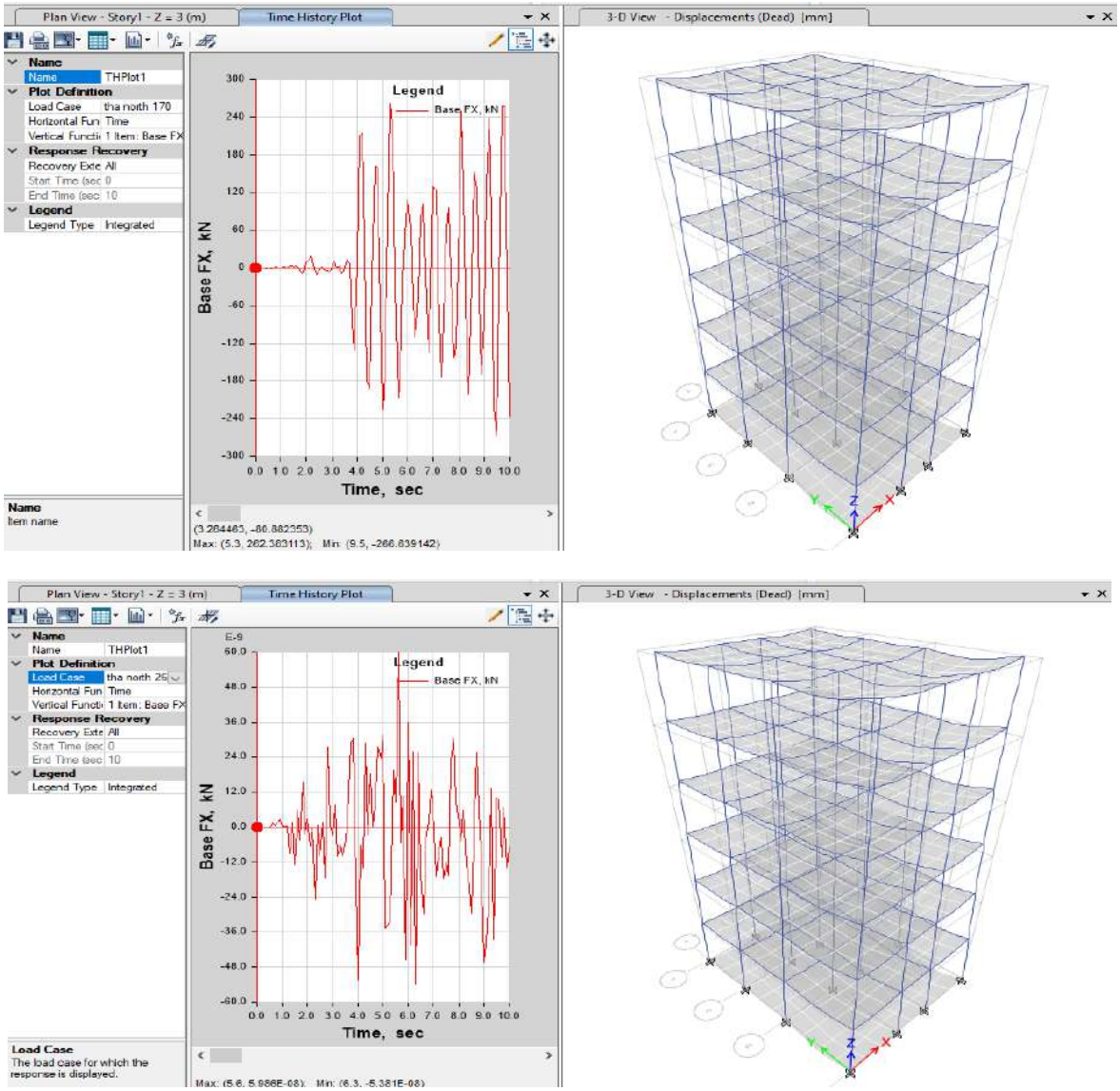

5.9Response-spectral modeling

In order to estimate the most likely maximum seismic response of a basically elastic structure, response-spectrum analysis (RSA), a linear-dynamic statistical analytic method, evaluates the contribution from each natural mode of vibration.

The following reasons are why the earthquake engineering community prefers the response spectrum method:

• It offers a method for carrying out an equivalent static lateral load analysis.
• It enables a clear understanding of the contributions of various modes of vibration.
• It offers a simplified method for determining the design forces for structural members for earthquake.

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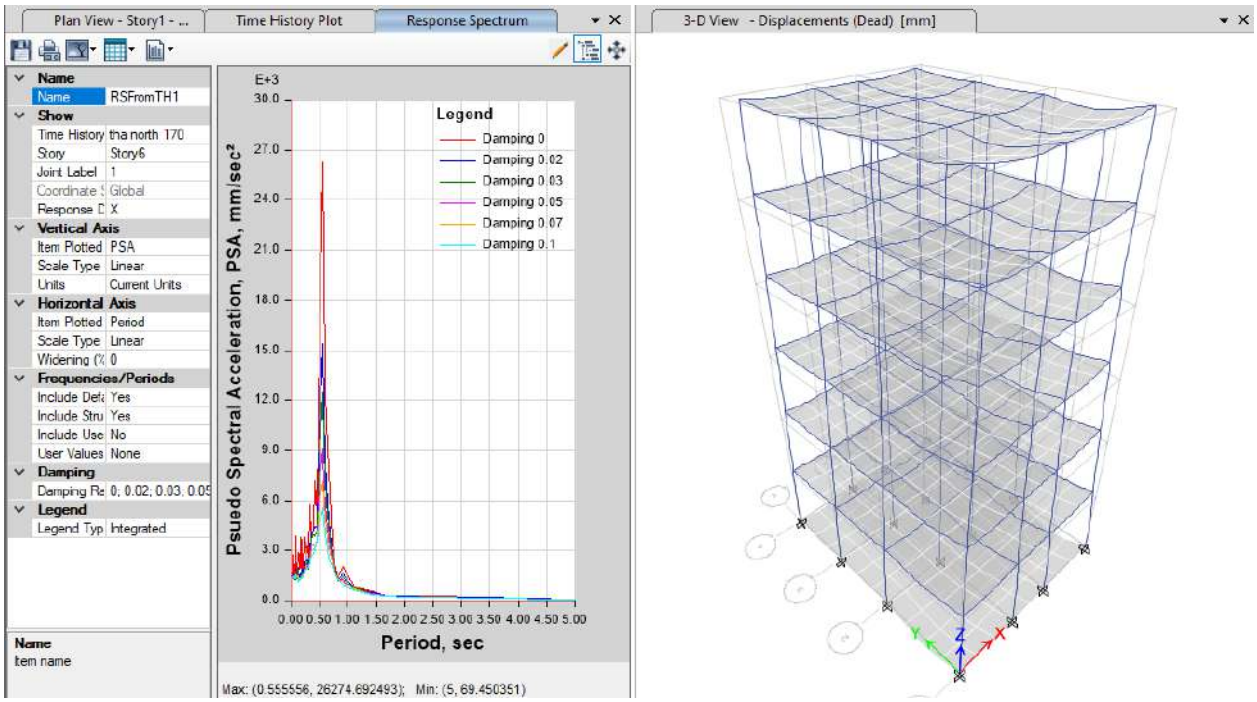

6. DIFFERENCE BETWEEN COLUMN AND COLUMN JACKETING

	COLUMN	COLUMN JACKETING
Definition	A column is a structural part used in structural engineering that compresses other structural elements below it to transfer the weight of the structure above. In other words, a column is a compression member.	Jacketing is the process of enclosing a column in an outer layer of material. Depending on the application and general design, it can be utilized for a wide range of purposes.
Layer	It contains a single layer.	It contains a two or more layers.
Purpose	Columns are essentially vertical structures for transferring compressive stresses. The floor and the columns on the floors above are supported by columns.	It increases the columns axial and shears strength such that extensive foundation strengthening may be avoided.

7. CONCLUSION

- The obtained design is suitable and can be utilized safely for analytical purposes.
- The IS 15988:2013 will provide basic guidelines for assessing existing structures and performing reinforcing measures.
- One practical way to improve the concrete member's ability to endure compression is to use strengthening procedures.
- The specimen's cracking behavior was exacerbated by the presence of the concrete jacket, and crack initiations were reduced by the specimen's high tensile capacity.
- The deflection of the column decreases as the cross section of the column widens and as the jacketing thickness increases.

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