Structural Concrete Repair against mechanical and thermal loads

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Abstract

The study presents applications of different material systems for repair that have evolved in recent years for application to structural concrete elements as a means of rehabilitation or retrofit. Both fibre reinforced polymer (FRP) of glass, or carbon in the form of a laminate or wrap with epoxy binding and fibre reinforced concrete with chopped short wire fibres that are mixed into a concrete matrix, even with a self-compacting concrete consistency at the time of casting as an alternate form of a repair system is discussed. Experimental results and analytical/numerical procedures that have been developed to predict the capacity of the variously (strengthened) reinforced structural elements is presented to illustrate the merit of different approaches. A model to predict thermos-mechanical damage is briefly discussed. Possible repair and protection against thermal damage is also briefly discussed.

Keywords: Reinforced Concrete, Repair, FRP, SCC with fibres, FE Modelling, Temperature damage, geopolymer.

1 Introduction

Development of repair / rehabilitation or retrofit techniques in existing structures offers engineer / planner additional possibilities in deployment of funds in an effective manner. The initial development in retrofitting RC beams having damage in the tension region using FRP plates (Carbon, Glass and Aramid fiber plates) was proposed by Meier[1]. A number of other studies [2-3] have experimentally or analytically shown the benefits of FRP as a strengthening system. These studies conclude that the surface preparation of the concrete, the selection of the adhesive, amount of tension steel and its effective cover in the concrete beam were some of the important factors affecting the overall performance of the retrofit. Carbon and glass fibers were found to be more suitable in FRP plates used in retrofit. Significant enhancement in strength and ductility has been reported in a study [4] with the use of FRP tubes and the filament winding (GFRP). The use of FRP plates in repair and strengthening of RC member against failure in shear have also been reported [5-6]. The studies have reported equations for effective FRP strain as function of axial rigidity of FRP based on several experimental works.

Consequences of long term exposure to high temperatures (e.g. fires) i.e., thermal induced damages can result substantial degradation of concrete, which is the backbone for all major structures used in both strategic (e.g., reactors) and common applications (buildings and outer urban structures). Cement based materials such as concrete have a very complex structure over many length scales. Recently, Aslani and Bastami (2011)[7] presented the constitutive relationships developed for normal-strength concrete and high-strength concrete subjected to fire to provide efficient modeling and specify the performance criteria for concrete structures exposed to fire. Khaliq and Kodur (2011)[8] reported the strength and stiffness properties of concrete deteriorate with an increase in temperature as encountered during exposure to fire. At the macro level, comprising of full-scale structures, the material may be considered as an isotropic continuum (meter scale). The meso-scale operates at the

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