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Investigation of Rehabilitation Effects on Fire Damaged High Strength Concrete Beams

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Abstract : As the number of fire incidents has been increased, fire incidents significantly damage economy and human lives. Especially when high strength reinforced concrete is exposed to high temperature due to a fire, deterioration occurs such as loss in strength and elastic modulus, cracking, and spalling of the concrete. Therefore, it is important to understand risk of structural safety in building structures by studying structural behaviors and rehabilitation of fire damaged high strength concrete structures. This paper aims at investigating rehabilitation effect on fire damaged high strength concrete beams using experimental and analytical methods. In the experiments, flexural specimens with high strength concrete are exposed to high temperatures according to ISO 834 standard time temperature curve. After heated, the fire damaged reinforced concrete (RC) beams having different cover thicknesses and fire exposure time periods are rehabilitated by removing damaged part of cover thickness and filling polymeric mortar into the removed part. From four-point loading test, results show that maximum loads of the rehabilitated RC beams are 1.8~20.9% higher than those of the non-fire damaged RC beam. On the other hand, ductility ratios of the rehabilitated RC beams are decreased than that of the non-fire damaged RC beam. In addition, structural analyses are performed using ABAQUS 6.10-3 with same conditions as experiments to provide accurate predictions on structural and mechanical behaviors of rehabilitated RC beams. For the rehabilitated RC beam models, integrated temperature–structural analyses are performed in advance to obtain geometries of the fire damaged RC beams. After spalled and damaged parts are removed, rehabilitated part is added to the damaged model with material properties of polymeric mortar. Three dimensional continuum brick elements are used for both temperature and structural analyses. The same loading and boundary conditions as experiments are implemented to the rehabilitated beam models and nonlinear geometrical analyses are performed. Structural analytical results show good rehabilitation effects, when the result predicted from the rehabilitated models are compared to structural behaviors of the non-damaged RC beams. In this study, fire damaged high strength concrete beams are rehabilitated using polymeric mortar. From four point loading tests, it is found that such rehabilitation is able to make the structural performance of fire damaged beams similar to non-damaged RC beams. The predictions from the finite element models show good agreements with the experimental results and the modeling approaches can be used to investigate applicability of various rehabilitation methods for further study.

Keywords : fire, high strength concrete, rehabilitation, reinforced concrete beam
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