Influence of aggregate type and moisture on heat transfer of concrete columns subjected to elevated temperatures

Hamed Sadaghian

Graduated student, Dept. of Civil Engineering, University of Tabriz, Iran. Email: sadaghian.hamed@gmail.com

Abstract

Of many various parameters affecting heat transfer, this study aims to investigate the aggregate type and moisture content. Different characteristics of aggregates in terms of thermal conductivity and specific heat capacity play the utmost role in diffusing heat. To this end, in this study, the effect of calcareous, siliceous and lightweight aggregates are investigated based on the proposed equations from common codes of practice, namely, ASCE and Eurocode. Furthermore, both dry and wet concrete are taken into account. Numerical analyses are carried out on a concrete column chosen from the literature and the hydro-thermal procedure is validated with experimental models. Results indicate better efficacy of calcareous aggregates with respect to other types of aggregates and the significant role of high moisture contents in temperature reduction.

Keywords: Fire, Elevated Temperatures, Concrete column, Aggregate, Moisture content

1. Introduction

There is conclusive evidence in literature that fire is among the most hazardous events if not the most, wreaking havoc on farms, forests, etc. and causing billions of damage. Abundant number of nuclear facilities, thermal powerhouses and similar facilities of this sort demand for serious proactive measures to be taken before incidents such as this occur in cities. According to a survey conducted by the Concrete Center in UK [1], of half-million fires put out by firefighters, about one-third of them occur in occupied buildings, with a consequential result of 600 fatalities.

Concrete as a common construction material has good performance against fire. Its low thermal conductivity retards the dissipation of fire which delays the subjection of embedded reinforcement to elevated temperatures. Despite the advantages that concrete provides as a fire-retardant material, it has its drawbacks as well. A highly elusive phenomenon known as spalling occurs in concrete which is followed by the decrease of concrete cover and exposure of reinforcement to high temperatures, which in turn, owing to its high thermal conductivity, dissipates heat to other parts of the structure very quickly.

Numerous researchers [2-4] have studied the influence of aggregate on the mechanical and heat transfer properties of concrete. What they all conclude is that chemical composition of aggregate have significant effects on the overall behavior of concrete when subjected to fire.