Performance Based Seismic Design of RCC Building

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Abstract **- Performance-Based Design (PBD) is a comparatively new and powerful approach to structural engineering born from constant hard work to resolve the differences between the actual observed performance and the expected performance of structures. The main objective of present study is to find the performance of building under earthquake using performance based seismic design. In present study different set of reinforcement are made at different levels to study the performance of building due to the earthquake force and finally the best suitable combination of reinforcement is given i.e., economical effective and whose damage is limited in order to get the immediate occupancy level. The second to find the performance point of the building and to compare the seismic reaction of building in terms of base shear, storey drift, Spectral acceleration, storey displacement and spectral displacements. Then the resultant roof displacement will be compared with target displacement and if resultant displacement is lower than target displacement, then design will be performance based seismic design. And finally, performance-based design will be compared with code-based design.**

Index Terms **- Elastic response spectrum, inelastic response, performance based seismic design, pushover analysis, performance objectives, RC building.**

I.INTRODUCTION

Earthquakes have the potential for inflicting the Max damages. Since earthquake forces are unsystematic in nature & irregular, the engineering tools need to be most proficient for analysing structures underneath the action of these forces. Performance based design is gaining a replacement dimension in the seismic design idea wherein the near field ground motion (usually acceleration) is to be considered. Earthquake forces are to be carefully analysed so as to assess the real behavior of structure with an apparent understanding that harm is expected but it should be synchronized.
In contrast to prescriptive design approaches & stages, performance-based design provides a methodical methodology for assessing the performance capability of a building structure. It can be used to verify the equivalent performance of alternatives & options, deliver standard performance at a reduced economical cost, or confirm higher performance needed for critical facilities. It also establishes a vocabulary that facilitates meaningful discussion between stakeholders & design professionals on the development & selection of design options. It provides a framework for determining what level of safety & what level of property protection, at what cost, are acceptable to stakeholders based upon the specific needs of a project.

Performance-based Earthquake design can be used to.

- Design individual buildings & relevant structure with a higher level of confidence that the performance intended by present building codes will be achieved.
- Design individual building structures that are capable of meeting the performance intended by present building codes & guidelines, but with lower construction costs.
- Design individual building structures to achieve higher performance (& lower potential losses) than intended by present building codes & guidelines.
- Assess the potential seismic performance of existing buildings & structures & estimate potential losses in the event of a seismic conditions.
- Assess the potential performance of current prescriptive codal requirements for new building structures & serve as the basis for improvements to code-based seismic design criteria so that future buildings can perform more consistently & reliably.

Performance-based Earthquake design & engineering offers society the potential to be both more efficient & effective in the investment of financial resources to

avoid future earthquake losses & damages. Further, the technology used to implement Performance-based Earthquake design & engineering is transferable & can be adapted for use in performance-based design for other extreme hazards including fire, wind, flood, snow, blast, & terrorist attack.

The advantages of PBED or PBEE over the methodologies used in the current seismic design code are summarized as the following six key issues:

a. multi-level seismic hazards are considered with an emphasis on the transparency of performance objectives.
b. Building & structure performance is guaranteed through limited inelastic deformation in addition to strength & ductility.
c. Seismic design criteria are oriented by performance objectives interpreted by engineering parameters as performance criteria.
d. An analytical computational method through which the structural behavior, particularly the Non-linear behavior is rationally obtained & assessed.
e. The building structure will meet the prescribed performance objectives reliably with accepted confidence.
f. The design will ensure the minimum life-cycle cost (economical design).

II. METHODOLOGY

Performance based seismic design is a process of designing new buildings or seismic up-gradation of existing buildings, which includes a specific intent to achieve defined performance objectives in future earthquakes. Performance objectives relate to expectations regarding the amount of damage a building may experience in response to earthquake shaking and the consequences of that damage. Performance objectives are operational (O), immediate occupancy (IO), life safety (LS), collapse prevention (CP), in which Life safety is the major focus to reduce the threats to the life safety of the structure in Figure 2.

Performance based design approach in which performance levels are described in terms of displacement as damage is better correlated to displacements rather than forces. The fundamental goal of PBSD is to obtain structure which will reach a target displacement profile when subjected to earthquakes consistent with a given reference response spectrum. The performance levels of the structure are governed through the selection of suitable values of the maximum displacement and maximum inter storey drift.

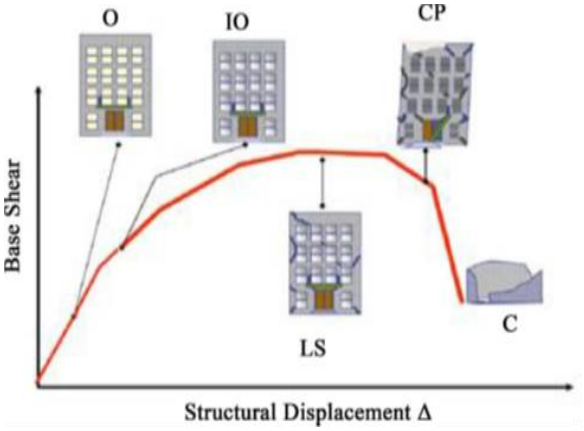

Fig.1 Performance Objectives

Geometry of building:

A four storey RC frame building situated in zone IV is considered for the present work.

- Bay Span along x-axis: 6m
- Bay Span along y-axis: 4m
- Storey height: 3.5m
- Size of Column 450mm x 450 mm
- Size of Beam 230 x 450 mm
- Thickness of Slab: 150mm

Material Properties and section sizes:

The following material sizes and Structural element sizes are considered in present study

- Concrete – M 30
- Steel –HYSD reinforced of grade FE 415 confirming to IS: 1786
- Size of Beam - 250mm X 450mm
- Size of Column - 350mm X 350mm
- Thickness of Slab - 150mm

Assumptions for Pushover analysis:

- Materials are isotropic, homogeneous, and linearly elastic.
- Supports at column are fixed.
- In the case of bending, tensile strength is ignored.
- Structure is analysed, assuming the foundation is fixed.

- In pushover analysis, plastic hinges are assigned at the end of member. In beam M3 hinges are provide and in column PMM hinges are provided-
- M3 < bending moment hinges> PMM <axial force and bi axial moment hinges>
- Maximum target displacement is 2.5 % of the total height of building.

III. RESULT

- It has been observed that by increasing the reinforcement in the beams of ground floor, there is a decrease in the roof displacement.
- In case of first storey beams, if we increase the reinforcement there will be decrease in the roof displacement.
- There is no effect on roof displacement if we increase reinforcement on second and third storey beams.
- It has been observed that when the reinforcement in beams of ground storey is increased then base force ranges from -7.56 to 6.8 %.
- It has been observed that when the reinforcement in beams of first storey is increased then base force ranges from -5.56% to 7%.
- There is no effect on base force, on increasing reinforcement of second and third storey beam.
- It has been observed that there is decrease in roof displacement when the reinforcement of ground and first storey columns is increased.
- There is no change in roof displacement by increasing the reinforcement of second and third storey columns.
- There is large increase in base force when reinforcement of ground and first storey column is increased.

It has been observed that there is no effect on base force, on increasing reinforcement of second and third story columns.

IV. CONCLUSION

- In the present study, a four-storey frame building performance has been analysed using Pushover analysis. Pushover performance had been carried out by SAP2000 (nonlinear software tool). The effect of different combination of reinforcement has been seen and its effect on the performance of building is observed. The shear wall on the building is studied and its effect on the performance is also observed. The main conclusions are summarized below:
- It has been observed that on increasing the reinforcement of ground storey beam, structure performance also improved.
- On increasing the reinforcement of first storey beam, structure performance increases up to some limit then after its performance remain same. And it is observed that, there is no effect in performance of building on increasing the reinforcement of second and third floor.
- Roof displacement decreases on increasing reinforcement of ground floor beam and first floor beam but there is no variation of roof displacement in cases of second and third storey.
- There is a variation in base force on increasing the reinforcement of ground storey and first storey beam. While there is no variation in base force is found on changing the reinforcement of second and third storey beams.
- It has been observed that there is appreciable change in roof displacement on increasing reinforcement of ground and first storey columns while there is no change in roof displacement if we increase the reinforcement of second and third storey columns.
- There is large increase in base force when reinforcement of ground and first storey column is increased but there is no change in base force when reinforcement of second and third storey is increased.
- It has been observed that, by providing shear wall there is an appreciable decrease in roof displacement of the building.
- There is an increase in base force by on providing shear wall in the building.
- After doing all the arrangement it has been observed the building is coming in acceptance criteria of immediate occupancy for various level of earthquake in zone four.
- It has been observed that in performance based seismic design, there is a decrease in reinforcement in some members of the structure when compared to building designed by IS 1893:2002.
- It has been observed that for the building to be in immediate occupancy level, reinforcement of

ground and first storey floor has been increased but reinforcement of second and third floor members had been reduced as compared to reinforcement designed by of IS1893:2002.

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