ARCE
ADVANCE RESEARCHES IN CIVIL ENGINEERING
Volume 1, No.1, pages: 32-41

Investigation of Fire Effects on Columns of High-Rise Reinforced Concrete Buildings

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ABSTRACT:

The effects of firebreak in high-rise buildings seem essential to be investigated cautiously since world trade center towers incident. Consequently, many technological advancements were achieved and numerous researches were performed. Nevertheless, in 2017, Plasco building in Iran also was set ablaze and the consequence was the full destruction of the building, claiming lives of at least 20, injuring 70 and loss of thousands of jobs. Therefore, it is crucial to investigate the effects of fire in high-rise buildings more thoroughly in order to prevent progressive collapse, a phenomenon that caused the destruction of the two landmarks. Ordinarily, to achieve this goal, methods of analysing fire effects are developed. So by choosing a logical fire scenario, design fire is extracted from time-temperature relations of design codes. After determining the firing temperature at various times, effects of temperature increase on the material's mechanical properties are investigated. Important characteristics such as concrete compressive strength, concrete and steel modules of elasticity, tensile strength, the coefficient of thermal expansion and steel rebar yielding stress are affected by alterations of temperature. Finally, by analysing structural behaviour utilizing modelling programs and comparing results of different fire temperatures and stories in which fire occurs with the initial design of the building RCC frame, it can be concluded that axial forces increases in columns are the critical condition in fire situations and in case of fire break in distinct stories, lower floors will experience a sharper surge of axial forces.

Key words: RCC, High-rise, Progressive-collapse, Fire, Thermal-analysis, Column.

ORIGINAL ARTICLE
Received 10 Mar. 2018
Accepted 20 Oct. 2018

1- Introduction

There have been numerous reports of structural failure and collapses due to the effects of fire and high temperatures, influencing material and mechanical properties of structures. The devastating consequences of collapses have claimed lives of many. Nevertheless, economic, social and political penalties cannot be overlooked. Needless to mention that the scale of such catastrophe multiples in high-rise buildings, perfect examples to mention are Plasco building and WTC towers.

The twin towers were modern, technologically advanced, state of the art lightweight steel frame and a central core, assuring efficiency of the structural and architectural aspects of the design. The destruction of the WTC towers was due to progressive collapse. Although the high temperature almost halved steel frames load bearing capacity, uneven temperature load excreted to the building triggered buckling of the floors and excessive forces on the structural frame and collapses of floors one after the other [1]. Moreover, on 19 January 2017 fire was initiated on the ninth floor of Plasco commercial building in downtown Tehran, Iran, built in the 1960s and once the tallest building in the country, leading to total collapse of the beloved landmark after hours of burning. Consequently, 20 firemen were reported killed and at least 70 were injured in the collapse.[2]

Since both buildings had no significant design faults, catastrophic collapses of the two buildings indicate intensive necessities of research in the areas of progressive collapse, understanding, and prevention in case of fire breaks.