Evaluation of Seismic Behavior in Exoskeleton Structural System for Reinforced Concrete Tall Buildings

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Abstract

Structural systems for tall buildings have undergone an evolution throughout the previous decades. Nowadays, the new structural system used for reinforced concrete tall buildings in which the exterior shell is the primary structure of the building. This shell located out of the building's primary skeleton and acts as a perimeter tube. The exterior shell has many openings that size and location of openings were carefully coordinated in order to make the wall effective in channeling both gravity and lateral loads down to the base of building. Openings layout in exterior shell creates a diagonal grid to enable its use both as gravity and lateral support that this structural system is named "Exoskeleton". This paper presents analysis of concrete exoskeleton structures under lateral loads and completely presents description of exoskeleton structural system and the manner of its connection to interior structure. In order to predict their seismic response in a building when subjected to sereve ground motion; 20-story structure with plan dimensions of 40 m×30 m has analyzed and designed. Several analytical studies were conducted, then some selected results obtainded and compared. The comparison of analytical results indicate that this system can provide the required lateral stiffness and strength for resisting the lateral loads due to earthquakes. Moreover the focus of this paper will be on some specifications of structures alike drift, the shear absorbing percent, performance of interior core and exterior shell and stresses values.

Keywords: Exoskeleton, Reinforced concrete, Seismic behavior, Exterior Shell, The shear absorbing percent .

1. INTRODUCTION OF EXOSKELTON STRUCTURAL SYSTEMS

From the structural point of view, a building is considered as tall when its structural analyses and design are affected by the lateral loads, particularly sway caused by such loads. In addition to aspect ratio (height to width) can be a criterion for classification of tall buildings, thereby 1.5π, π, π/2 and π/3 of aspect ratio respectively are related to Ultra High-Rise buildings, High-Rise buildings, Mid-Rise building and Low-Rise buildings. Then the effets of these items had to be considered at the beginning of design procedure [1].

In these days, Structural system of tall buildings has been a continuously evolving process. In 1969 the late Dr.Fazlur Khan classified structural systems for tall buildings relating to their heights with considerations for efficiency in the form of "*Heights for Structural Systems*" diagrams. Later, he developed these schemes for both steel and concrete structures [2]. As time passes, classification of tall Building structural systems accomplished and structural systems of tall buildings can be divided into two broad categories: *interior structures* and *exterior structures*. This classification is based on the distribution of the components of the primary lateral load-resisting system over the building. A system is categorized as an interior structure when the major part of the lateral load resisting system is located within the interior of the building; alike Rigid Frame, Braced Frame, Outrigger and Belt trusses and Core structures. Likewise, if the major part of the lateral load-resisting system is located at the building perimeter, a system is categorized as an exterior structure; alike Framed Tube, Braced Tube, Tube in Tube, Bundled Tube and Diagrid systems [3].

Recently the *Exoxkeleton system* is exhibiting for tall buildings, even it can use in ultra high-rise buildings. In the Exoskeleton system, structural system located in perimeter of building and out of the building's primary skeleton and acts as a perimeter tube. Generally the structural system such as exoskeleton system, can be said "Out of The Box". Using Exoskeleton system, provides column-free open spaces between core and exterior system which is effective from the viewpoint of architecture and makes flexible floors. Additionally by moving the lateral bracing for the building to the perimeter, the core which is