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Seismic Study on Tall Structures with RC Shear Walls: Static and Dynamic Analysis

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Abstract: Structural design is the primary aspect of civil engineering. In India, multi-storied buildings are usually constructed due to high cost and scarcity of land. In order to utilize maximum land area, builders and architects generally propose symmetrical as well as asymmetrical plan configurations. The asymmetrical plan buildings, which are constructed in seismic prone areas, are likely to be damaged during earthquake. Earthquake is a natural phenomenon which can generate the most destructive forces on structures. Buildings should be made safe for lives by proper design and detailing of structural members in order to have a ductile form of failure.

The concept of earthquake resistant design is that the building should be designed to resist the forces, which arises due to Design Basis Earthquake, with only minor damages and the forces, which arises due to Maximum Considered Earthquake, with some accepted structural damages but no collapse. This present analytical study comprises of seismic analysis various storeyed R.C. structures (from low-rise to mid-rise to high-rise) with regular or symmetrical plan. The following building models such as G+1, G+4, G+9 and G+24 storeyed have been taken into account. The building is modelled as a 3D space frame with six degrees of freedom at each node using the software STAAD PRO v8i v 14.2.4. All the building models are analysed using Equivalent Static analysis. The building models are located in zone IV with S.M.R.F. Furthermore, Response Spectrum Analysis is also conducted on the entire regular plan building models as well as irregular plan building models. Detailed seismic response and behaviour are discussed well in this present study.

Keywords: Response spectrum, Modal analysis, Shear wall, Tall structure, Storey drift.

I. INTRODUCTION

Earthquake and wind forces is known to be one of the most destructive phenomena experienced on earth. It is caused due to a sudden release of energy in the earth's crust which results in seismic waves. When the seismic waves reach the foundation level of the structure, it experiences horizontal and vertical motion at ground surface level [1]. Due to this, earthquake is responsible for the damage to various man-made structures like buildings, bridges, roads, dams, etc. it also causes landslides, liquefaction, slope-instability and overall loss of life and property. When earthquakes occur, a building undergoes dynamic motion. This is because the building is subjected to inertia forces that act in opposite direction to the acceleration of earthquake excitations. These inertia forces, called seismic loads, are usually dealt with by assuming forces external to the building. So apart from gravity loads, the structure will experience dominant lateral forces of considerable magnitude during earthquake shaking. It is essential to estimate and specify these lateral forces on the structure in order to design the structure to resist an earthquake. The ductility of a structure is the most important factors affecting its seismic performance and it has been clearly observed that the well designed and detailed reinforced structures behave well during earthquakes and the gap between the actual and design lateral force is narrowed down by providing ductility in the structure. A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression. The beams and columns that form the frame carry vertical loads, and the bracing system carries the lateral loads [2]. This system tube in tube is also known as 'hull and core' and consists of a core tube inside the structure which holds services such as utilities and lifts, as well as the usual tube system on the exterior which takes the majority of the gravity and loads. The inner and outer tubes interact horizontally as the shear and flexural components of a wall-frame structure. They have the advantage of increased stiffness. The core tube system concept is based on the idea that a building can be designed to resist lateral loads by designing it as a hollow cantilever perpendicular to the ground. In the simplest incarnation of the tube, the perimeter of the exterior consists of closely spaced columns that are tied together with deep spandrel beams through moment connections.