Studying the effect of vertical irregularities on the seismic vulnerability of setback buildings using Linear and Non-Linear methods

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Abstract

In the present study, the behaviour of setback buildings under seismic excitation is analysed using Finite element (FE) method using SAP2000. A model of G+9 storey RC building was considered with setbacks at different floor levels to introduce the vertical irregularities. Three different configurations of the building models, with varying setbacks, are analysed using different methods – 1) Response Spectrum Method (linear dynamic) as per IS 1893:2016 (Part-I), 2) Push over Analysis (non-linear static) using FEMA 356 and 3) Time History Analysis (non-linear dynamic). The response such as base shear, storey displacement, Angle of incidence, Time period, Column and beam moments are analysed in both X and Y directions and compared with the regular model. Effect of irregularities caused due to variation in plan and setbacks, on the response have been discussed, which governs the seismic vulnerability of setback RC buildings.

Keywords: Setback, ground motion, Response spectrum, Pushover, Vertical Irregularity, Target displacement, Time history analysis

1 Introduction

The need for extensive building construction in metropolitan regions has increased due to rising population and urbanization. The expansion of Reinforced Concrete (RC) building construction has constraints in horizontal direction due to the limited land availability. To manage for the same, constructors and designers are looking for the vertical expansion of the multi-storey buildings. Various types of vertical irregularities are provided for the aesthetic consideration or setback due to space requirement at a particular floor level. These building, having irregularities, are susceptible to severe damages in earthquake prone areas leading to the substantial loss of economy and resources.

The behaviour of multi-storey framed buildings during strong earthquake motions depends on the distribution of mass, stiffness, and strength in both the horizontal and vertical planes of buildings. In some cases, these weaknesses may be created by discontinuities in stiffness, strength or mass between adjacent storeys. Such discontinuities between storeys are often associated with sudden variations in the frame geometry along the height. In setback

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