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钢筋增强超高韧性水泥基复合材料弯曲性能计算分析与试验研究

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摘要: 超高韧性水泥基复合材料(UHTCC)具有优异的抗裂和能量吸收能力,用其取代混凝土可显著提高结构的耐久性和延性。为了推广 UHTCC在限裂要求严格的结构中的应用,开展了钢筋增强 UHTCC受弯构件即 RUHTCC梁的研究。根据 RUHTCC梁受拉区 UHTCC不退出工作的特点,采用弹性理论推导 RUHTCC梁受弯承载力计算公式,并将计算结果与无腹筋长梁弯曲试验结果进行验证对比。结果表明:在正常使用状态下,裂缝宽度保持在 0.05mm以内,满足处于高腐蚀环境下结构裂缝宽度限值要求;RUHTCC梁平截面假设成立;起裂后直至钢筋屈服,UHTCC和钢筋保持很好的变形协调性;试验结果与理论计算吻合,计算得到的延性指数偏于安全,在实际工程设计中用其来预测结构或构件的延性是合理的;与钢筋混凝土梁相比,UHTCC能够延缓钢筋屈服,提高结构或构件的承载力和延性,降低钢材用量;低配筋率有利于 UHTCC材料性能的发挥。

关键词: 超高韧性水泥基复合材料; 钢筋增强; 受弯承载力; 延性
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Analysis and experiment of reinforced ultra-high toughness cementitious composite flexural members

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Abstract Ultra-High Toughness Cementitious Composite (UHTCC) exhibits excellent crack controlling and energy absorbing ability, thus can remarkably improve durability and ductility of structures. To generalize the application of UHTCC in structures with high requirement of anti-crack, investigations on flexural behavior of reinforced ultra-high toughness cementitious composite (RUHTCC) members were carried out. On the basis of strain-hardening behavior of UHTCC after first-cracking, theoretical formulae were derived according to elastic theory and compared with four-point bending test results of RUHTCC long beam specimens without web reinforcement. It is discovered that crack width of RUHTCC beams is limited to 0.05mm under service load conditions, which satisfies the limitation for structures under exposure conditions. The plane-section assumption is tenable for RUHTCC beams with the compatible state of deformation between reinforcement and UHTCC exists till yielding. A good agreement between test results and theoretical calculation is found, and the conservative calculation of the ductility index can be used to predict ductility of structures or members in practical design. Compared with conventional reinforced concrete beams, RUHTCC beams have the tendency of delayed yielding of reinforcements and improved load bearing capacity and ductility, thus may result in saving of steel to further take the advantage of UHTCC with lower reinforcement ratio.

Keywords ultra high toughness cementitious composites; reinforced; bending load capacity; ductility

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