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FRP Bars Spacing Effect on Numerical Thermal Deformations in Concrete Beams under High Temperatures

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Abstract : 5 In order to eradicate the degradation of reinforced concrete structures due to the steel corrosion, professionals in constructions suggest using fiber reinforced polymers (FRP) for their excellent properties. Nevertheless, high temperatures may affect the bond between FRP bar and concrete, and consequently the serviceability of FRP-reinforced concrete structures. This paper presents a nonlinear numerical investigation using ADINA software to investigate the effect of the spacing between glass FRP (GFRP) bars embedded in concrete on circumferential thermal deformations and the distribution of radial thermal cracks in reinforced concrete beams submitted to high temperature variations up to 60 °C for asymmetrical problems. The thermal deformations predicted from nonlinear finite elements model, at the FRP bar/concrete interface and at the external surface of concrete cover, were established as a function of the ratio of concrete cover thickness to FRP bar diameter (c/d_b) and the ratio of spacing between FRP bars in concrete to FRP bar diameter (e/d_b). Numerical results show that the circumferential thermal deformations at the external surface of concrete cover are linear until cracking thermal load varied from 32 to 55 °C corresponding to the ratio of e/d_b varied from 1.3 to 2.3, respectively. However, for ratios e/d_b >2.3 and c/d_b >1.6, the thermal deformations at the external surface of concrete cover exhibit linear behavior without any cracks observed on the specified surface. The numerical results are compared to those obtained from analytical models validated by experimental tests.

Keywords : concrete beam, FRP bars, spacing effect, thermal deformation
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