Effect of High Temperature Exposure on Concrete: Damage Assessment and Repair Methodology

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Summary

Consequences of long term exposure to high temperatures (e.g. fires) i.e., thermal induced damages can result in substantial degradation of concrete and steel, which are the primary materials of construction for all major structures used in both strategic (e.g., nuclear reactors) and common applications (buildings, bridges and other urban structures). Response of real buildings to fire has highlighted that structural resistance to fire depends strongly on the level of redundancy. Therefore structural fire resistance cannot reliably be estimated by only assessing the resistance of individual structural members (beams, columns, slabs, etc) to fire, as is broadly the current practice internationally.

The present study experimentally evaluates the performance of control (standard cylinder specimen), damaged (mechanical loading after thermal exposure) and repaired / retrofitted normal plain concrete cylinders using different repair schemes such as use of carbon fiber reinforced polymer (CFRP) wraps. Sustainability of the repair/ retrofit scheme against additional thermally induced damage has been examined using thermally stable insulating materials such as geo-polymers applied on CFRP, to assess the combined benefit in mechanical strength due to thermal insulation and confinement. The control-companion specimen in the series provides the reference for comparison. Micro scale investigations (Scanning electron microscopy of thin sections, Electron Probe Micro Analysis, micro/ nano indentation methods) is used to develop insights into behavior at these length scales. The reasons for the degradation of the strength of concrete is attributed to drying of concrete and cracking of the mortar(matrix) at the interface of aggregates in part and to some extent to the melting in the coarse aggregates at very high temperatures. Computational models based on finite element method (ABAQUS) has been used to assess the contribution from different elements in the various repair schemes.

Keywords: Structural Concrete Repair, SCC with fibres, Carbon and glass fibre reinforced polymer, high temperature, Geo-polymer

1. Introduction

Consequences of long term exposure to high temperatures (e.g. fires) can also result in substantial degradation of concrete. Micro-textural (petro-graphical) and chemical exchange / diffusion studies are not widely used in concrete research. The major studies using the petrographic studies were done on old structures from which only limited samples are available. The major areas of research with petrographic application are on various aspects of cement alterations by time example thaumasite sulphate attack [1].

The research in concrete is highly concentrated on the quality development of the cement however very little research attention given to the material property of coarse and fine aggregates. Recently, [2] presented the constitutive relationships developed for normal-strength concrete and high-strength concrete subjected to fire to provide efficient modelling and specify the fire-performance criteria for concrete structures exposed to fire. A recent study [3] reported the strength

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