International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 09 | Sep 2021 www.irjet.net p-ISSN: 2395-0072

SEISMIC CAPACITY ENHANCEMENT OF SUB-STANDARD RCC COLUMN USING RETROFITTING TECHNIQUE (PVA FIBRE) ON ETABS

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Abstract – *As part of the project, ETabs software will be used to design and analyze a G + 10 storey multi-storey building. The dimensioning is carried out in accordance with the norms and standards of IS codes and national building codes. PVA fiber is used for modification. As a reinforcing material of cement-based composite materials, PVA fiber is superior to other ordinary fibers in terms of performance. . In concrete mixtures, PVA (polyvinyl alcohol) fiber can be used as a substitute for aggregate in concrete. The improvement of the compressive and tensile strength of concrete is achieved through the transformation process. Polyvinyl alcohol fiber reinforced concrete is an ideal material to achieve the goals of controlling thermal cracking, plastic shrinkage, durability, toughness and abrasion resistance. There are two key problems with this cement substitute; i.e. Changes in concrete physical properties in terms of compression, tensile strength and cost analysis.*

Key Words: **Retrofitting, Polyvinyl Alcohol Fibre(PVA), Etabs, Force, Bending Moment, storey displacement, storey shear, base shear, etc**

1.INTRODUCTION

Earthquakes are the most catastrophic, unpredictable and unavoidable natural phenomenon, causing huge damage to buildings, property and lives. Earthquake exposure is extremely uncertain, depending on the period, amplitude and frequency components of the seismic wave. The response of a structure to an earthquake depends on many factors, such as: The number of floors, soil-structure interaction, stiffness, structural quality, verticality, planar and torsional irregularities, and concave angles. According to the Bureau of Indian Standards 1893-Part 1 (2002), the Indian Plateau is divided into four seismic zones-Zone II, Zone III, Zone IV and Zone V. However, due to the lack of seismic experience, the structures built in India in the past ten years are only used for gravity loading, so seismic resistance is poor. Therefore, some precautions should be taken to minimize the loss rate. One such measure that can be taken in a building structure is modification. A variety of modification techniques can be used. However, the project adopted the PVA transformation method because of its feasibility and ease of construction. In this project, the seismic qualification and modification of the existing structure was evaluated. The structure is analyzed by the equivalent static method, and the modeling uses ETABS2018 software.

1.1 Objective

1. Conducting an extensive literature investigation on the available tests and analytical models concerned with seismic performance of RCC column.

2. Study of various retrofitting techniques.

3. Identifying and quantifying the key influence parameters and important failure modes in seismic performance of RCC column using Etabs

4. Quantification of the effect of high axial loads on strength and deformability of columns.

1.2 Methodology

1. Evaluation of existing capacity of column.

2. Design of G+10 Building using retrofitted Column.

3. Design of column to fulfill zone wise seismic requirements using Etabs.

4. Design of retrofitting technique to improve capacity of column by using PVA fiber on Etabs.

5. Comparisom of Etabs Results.

1.3 PVA Retrofitting

PVA Wrapping : Like steel plates, PVA Fibre are attached to column to increase their axial and shear capacities. The amount of PVA attached to the column should be limited to retain the ductile flexural failure mode.

Poly-Vinyl Alcohol fibers are a recently developed material for strengthening of reinforced concrete and masonry structure. This is an advanced material and most of the development in its application in structural retrofitting has taken place in the last two decades. It has been found to be a replacement of steel plate bonding. The main advantage of PVA is its high strength to weight ratio and high corrosion resistance. PVA plates can be stronger than steel plates, while their weight is just 20 percent of that of steel. These are glued to walls or columns using epoxy mortars.

Properties of PVA Fiber:

		Dia. (mm)	Tensile Strengh (MPa)	Young's Modulus (GPa)	Fiber Elong-ation (%)
Standard	RM 182	0.014	1600	37	7
	RM 400	0.20	1000	130	7
	RF 1000	0.31	1000	29	7
	RF 4000	0.67	900	30	7
Ductile	REC7	0.040	1600	37	6
	REC 15	0.040	1600	37	6
	REC 1000	0.10	1100	30	10

1.4 Modelling

1. RCC building with conventional columns.
2. RCC building with PVA Retro-fitted columns.

Structural Dimensions of building

- Building type – RCC building
- No. of storeys – G+10
- Plan area– 600 sq meter
- Plan dimensions – 30 m X 20 m
- Height of building – 30 m
- Type – Commercial
- Beam – 0.230 m x 0.230 m
- Column– 0.45 m x 0.6 m

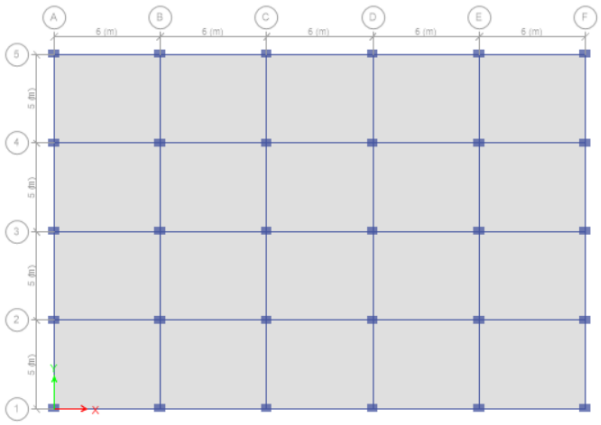

Fig 1: Plan of RCC building

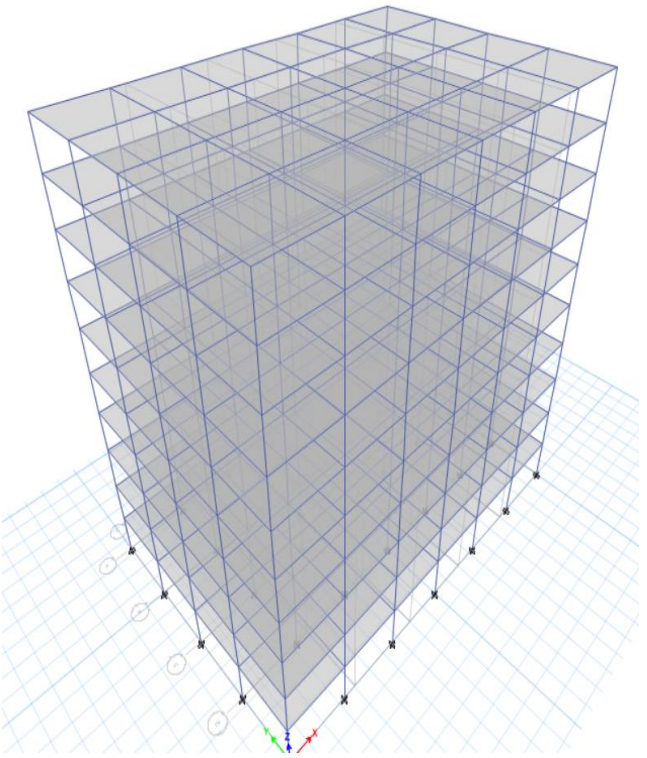

Fig 2: Elevation of RCC building with Conventional Columns

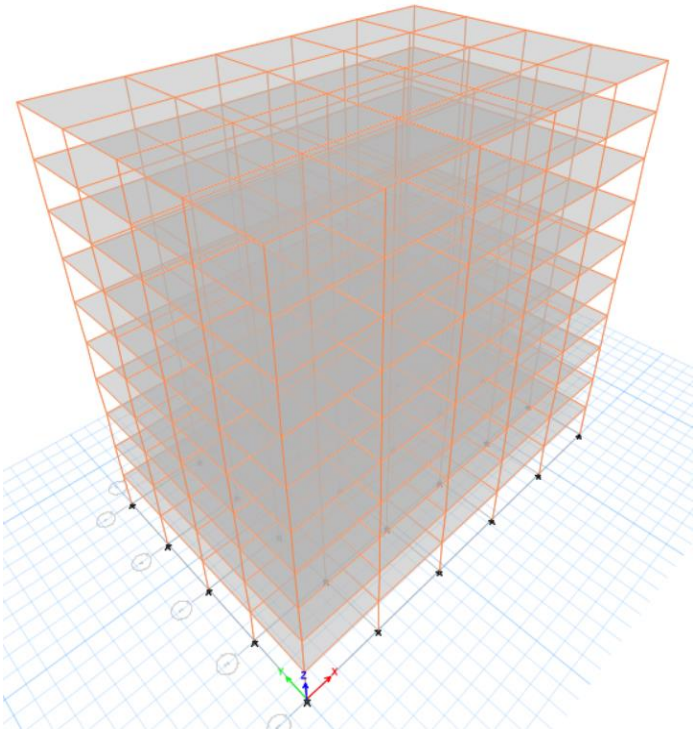

Fig 3: Elevation of RCC building with Retrofitted Columns

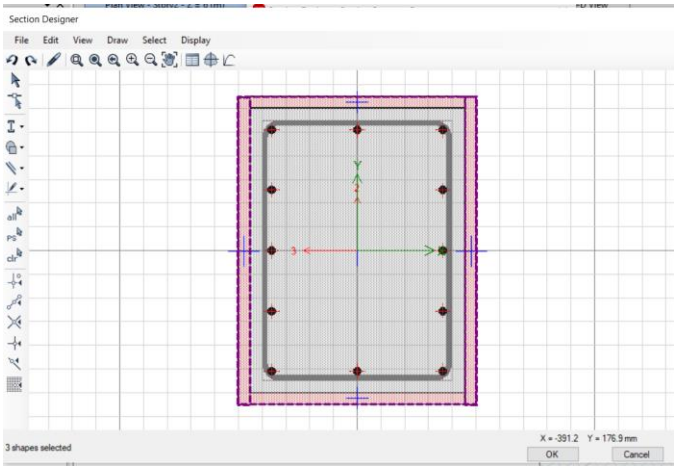

Fig 4: PVA Fiber wrapping on existing column

1.5 Load Calculations

Dead Load: Self wight of beams, column, slabs.
Live load: 4Kn/m^2(As per the IS 875 Part 1)
Floor Finish Load: 1 Kn/m^2
Seismic Loads (IS 1893:2016)
Seismic Zones Z= 0.24 and 0.36
Response reduction Factor R=5
Importance Factor I= 1
Silt Type=2

1.6 Literature Survey

Promis & Ferrier [1] Research developed in this paper concerns seismic FRP reinforcement. The main objectives are to guage CFRP's contribution to the mechanical and energetic performance of RC short columns submitted to combined compressive and flexural loading. During earthquakes, short columns undergo shear stress due to their low resistance to high imposed horizontal displacements. In the first study, eight short columns were tested; their longitudinal reinforcement was above the Eurocode 8 upper limit, while their transverse reinforcement was insufficient, so as to ensure shear failure. Seven were continuously or discontinuously reinforced by CFRP or GFRP. In order to estimate the influence of the character and geometry of the composite reinforcement, damage indices were calculated. Different modes of mechanical behaviour, counting on the pliability of FRP reinforcement, were confirmed.

Ghazal & Azim [2] Did an experimental research to study the behavior of concrete columns containing Poly Vinyl Alcohol fibers (PVA) under fire conditions and axial compression loads. In this research, a total of five reinforced concrete columns with constant longitudinal and transvers reinforcement, one of them had no fiber (control specimen) and the others containing constant ratio of polyvinyl Alcohol fibers (PVA)=0.75% of concrete volume as a main component of concrete mix subjected to variables periods of fire (0.0 min,30 min,60min, and 120 min) of firing at 6000 C were tested under concentric compression. The results proved that reinforced columns wit (PVA) fiber gave higher results than concrete column without (PVA) fiber in terms of ultimate loads, stiffness, and fire resistance.

Truong & Kim [3] Developed and researched various methods for the transformation of concrete columns with no seismic reinforcement details: steel sheath, carbon fiber reinforced polymer (CFRP) sheath, non-shrinkage mortar concrete sheath and amorphous metal fiber (AMF) new concrete sheath Set of reinforced concrete. 11 half-scale reinforced concrete columns were produced and tested cyclically, including two different control specimens designed for shear or bending shear and nine modified specimens to simulate the combination of seismic load and axial load. The control sample adopted two different transformation strategies: partial transformation of the plastic hinge area, mainly to increase the deformation capacity, and complete transformation of the entire column area, to increase the shear strength and deformation capacity. The seismic capacity of the test sample is analyzed, and various factors are considered: load-drift relationship, dissipated energy, damping ratio, effective stiffness and ductility. The test results show that the modified specimen has a ductile failure mode, and the dissipated energy and damping ratio are improved, but the effect of each modification method is different.

Ozcana & Binici [4] The bending behavior of a CFRP-reinforced rectangular RC column with smooth steel bars and insufficient steel encapsulation was studied. Five samples were tested under cyclic displacement deflection and constant axial load. These samples represent typical building support insufficiency, poor transverse reinforcement details, and low concrete strength. The positive effects of CFRP anchors and FRP inclusion rate on the final drift rate of the specimen were evaluated. The results show that increasing the rejection rate can keep the column higher and enhance the column end drift capacity. In addition, the corresponding configuration of CFRP anchor pins results in better seismic performance compared to modified CFRP columns without pins. Then a simplified drift-based design equation was proposed for the FRP reconstruction of the failed rectangular column.

2. Results

2.1 Axial Force

Axial Force of retrofitted building is maximum than the conventional building. This is satisfactory result. In graph, $Pu0$ axial strength of undamaged RC column(before retrofitting)and $Pu1$ axial strength of retrofitted column are summarized. Here, axial strength is assumed to be an axial load level in which by 1% increase in load, displacement increases more than 10%.

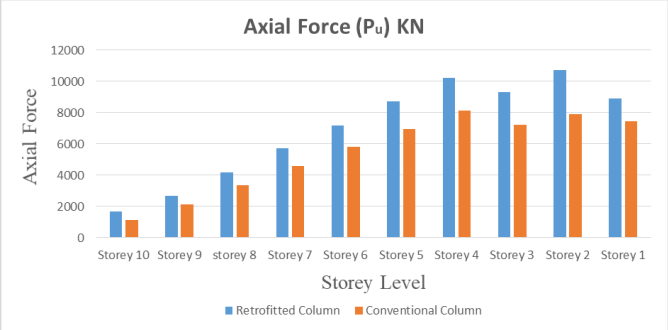

Chart 1: Axial Force

2.2 Bending Moment

2.2.1 Maximum Bending Moment

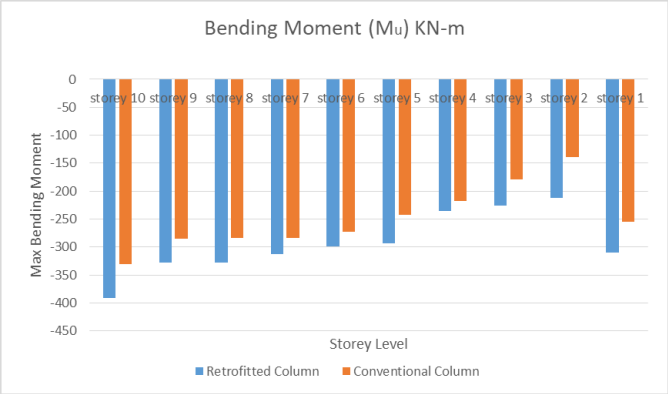

Chart 2: Maximum Bending Moment

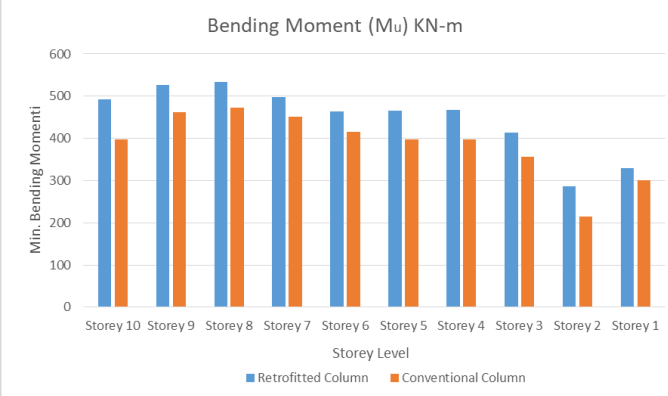

Chart 3: Minimum Bending Moment

2.1 Storey Displacement

Storey displacement is the lateral displacement of the story relative to the base. The lateral force-resisting system can limit the excessive lateral displacement of the building.

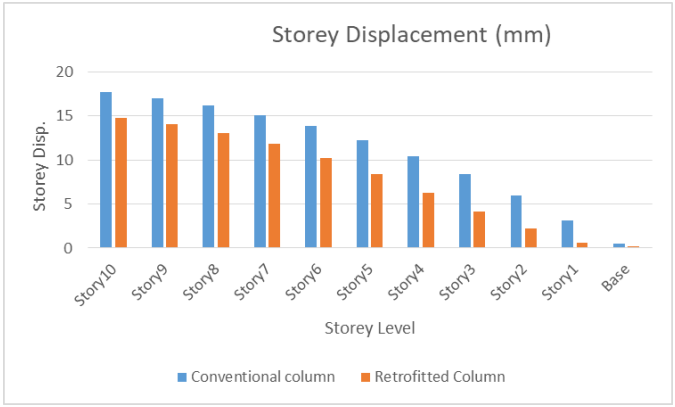

Chart 4: Max storey displacement

2.2 Storey Drift

Storey drift is the lateral displacement of one level relative to the level above or below. Storey drift ratio the story drift divided by the story height.

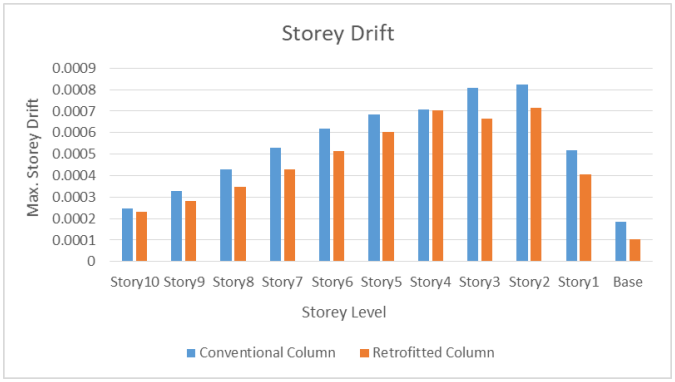

Chart 5: Storey Drift

3. CONCLUSIONS

1] PVA Retrofitting considerably increased the axial force capacity of the retrofitted column. The axial force after retrofitting was increased by 6.27% .
2] PVA Retrofitting was done to increase their shear capacity and the flexural ductility without significant increase in the column's stiffness.
3] The bending moment capacities (Max. & Min) are increased by almost 10 % & 12%.The moment capacities of the retrofitted columns were substantially more than those of the Conventional columns.
4] The PVA fiber-reinforced concrete significantly improves the ductility of the column.
5] The column modified by PVA shows a more rigid behavior, so the load-bearing and non-load-bearing parts are less damaged.

3.1 Future Scope of work

1. Present work is comparison for conventional and retrofitted columns analytically. This method can be studied for the building also experimentally.
2. Other fiber techniques also can be used for retrofitting analytically and experimentally.

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