EEFECT OF FIRE EXPOSURE ON RESIDUAL LOAD CAPACITY OF SHORT COLUMNS

By

AHMED SERAG FARID MAHMOUD GABR

A Thesis Submitted to the
Faculty of Engineering, Fayoum University,
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

Civil Engineering (Structures)

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ABSTRACT

Reinforced concrete structure is the common structural system used in Egypt and all over the world. Thus, the behavior of reinforced concrete structures and its failure modes have been extensively studied. Combustibility of contents is the main problem to be faced due to fire, which lead to the failure of structure. The extent of ensuing damage depends primarily on the structural performance of building both during and after the fire. The behavior of concrete elements exposed to fire depends on its mix composition, size of cross section, concrete cover, percentage of reinforcement and thermal properties. It is determined by complex interactions during heating process. The modes of concrete failure under fire conditions vary according to the nature of the fire, the loading system and the type of structure.

The main objective of this research is to study the behavior of axially loaded reinforced concrete columns subjected to fire conditions and to estimate the percentage of losses on its original compressive strength using FEA ANSYS program (version 10). In addition, it is required to estimate the effect of the following parameters on residual load capacity: column dimensions, concrete characteristic strength, fire duration (at 600°C & after 20 min heating), percentage of main steel reinforcement and steel diameter and concrete column cover.

In this research, a three-dimensional finite element using the models is developed to analyze the mechanism and axially loaded reinforced concrete columns subjected to fire. Theoretical results are contrasted with experimental test results of other researches with a good agreement for using ANSYS program to study effect of fire on R.C columns.

Sixty-three reinforced concrete scale model columns (1/3 scale) were analyzed under the effect of axial compression load and high temperature. Specimens were classified into three group according to specimens cross sections (Group "C1= 10x15 cm", Group "C2= 15x15 cm", Group "C3= 15x20 cm"). and all specimens were 90 cm high. Each group was sub-classified to three subgroups according to the following studied parameters, (Concrete cover, Concrete characteristic strength and Percentage of main steel reinforcement). Finally, each sub-group was divided into three sections according to exposure firing time (in air condition, at 600°C and for 20 min exposure to temperature).

Finally it was found that increasing concrete cover thickness leads to improving residual load capacity. In addition, the columns residual load capacity were increased with the increase of concrete characteristic strength for higher concrete strength. In addition, the residual load capacity increases for higher percentage of main steel reinforcement. In the

same way, Column cross-sectional rectangularity ratio affected the residual crushing loads of different modeled columns after fire. The square cross-section model (groupC2 15x15cm) had more residual load capacity than the other two groups, C1 (10x15 cm) and (C3 15x20 cm).

Keywords: ANSYS, F.E.A, Reinforced Concrete, Columns, Concrete Cover, Steel Percentage, Concrete Characteristic Strength, Column Cross-Section, Residual Load Capacity.