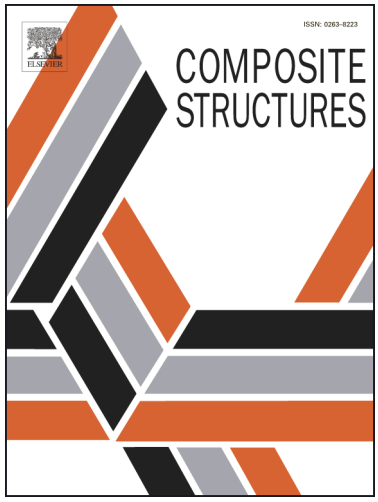


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# Flexural behavior and serviceability of concrete beams hybrid-reinforced with GFRP bars and steel bars

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## Abstract

In this paper, six concrete beams reinforced with a combination of GFRP (glass fiber reinforced polymer) bars and steel bars, and three concrete beams reinforced only with steel bars were designed and tested. Several flexural behaviors of the tested beams were analyzed and compared with theoretical models. The experimental and analytical results showed that under the designed service loads, the crack width and deflection that appeared in the GFRP-steel reinforced concrete beams developed faster than those shown by the steel-reinforced concrete beams. With the same total reinforcement amount of GFRP and steel bars, the ultimate flexural capacity of GFRP-steel reinforced concrete beams was nearly 91−97% of that of steel-reinforced concrete beams, but the deflection and maximum crack width were obviously larger than those of steel-reinforced concrete beams under the same service load levels. The beam deformability coefficient approximately decreased with increasing nominal reinforcement ratio $\rho_{nom,F}$. The area ratio of GFRP bars to steel bars $A_f/A_s$ had a great

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