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Compartment Fire Test on Steel Columns with Various Fire-Resistant Methods

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Extended Abstract

In this study, compartment fire test was conducted to evaluate the fire characteristics of steel members in case of a fire for performance-based fire design of steel structures. Two H-sections (H-300×300×10×15) and six rectangular steel tubes (□-200×100×9) with a height of 1.0 m were installed inside a compartment of 2,400 mm (B) × 3,600 mm (D) × 2,400 mm (H), which is the same size ISO 9705 room-corner test. Fire intensity was set as a half-scale fire based on the fire load of 17.45kg/m^2 in the living room of the house and 81 wood clips with dimensions of 50mm (B) × 50mm (D) × 730mm (L) were used as a fire source. Test parameters were set as application of spray-applied fire-resistant material (SFRM), attachment of finishing mortar, and mortar filling inside the steel tube to compare the fire effect of the steel columns according to the fireproofing method.

Test results show that the maximum heat release rate (HRR) was measured as 1028kW and the total heat release (THR) was 855kW after 14 minutes, and the maximum temperature inside the compartment was 1076℃ at the height of 1.0m at the center of the fire source. The maximum temperature of the column surface without fireproofing was 384℃ for H-section and 394℃ for rectangular steel tube, and after reaching the maximum temperature, the temperature decreased linearly over time. Test results with fireproofing on the column show that the maximum temperature of the H-section sprayed with 10mm-thick SFRM was 95.8 ℃, which was 75% lower than that of the uncoated H-section installed at the same distance from the fire source. In the case of the rectangular steel tube with 10mm-thick SFRM, the maximum temperature was 91.5℃, which was 77% lower than that of the uncoated rectangular steel tube in the same distance from the fire source. When mortar was filled in the rectangular steel tube, the maximum temperature is 316℃, which is 20% lower than that of the unfilled rectangular steel tube and 10mm-thick SFRM and mortar were filled at the same time, the maximum temperature was 70.4℃, which was 82% lower than that of the bare steel tube. The maximum temperature was 109℃ when 30mm-thick finishing mortar was attached to the outside of the rectangular steel tube and 107℃ when mortar was also filled inside the rectangular steel tube, showing 72% and 73% lower temperatures, respectively, than that of the bare steel tube.

In order to develop a fire evaluation model for steel columns during a compartment fire, Computational Fluid Dynamics (CFD) analysis was performed using the Fire Dynamic Simulator (FDS) and compared with the test results.

References

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