



## Judgement methods of fire resistance time of hybrid reinforced concrete beams

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### Abstract

Hybrid reinforced concrete beams have been designed by replacing the steel bars in areas with weak durability with fiber-reinforced plastic bars. This paper suggests the judgement methods of fire resistance time of hybrid reinforced concrete beams by considering about the judgement methods of fire resistance time of steel reinforced concrete beams and FRP reinforced concrete beams that were proposed by scholars and standards of various countries. Six hybrid reinforced concrete beams were subjected to a fire test. The deflection and the temperature of hybrid reinforced concrete beams in the fire test were recorded. These judgement methods suggested by these scholars and standards are applied in judging the fire resistance time of these six hybrid reinforced concrete beams respectively. The results are compared to suggest that almost all the main factors having a great influence on fire resistance time of hybrid reinforced concrete beams are considered by the deformation limitation method, and this method can be taken as the main determinant in the judgement methods. The heat insulation of beams and the average temperatures of the surface of beams cannot be used directly to judge the fire resistance time. The judgement methods are improved by combination of these methods so that the judgement methods can be used for the design.

**Keywords:** hybrid reinforced concrete beams, fiber-reinforced plastic, judgement methods of fire resistance time

### 1. Introduction

Based on the concept of designing cross sections with homogeneous durability, hybrid reinforced concrete structures have been designed by replacing the steel bars in areas with weak durability (the corners and edges of the cross sections) with fiber-reinforced plastic (FRP) bars<sup>[1]</sup>.

These reinforced concrete structures have excellent mechanical properties and durability. However, because the fire resistance of these FRP bars, which are placed in the corners, is inferior to that of the steel bars, the fire resistance of concrete structures reinforced by both FRP bars and steel bars is inferior to that of concrete structures reinforced by only steel bars, and is superior to that