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CONTROL OF PROGRESSIVE COLLAPSE OF THE STRUCTURE USING SHEAR WALL

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Abstract - When the vertical member is knocked down either due to natural or man-made destruction like vehicular impact or due to fire hazard of the structure about that vertical member will be transferred to the nearby column of that structure. Therefore, this study is carried out to irregular multi storey structure under different location column removal consideration like corner column, middle column and interior column. The analysis is carried out using ETABS software. to evaluate the demand capacity ration (DCR), the ratio of the member as per general services administration (GSA) guidelines. In this study collapse of column due to accidental loading, the loads are distributed to adjoin member. The DCR value is more than the limit (1.5) the structure is un safe. The adjacent members are treated has safe as DCR value less than 1.5. As attempted is made to control progressive collapse by providing shear wall the nearest the accidental collapsed column.

***Key Words*: General Service administration, demand capacity ratio, Shear wall.**

1. INTRODUCTION

One or more than one vertically load carrying members are removed or made the enter structure begins to collapse progressively. When the vertical member is knocked down either due to natural or man-made destruction like vehicular impact or due to fire hazard or may be due to seismic the weight of the structure about that vertical member will be transferred to the nearby column of that structure. When collapse of column due to accidental loading, the loads are distributed to adjoin member. Therefore the DCR value of members changes. The adjacent members are treated has safe as DCR value less than 1.5. As attempted is made to control progressive collapse by providing shear wall the nearest the accidental collapsed column. Progressive collapse normally may occur when the loading condition is abnormal or un-symmetrically excess. Abnormal acting loads will generally be acting for a comparatively shorter duration when compared with ordinary loading condition. An ordinary structure in general will not be designed for these types of abnormal loading conditions. Hence when such structures as a result of this, situations progressive collapse may take place.

1.1 SHEAR WALL

A Shear wall can be called as a structural component in a give RC structure which is provided resistance to the forces like wind or seismic which are acting in horizontal axis. In most of the scenario shear wall is used in tall building even though it is in small buildings in some of the exceptional cases. These are commonly used in tall structures as the tall structures are exposed to lateral forces very often. Hence, in order to add more stiffness to the structure shear wall is used or introduced. In any tall structure the effect of the forces acting in horizontal axis increase as its height increases. Since the codes have provided limitations on lateral sway it becomes very important to limit the structure's sway within the permitted values. Once of the way to achieve this is by increasing the stiffness due to the introduction of shear wall.

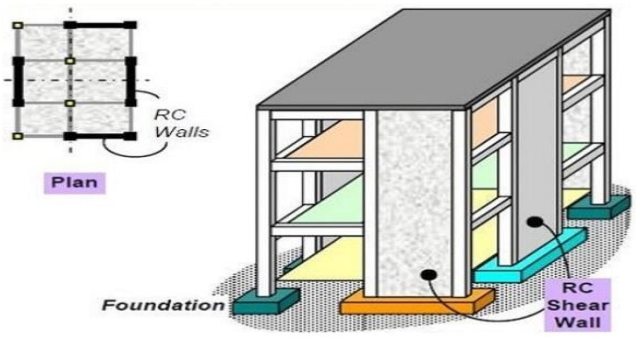

Fig-1: Typical Placement of shear wall

1.2 GUIDELINES

General Service Administration (GSA 2003) has listed out a set of guidelines in order ascertain the possible progressive collapse situation. GSA spells out localities of the columns to be taken out as listed below. Removing the corner column, Removing the exterior middle column removal in the structure and Removing the interior columns

For the purpose static analysis, GSA has recommended a generalized loading factor. This is represented in the form of an equation as shown below

Load = 2(DL + 0.25LL)

Where, DL = Dead Load & LL = Live load

For both primary & secondary structural elements the acceptance criteria can be established as DCR - Demand Capacity Ratio as shown in the equation below

DCR = QUD/QCE

Where, QUD = Acting force also called as the demand obtained as the component or joint (moments, shear forces, axial forces and probable combined forces) obtained using linear elastic analysis. QCE = Expected an ultimate & un-factored capacity of an element or a joint (moments, shear forces, axial forces and probable combined forces)

Permissible DCR values suggested by GSA are:

DCR lower than 2.0 for a typical structural configuration

DCR lower than 1.5 for an untypical structural configuration

DCR value which exceeds the permissible value will be treated as collapsed or severely damaged. While calculating the capacity of a component or a connection, GSA guidelines suggests enhancing the strength of the design material by a factor called strength-increase in order to obtain the material strength as per the expectation.

2 BUILDING CONFIGURATION

A public building is taken in to consideration where we have verities of occupancy. The structure total length in X direction is 39.4 m and the total length in Y direction is 33 m. The structural details are**:** Height between floors= 3.5 m, Column size = 400 mm x 400 mm and Slab depth = 175 mm Building height = 37 m. Material details **:** Concrete = M40, Steel = Fe550and Concrete density = 25KN/m^3 Section details : Beam = 300mmx600mm & 400mmx600mm Column = 400mmx400mm Slab = 175mm. However, while modelling this building we have followed IS: 875 part 2 for imposed load.

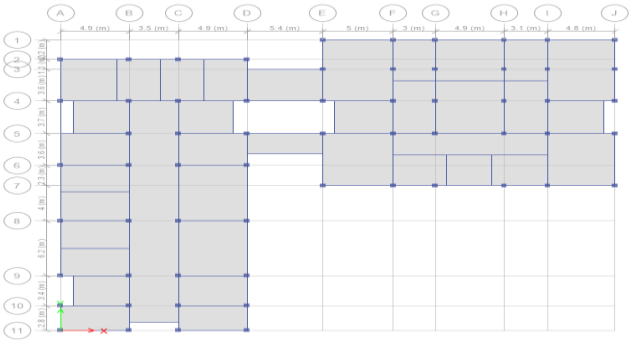

Fig-2: Plan of the Building

2.1 CASES CONSIDERED

Removing Columns At Corner

- CASE -1**:** Column On Grid A2 & B2

Removing Columns At Middle

- CASE-2: Column On Grid F7 & G7

Removing Columns At Interior

- CASE-3: Column On Grid B5 & C5

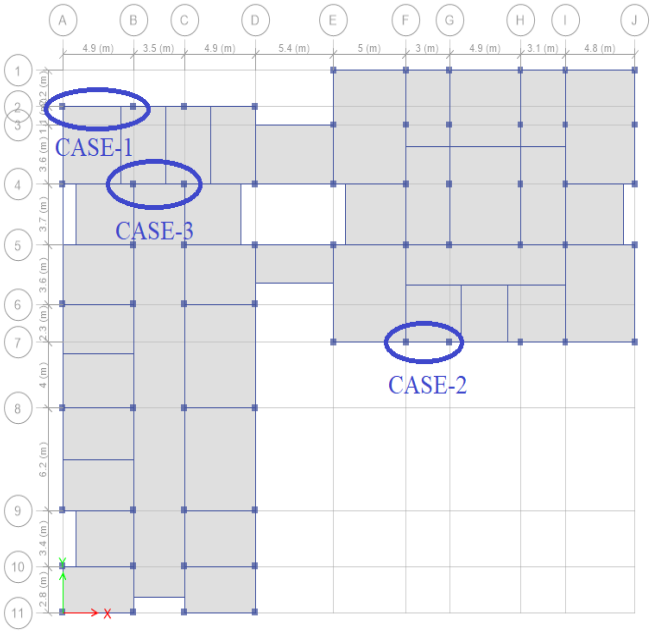

Fig-2: Three Cases defined

3. RESULTS AND DISCUSSION

indicates the column is removed due to the load of the structure around that vertical member will be transferred to the nearby column of the structure due to natural or manmade destruction such as vehicular impact or fire hazard. When the C26 & C27 column removed in 1st floor and the removed column adjacent column are C25, C28, C07, C10, C13, & C16 is more affected in a ground floor, 1st floor, 2nd floor & 3rd floor. The higher stories are less affected. In this column removed the DCR value comes more than 1.5 its indicates the progressive collapse of the structure. The DRC value is decrease to higher story. The table 6.6 is indicates the shear wall is provided in a accidentally collapse column removed location. The shear wall is gives more stiffness and reduce load in a surrounding column. To reduce DRC value is less than 1.5. all of the structures columns should be safe. Same produce to continue in corner column removed and interior column removed condition.

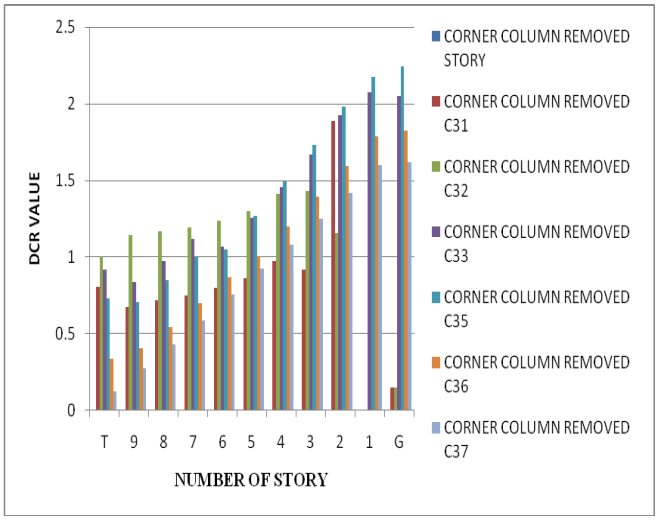

Fig-3: corner column removed DCR values v/s number of story

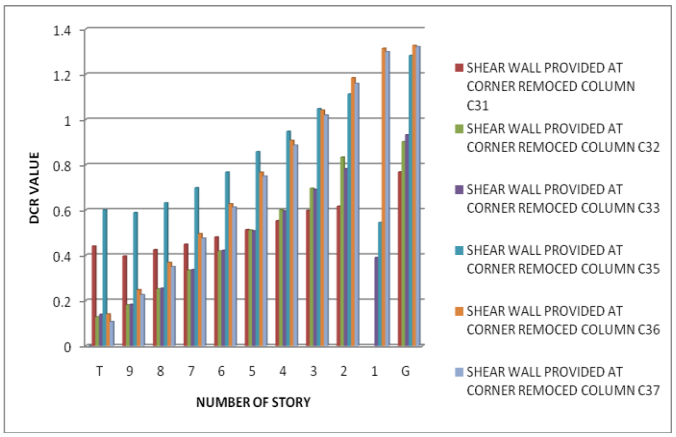

Fig-4: shear wall provided at corner column DCR values v/s Number of story

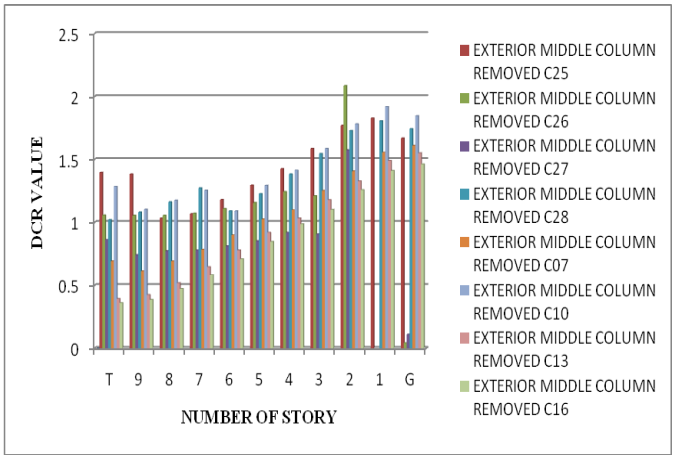

Fig-5: Exterior middle column removed DCR values v/s number of story

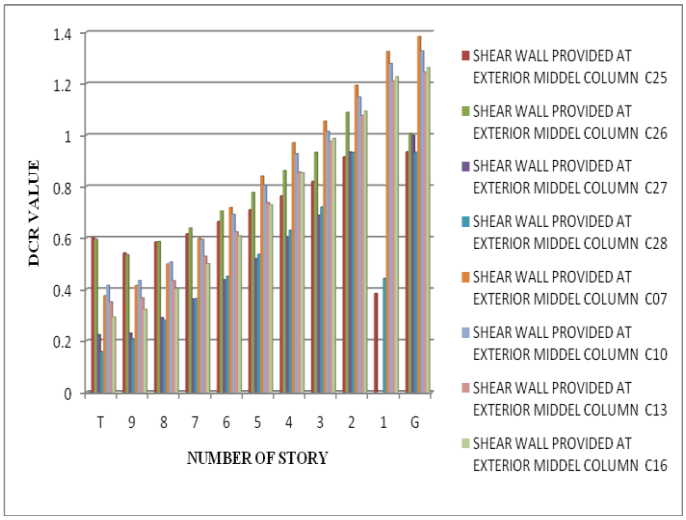

Fig-6: shear wall provided at exterior column removed DCR value v/s number of story

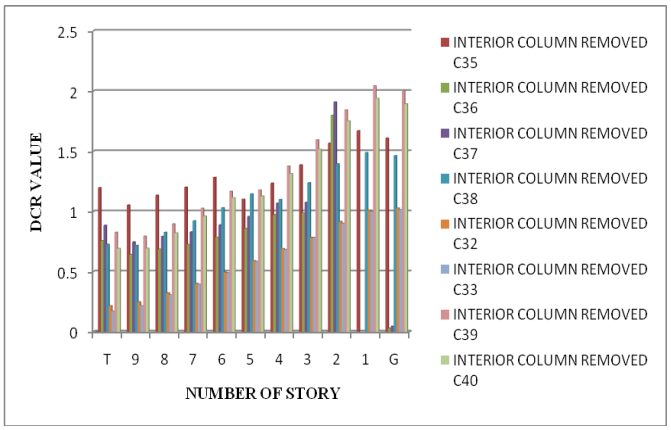

Fig-7: Interior column removed DCR value v/s number of story

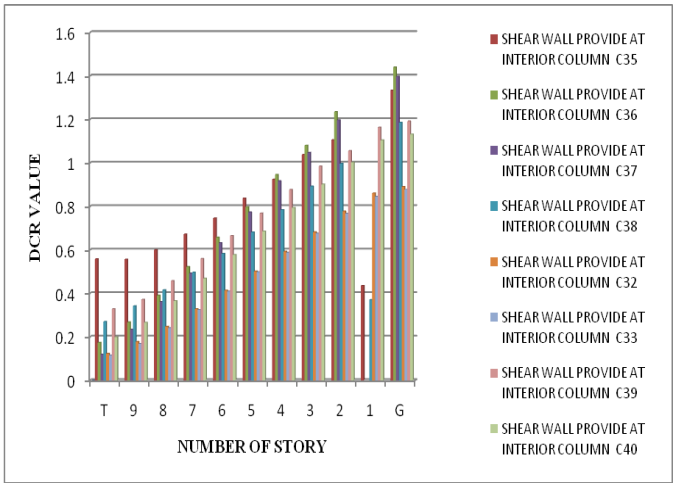

Fig-8: shear wall provide at interior column DCR value v/s number of story

- Graphical Representation of the DCR Values

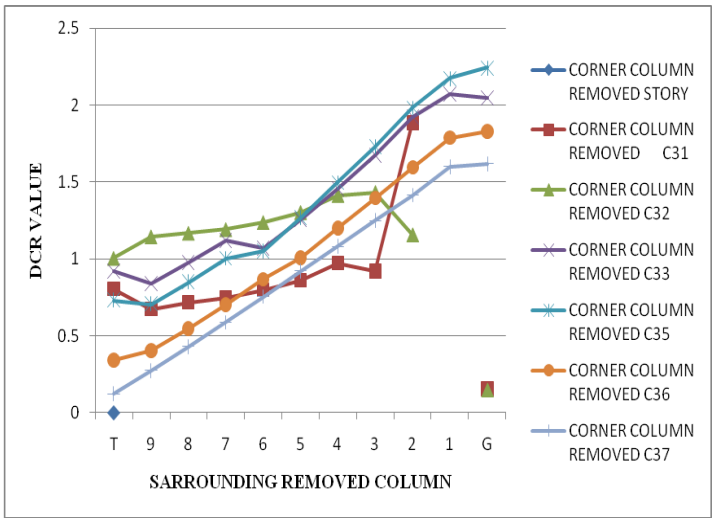

Chart -1: corner column removed DCR value v/s surrounding removed column

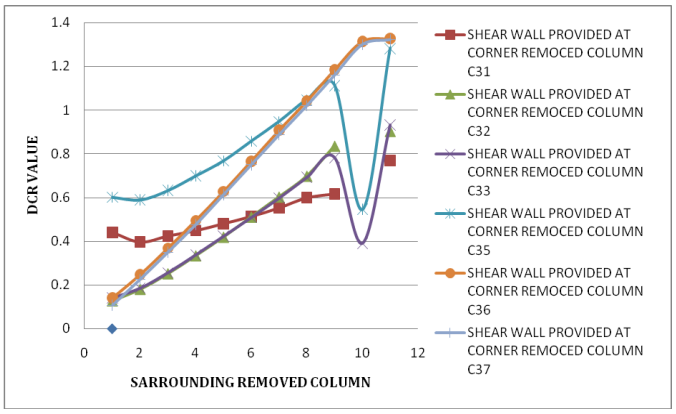

Chart -2: shear wall provided at corner column DCR value v/s surrounding removed column

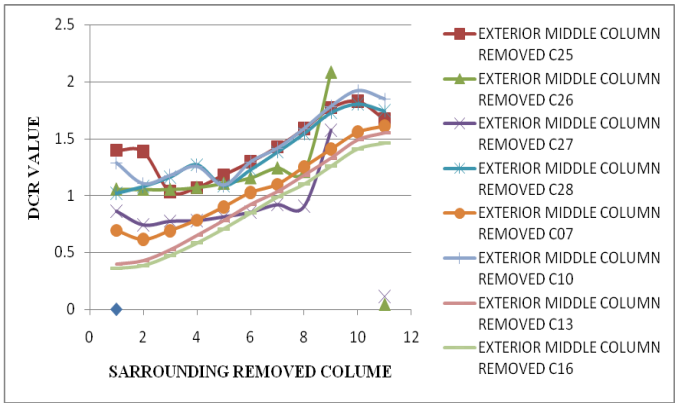

Chart -3: exterior middle column removed DCR value v/s surrounding removed column

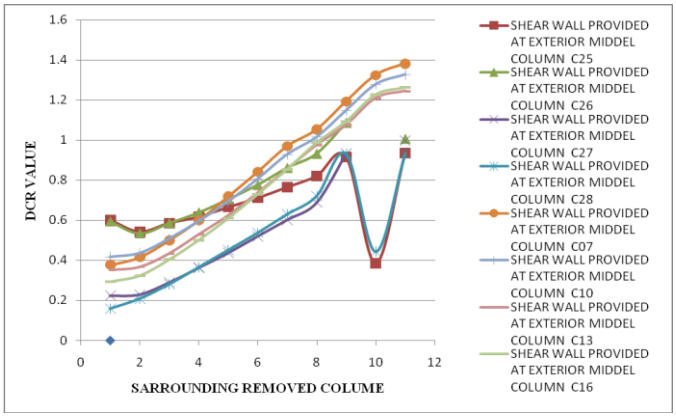

Chart -4: shear wall provided at exterior column removed DCR value v/s Surrounding removed column

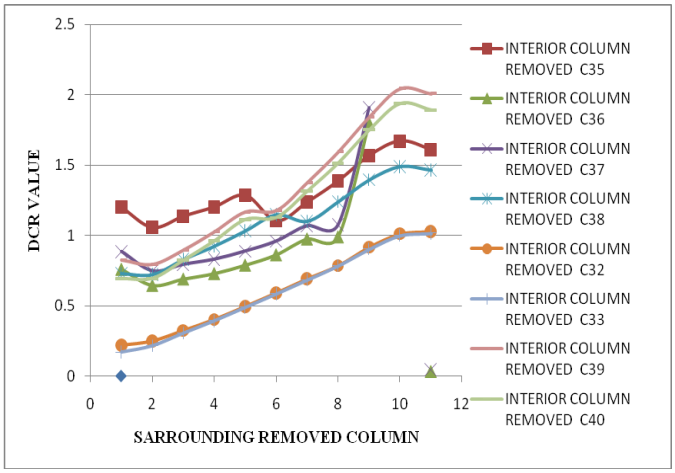

Chart -5: interior column removed DCR value v/s surrounding removed column

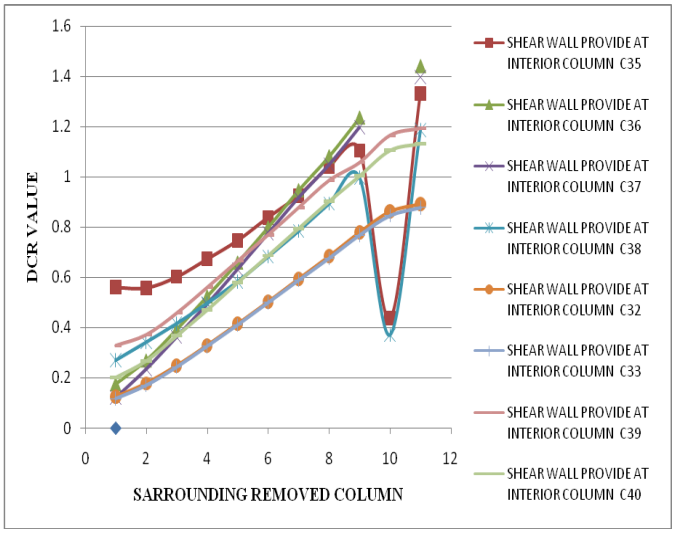

Chart -6: shear wall provided at interior column DCR value v/s surrounding removed column

3. CONCLUSIONS

The study was conducted on the columns were removed for progressive collapse and analysis was performed. The DCR values should be taken. The following major finding can be obtained from a study of a 10 story structure for progressive collapse.

- The DCR value of all structural elements is within the limit (1.5).
- Due to collapse for accidental failure for a column in a first floor. The DCR value in some of the column in ground floor, 1st floor, 2nd floor and 3rd floor greater than limit (1.5) for irregular structure.
- The column was removed in the lower stories, the DCR value is value is higher. Then there's a higher storey the DCR value is really low.
- The DCR value of the member is reduce to a value less than limit (1.5). by providing shear wall in the floor in which the column has collapse.

The progressive collapse of the structure due to accidental failure of the columns. The collapse can be controlled by providing the shear wall in the respective floor.

4. SCOPE FOR FUTURE STUDY

1. In present study we have introduced concrete shear walls in place of removed columns. However, it is possible to introduce other forms of shear walls like steel shear wall, hollow cement concrete block shear wall with reinforcement in hollow places etc.
2. In place of shear wall we can also introduce bracings and understand the performance and contribution of these bracings during the progressive collapses.

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