# SEISMIC RETROFITTING OF R.C.FRAMES BY LINEAR STATIC METHOD AT SEVERE ZONE OF SOFT SOIL

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## Abstract

*Few decades ago people were constructing the building without any future plan and not according to the IS codes. Now a days people need additional floors without demolishing the existing structure for the convenient requirement like commercial/ Residential purpose. Now a days purchasing a land in the urban areas is very costly like Bangalore, Mumbai, Calcutta etc.. like many metropolitan cities. When the Generation population is increased instantly they require space to live, and even for the commercial purpose also they require and instead of purchasing land, an additional floor is added to existing building to live the space for residential (or) commercial purpose.*

*The present work is to study the retrofitting/rehabilitation concept is taken on the weakening points of the structure by using ETABS 9.6.0, standard finite element software by linear static method When we constructing an additional floors to the existing structure, the lower portion means already existing structure will loose the strength, so to regain its strength Rehabilitation technique (Retrofitting method) is attempted. In this paper Retrofitting as a local retrofit strategies of column, column strength will get weaken to increase strength here we have to attempt the concrete jacketting concept, to withstand the heavy load (upper portion load) and to regain its original strength. The parameters checked before and after retrofitting the structure are Story displacement, Base shear carried for different loading, Story drift and Percentage of reinforcement increased.*

***Keywords:*** *Linear static Analysis, base shear, storey displacement, storey drift, percentage of reinforcement.*

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## 1. INTRODUCTION

A number of reasons may necessitate the need to retrofit existing structures. It may be the rehabilitation of a structure damaged by an earthquake or other causes, or the strengthening of an undamaged structure made necessary by revisions in structural design or loading codes of practice. Earthquakes are by far the most common cause of damage structure to structures in earthquake-prone areas. Also, as the seismic loading and design codes are subjected to more frequent revision than the rather established gravity-based codes, earthquake consideration becomes a prime reason for the need to strengthen existing structures.

A number of techniques may be used to retrofit concrete structures. Retrofitting may be carried out on a basis by extra adding load-resisting elements such as steel frames or steel braces to the structure or it can be performed on local basis by retrofitting the existing structural elements. Beam column joints are critical components of a frame both in terms of structural stability and its seismic performance.

**RC JACKETING** is widely used of seismic upgrading of existing RC structures, repairing and strengthening of damage structures and strengthening of deficient members. The seismic retrofitting of an RC frame may include strengthening members such as beams, columns and beam-column joints.

**RETROFITTING** means Restrengthening of the existing structure which is taken by one of the Rehabilitation method, usually damaged by overloading or because of the seismic effects.
There are 2 types of Retrofitting Strategies.
1. Local Retrofit Strategies.
2. Global Retrofit Strategies.

### 1.1 Local Retrofit Strategies

Local retrofit strategies include local strengthening of beams, columns, slabs, beams to column or slab to column joints, walls and foundation. A scheme with such strategies tends to be the economical alternative when only few of the elements are deficient.

### 1.2 RC Jacketing

Concrete jacketing involves addition of a thick layer of RC in the form of a jacket, using Longitudinal reinforcement and closely spaced ties with seismic detailing. The method increase both strength and ductility. But, the composite deformation of the existing and the new concrete requires adequate dowelling to the existing column. Also, the additional longitudinal bars need to be anchored to the foundation and should be continuous through the slab. The disadvantage is that the size of the column increase.

**Fig-1**

Figure-1 Shows column has got lesser strength to withstand the additional floor loads ,so to increase the strength the column size should increase which means retrofitting to column is done by R.C.jacketting method.

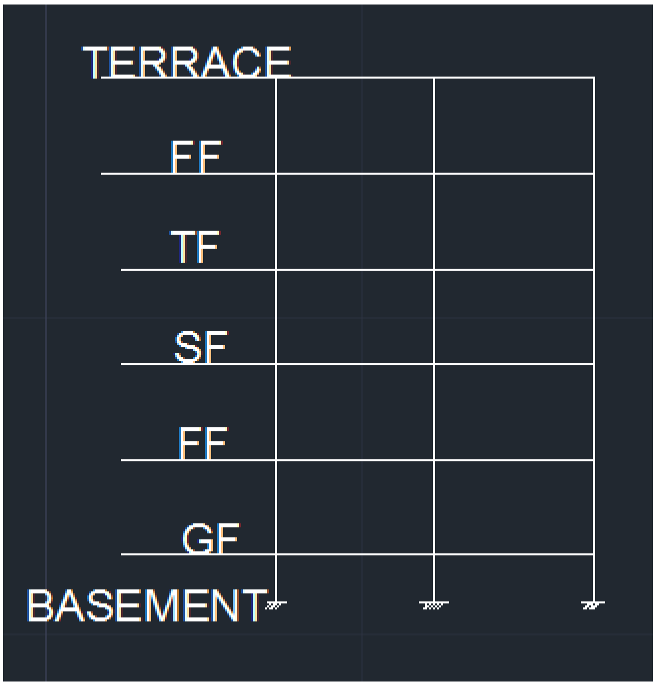



**Fig-2**

Figure-2:An Existing structure (G+4), basement to ground floor 1.5m height and each floor 3.0m height.


**Fig-3**

Figure-3: Structure extended (G+4 to G+6), basement to ground floor 1.5m height ang each floor 3.0m height.

## 2. LINEAR STATIC ANALYSIS

This linear static analysis is the simplest of all the analysis, which assumes a code, based calculation of base shear as the lateral horizontal force and is applied on the building. This is assumed to be equal to dynamic linear analysis. The calculated base shear on the basis of structural mass and fundamental period of vibration is then distributed to individual lateral load resisting elements depending upon the floor diaphragm action. All these calculation is based on IS1893:2002 (PART1) shall be determined by following expression.

**Determination of Base shear:** Design base shear ($V_B$) along any principle direction shall be determined as,

$$V_B = A_h W \qquad \text{------ (1)}$$

Where, W= Seismic weight of the building

$A_h$= Design horizontal seismic co-efficient for a structure given by.

$$A_h = \left[\frac{Z}{2}\right]\left[\frac{I}{R}\right]\left[\frac{S_a}{g}\right] \leq \left[\frac{Z}{2}\right] \qquad \text{------ (2)}$$

**Z is the Zone factor** for (MCE) Maximum Considered Earthquake [IS1893 (PART 1):2002, Table 2], denominator 2 is to reduce the MCE to design basis earthquake (DBE).

This maximum intensity is fixed such that lifeline/critical structure remain functional and there is low probability of collapse for structures designed with the provision of code even after occurrence of higher intensity earthquake

## 3. MODELLING AND ANALYSIS:

- The present study is carried out to understand the Technique of Retrofitting.
- The design of RC frame by linear method considering retrofitting points.
- The normal RC frame is desinged with some gravity load.
- FE model is developed using a standard software.
- Now extra load is applied due to this the joints may get weak.
- Finding the weak joints(column) and Rehabilitation technique is taken as this joints.
- After retrofitting is done. The RC frame is re-desinged.
- Plotting the curve for plain n retrofitting RC frame.

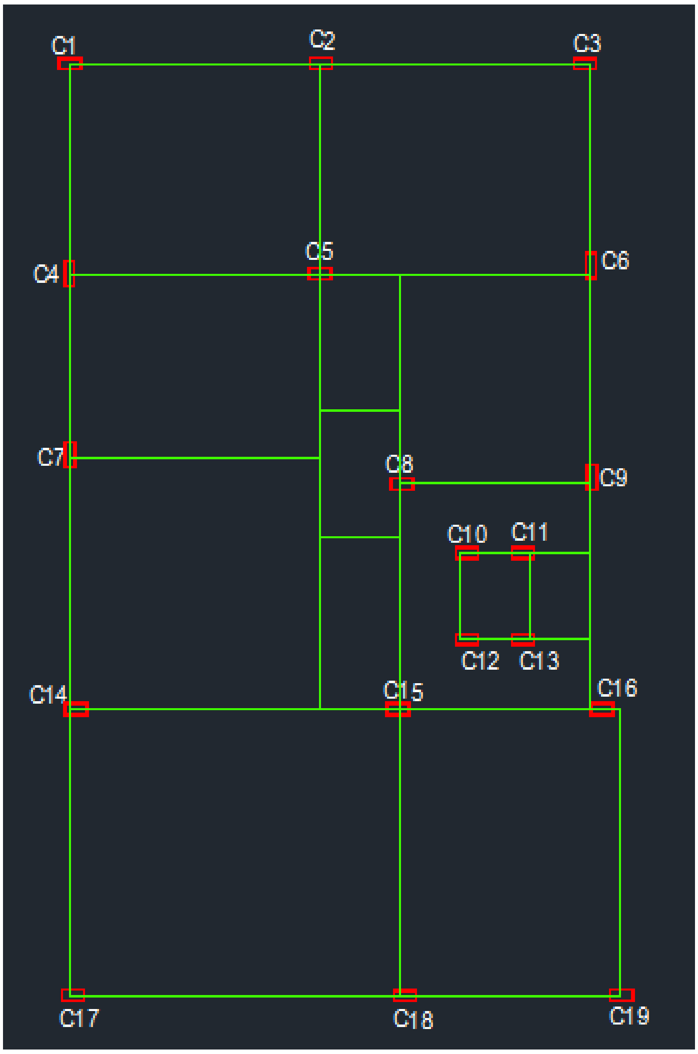



**Fig-4**

Figure-4: Plan of the existing structure with column numbering.

**Table-1:** Before Retrofitting Column Sizes:

| COLUMN NO`S | BASEMENT | GF | 1F | 2F | 3F | 4F |
|---|---|---|---|---|---|---|
| C1 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C2 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C3 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C4 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C5 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C6 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C7 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C8 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C9 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C10 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C11 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C12 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C13 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C14 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C15 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| COLUMN NO`S | BASEMENT | GF | 1F | 2F | 3F | 4F |
| C16 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C17 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 | 200*450 |
| C18 | 200*600 | 200*600 | 200*600 | 200*600 | 200*450 | 200*450 |
| C19 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |

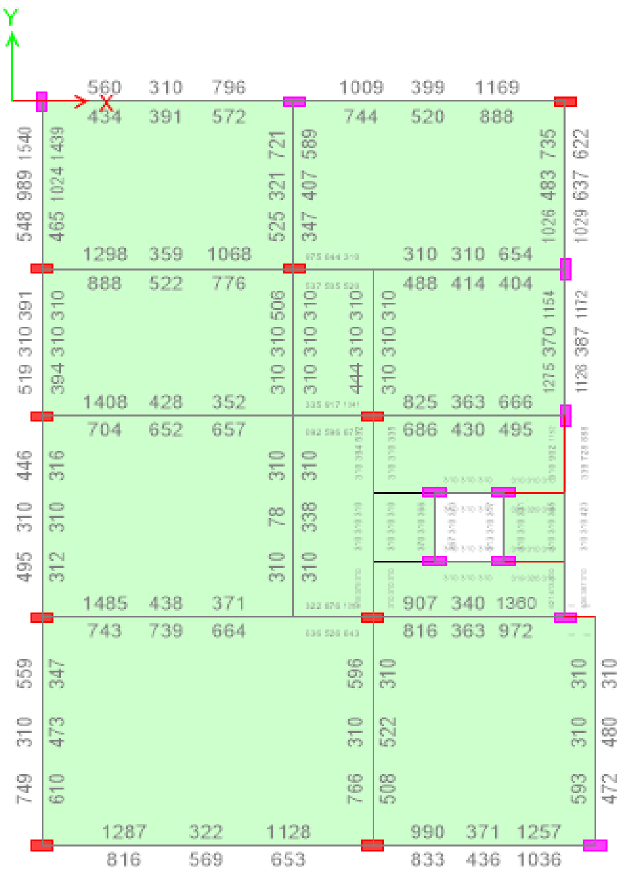



**Fig-5**

Figure-5: column failures when additional floors load is applied on existing structure, and to failure columns RETROFITTING is done.

Additional Floors are Fifth Floor, Sixth Floor.

Column Sizes of Fifth Floor:

C1 TO C19 200*450, EXCEPT C4,C5,C7,C8,C14,C15=200*600.

Column Sizes of Sixth Floor:

C1 to C19 =200*450, EXCEPT C4,C7=200*600

**Table-2:** After Retrofitting Column Sizes With Additional Floors:

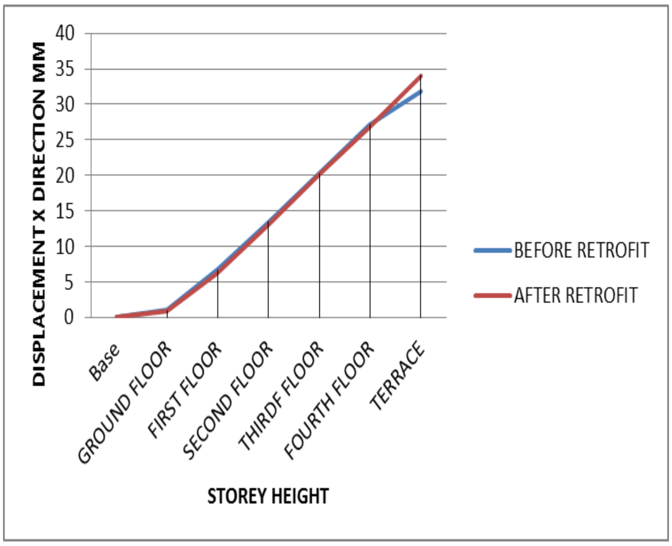
| COLUMN NO`S | BASEMENT | GF | 1F | 2F | 3F | 4F |
|---|---|---|---|---|---|---|
| C1 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | 200*450 |
| C2 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | 200*450 |
| C3 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | 200*450 |
| C4 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C5 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C6 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C7 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C8 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C9 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C10 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C11 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C12 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| **COLUMN NO`S** | **BASEMENT** | **GF** | **1F** | **2F** | **3F** | **4F** |
| C13 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 | 200*450 |
| C14 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C15 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C16 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C17 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C18 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |
| C19 | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** | **300*600** |

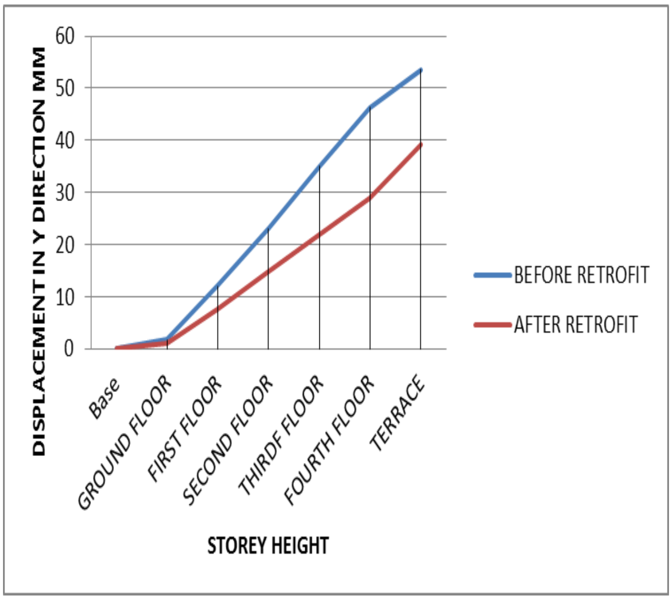
**Table-3:** Model Data of the Buildings

| | |
|---|---|
| Structure | OMRF |
| NO. of stories | G+4 |
| Storey height | 3.00m |
| **MATERIAL PROPERTIES** | |
| Grade of concrete | M30 |
| Grade of steel | Fe 500 |
| MEMBER PROPERTIES | |
| COLUMN SIZES | 0.200*0.450<br>0.200*0.600 |
| BEAM SIZES | 0.200*0.450 |
| Thikness of slab | 0.125M |
| **LOAD INTENSITIES** | |
| DEAD LOAD | 1.0KN/m² |
| LIVE LOAD | 2.75KN/m² |
| FLOOR FINISH | 1.5KN/m² |

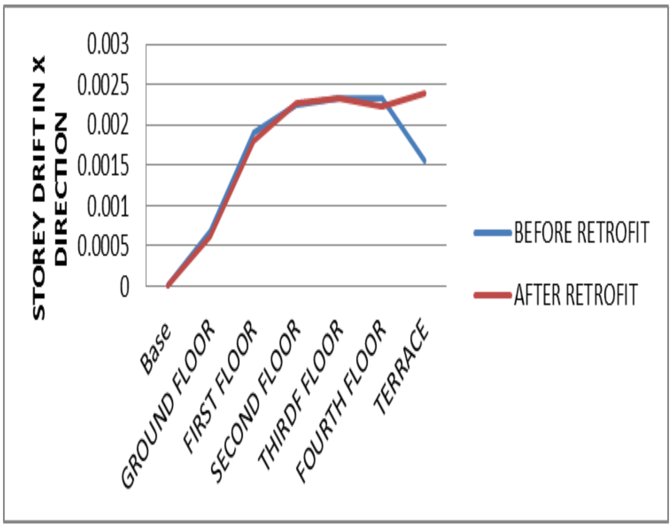
EARTHQUAKE LOAD as per IS1893(part-I)-2002
SEISMIC ZONE- IV
ZONE FACTOR,Z- 0.24
Importance Factor,I- 1.00
Response reduction factor,R- 3.00

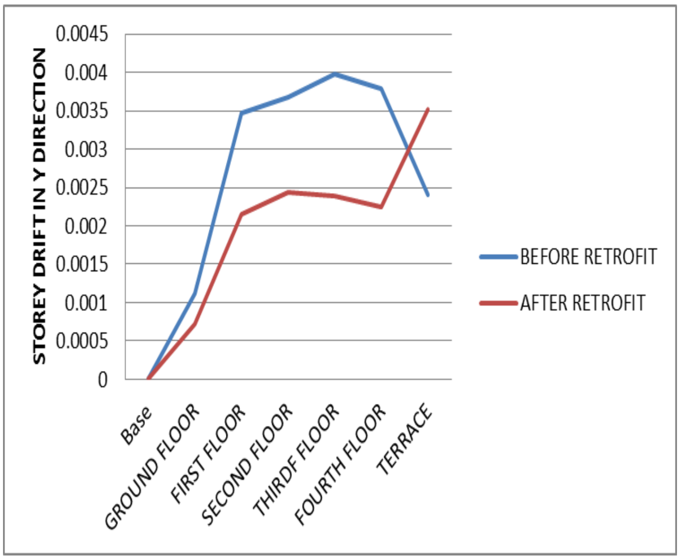
### 3.1 Storey Displacement




### 3.2 Storey Drift




### 5.3 Base Shear

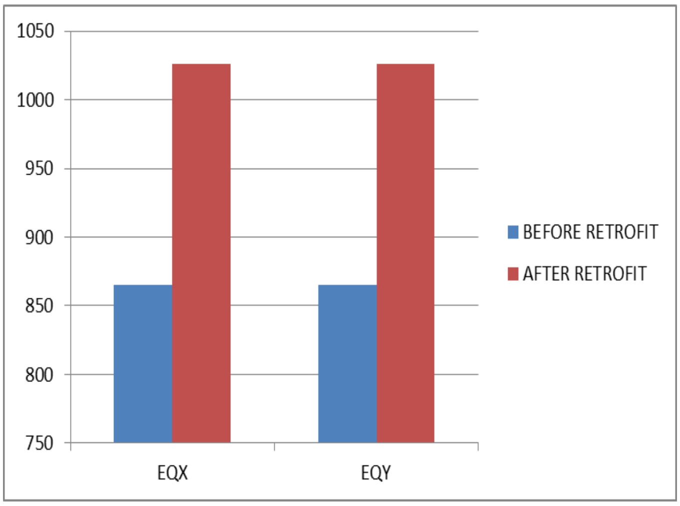



**Table-4:** Percentage of Additional Reinforcement after Retrofit

| FLOORS | NO OF COLUMNS | % OF EACH COLUMN | TOTAL % OF EACH FLOOR |
|---|---|---|---|
| FOURTH FLOOR | 12 | 0.27 | 3.24 |
| THIRD FLOOR | 15 | 0.27 | 4.05 |
| SECOND FLOOR | 15 | 0.27 | 4.05 |
| FIRST FLOOR | 15 | 0.27 | 4.05 |
| GROUND FLOOR | 15 | 0.27 | 4.05 |
| BASEMENT | 15 | 0.27 | 4.05 |

**TOTAL % OF REINFORCEMENT=23.49%**

## 4. CONCLUSION

In this paper, the study attempt is made on weakening points of structure(COLUMN RETROFITTING), when additional floor is constructed above existing floors. According earthquake code book IS 1893(PART-I) 2002, the analysis is made on existing building on weak zone(ZONE IV) and weak soil (TYPE-III).As above study G+4(existing structure) and 2storeys additionally added, so this the existing structure column has get weaken, so this column retrofitting technique is taken to regain its strength on existing columns.

The following are the conclusion taken before and after retrofitting.

- Storey displacement, is decrease displacement as storey height increase, displacement curve before and after retrofitting.
- Base shear is Increased for different loading as before and after retrofitting.
- Storey drift is decrease as height increase as retrofitting is done.
- Percentage of reinforcement/column sizes increase after retrofitting is done for existing structure.

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