COMPARATIVE STUDY OF PROGRESSIVE COLLAPSE ANALYSIS FOR RCC BUILDING IN DIFFERENT EARTHQUAKE ZONE

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Abstract - *When building is exposed to any natural hazards say tsunami or earthquake or due to manmade hazards such as a fire, explosion of gases, impact of vehicles it effect the behavior of structure and causes collapse of portion of structure or entire building. Progressive collapse is a result of localized failure of one or two structural element that lead to steady progression of load transfer that exceed the capacity of other surrounding element thus initiating the progression that leads to a total or partial collapse of structure. The U.S. General Services Administration (GSA) document provides the general guideline to assess the potential for progressive collapse in RCC and steel building. In present study G+10 storey RC framed structure is analyzed using linear static in different seismic zone as specified in GSA guidelines and potential for progressive collapse is evaluated. Buildings are design as per the Indian standard guideline for the gravity and seismic loading. Design and Progressive collapse analysis is carried out using computer program ETABS. From the study concluded that in zone v Building is safe against progressive collapse analysis but in zone III building is not able to resist the progressive collapse.*

Key Words: **PROGRESSIVE COLLAPSE ANALYSIS, DCR**

1. INTRODUCTION

Progressive collapse can be define as widespread propagation of structural member failure in which the resulting damage is disproportionate to original cause. Failure of one or more primary load carrying member cause overloading of nearby other structural member due to change of load pattern which ultimately leads to failure of the members. As a result, total or partial collapse of the structure occurs, which is termed as progressive collapse. The concern over progressive collapse had emerged considerable after the partial collapse of Ronan Point apartment building in UK in1968, especially after the malevolent bombing of Murrah Federal Building in1995 in Oklahoma City. A number of U.S. owned and occupied building along with building in other countries have become targets of terrorist attacks. These WTC in1993, The Khobar Towers, Saudi Arabia in 1996, The U.S. embassies in Kenya and Tanzania in 1998, WTC towers in US in Sept. 2001. These attacks generated considerable concern over the progressive collapse.

1.1 GSA GUIDELINE

The U.S. General Services Administration developed the progressive collapse analysis and design guideline for their Federal Office Building and major modernization projects to ensure that the potential for progressive collapse is addressed in design, planning and construction. The first edition was published in year 2000 and the revised edition issued in year 2003 with additional chapter on steel structure.

This guideline provides “threat independent” methodology to minimize the progressive collapse potential i.e. cause of element failure is not consider. Guideline provide simplified approach i.e. Linear Procedure for low to medium rise building i.e. building up to 10 storey and sophisticated approach i.e. Nonlinear Procedure for building above 10 storey or building with asymmetrical configuration. As it is not feasible to rationally examine all potential source of collapse initiation, “threat independent” approach is taken in to consideration in this guideline.

GSA guideline have specified the following load case for static linear analysis procedure.

Load = 2(DL + 0.25LL)

Where,

DL = Dead Load

LL = Live Load

The performance of structure is evaluated by DCR, which should not exceed 2 for regular structure and 1.5 for irregular structures or else they are considered as severely damaged or failed. GSA has defined DCR as below.

$$DCR = \frac{Q_{UD}}{Q_{CE}}$$

Where,

QUD = Acting force (demand) determined in component or connection/joint (moment, axial force, shear, and possible combined forces)

QCE = Expected ultimate, un-factored capacity of the component and/or connection/joint (moment, axial force, shear and possible combined forces)

2. ANALYSIS OF 10 STOREY BUILDING

To study the effect of column removal condition on the structure, hypothetical case of 10 storey building for zone III and zone IV are considered. Progressive collapse analysis is based on the GSA guidelines.

Structure considered in this analysis is assumed to be a public building, which is design for importance factor 1.0. Bay size taken as 5m in both directions. Building size in plane is 30m x 20m height of base to plinth is taken as 2m, Plinth to ground floor as 4m, which is considered as a hollow plinth and height of typical floor as 3.5 m. 230mm walls are assumed to be on peripheral beams only. For zone III beam size 300 x 500 and column size 500 x 500 and for zone V beam size 450 x 600 and column size 600 x 600 are taken. Slab thickness for both zone 150mm considered.

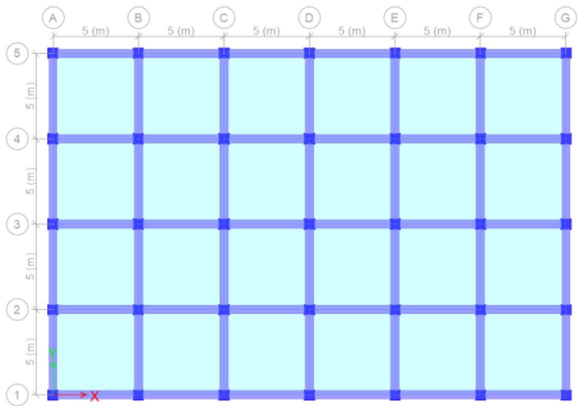

Fig -1: Plan of building

3. EXPERIMENTAL RESULTS

Comparison of DCR in flexure and shear at 3 supports i.e. right support, centrally removed support and left support are presented graphically. Below graph represent the flexural and Shear comparison of RCC building in Zone V and Zone III.

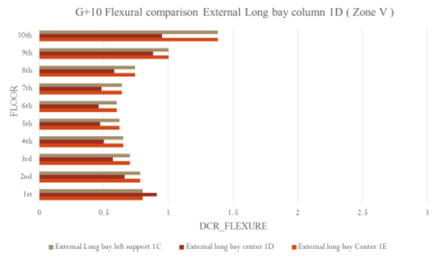

Chart -1: (Zone V) Flexural comparison External long bay column 1D

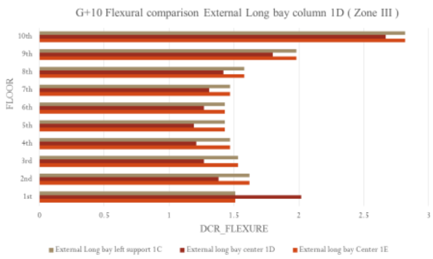

Chart -2: (Zone III) Flexural comparison External long bay column 1D

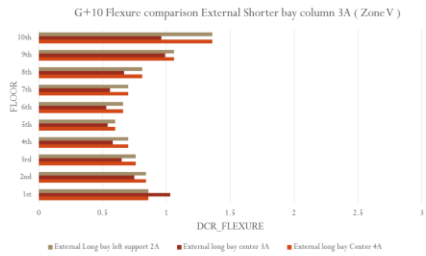

Chart -3: (Zone V) Flexural comparison External Short bay column 3A

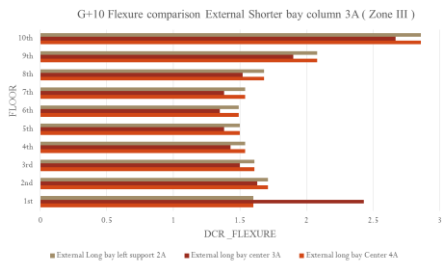

Chart -4: (Zone III) Flexural comparison External Short bay column 3A

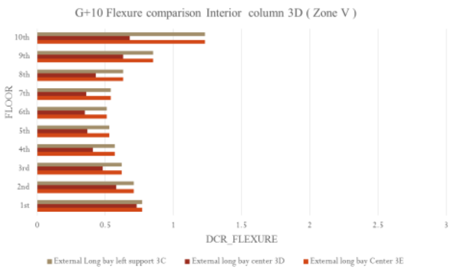

Chart -5: (Zone V) Flexural comparison Interior column 3D

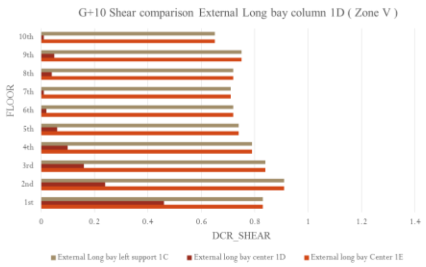

Chart -9: (Zone V) Shear comparison External long bay column 1D

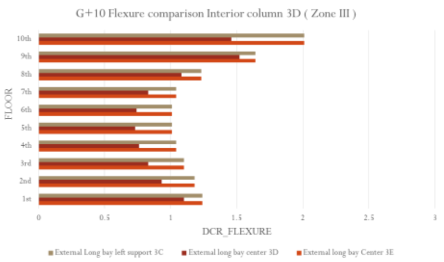

Chart -6: (Zone III) Flexural comparison Interior column 3D

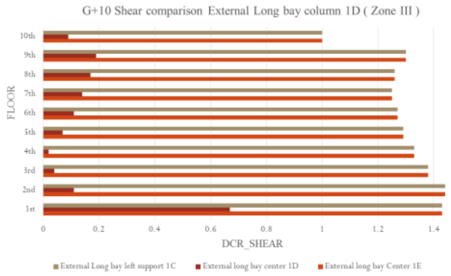

Chart -10: (Zone III) Shear comparison External long bay column 1D

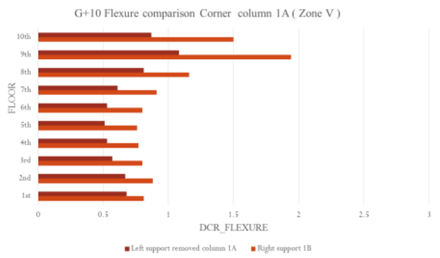

Chart -7: (Zone V) Flexural comparison Corner column 1A

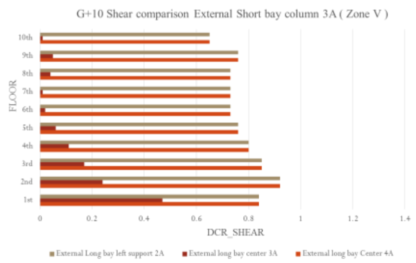

Chart -11: (Zone V) Shear comparison External Short bay column 3A

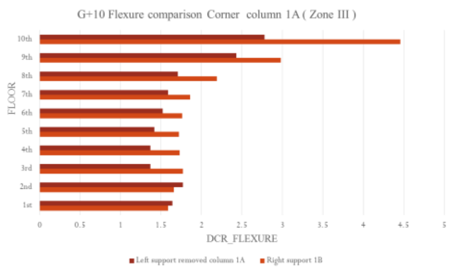

Chart -8: (Zone III) Flexural comparison Corner column 1A

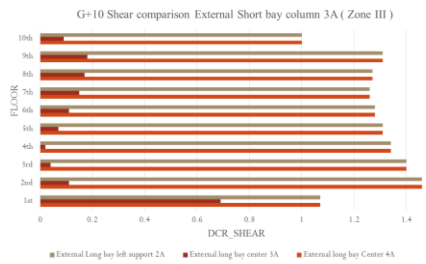

Chart -12: (Zone III) Shear comparison External Short bay column 3A

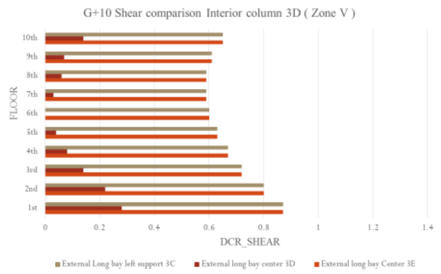

Chart -13: (Zone V) Shear comparison Interior column 3D

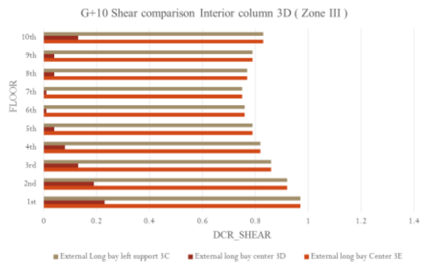

Chart -14: (Zone III) Shear comparison Interior column 3D

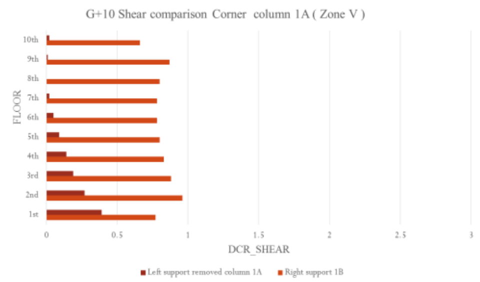

Chart -15: (Zone V) Shear comparison Corner column 1A

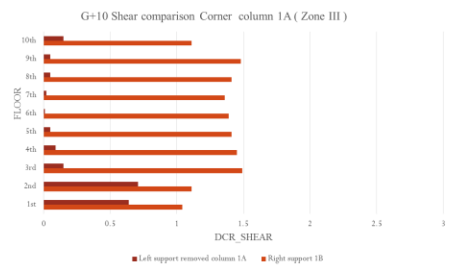

Chart -16: (Zone III) Shear comparison Corner column 1A

4. CONCLUSIONS

Building which are design in seismic zone V are safe against the progressive collapse analysis. Buildings which are normally designed in zone III is having high progressive collapse, but can be overcome by redesigning. Corner column removal condition 1A is having highest values compared to other column removal condition; hence corner column removal condition is the most critical among all 4 column removal conditions. On the other hand, Interior column is having the least DCR values compared to other column removal conditions; hence it has very less chance of collapse in case of progressive collapse failure.

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