

ENGINEERING/TECHNOLOGY

Investigation of Shear Capacity of Steel Bolts Under Elevated Temperatures

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Structures that have collapsed as a result of fire, such as the World Trade Center 7 building, have highlighted that the behavior of steel connections at elevated temperatures is not well understood. The purpose of this research project was to determine the shear capacity of structural steel bolts at 500°C and 550°C. A laboratory test setup was designed and built to conduct full-scale experimental tests on bolts within connections. The test setup allowed the specimen to be loaded in tension or compression using two hydraulic rams and heated with high-temperature ceramic radiant heaters to simulate fire conditions. Thermocouples were used to monitor the temperatures inside the bolt and on the exterior surface of the bolt, and displacement sensors were used to monitor the relative displacement of the bolt. A thermal test in which the shear surfaces of the bolt were heated to 550°C was conducted. The results show that when the bolt is heated at a rate of 7°C per minute, the temperature of the exterior bolt surface is 1.4 times higher than that of the interior shear surface of the bolt. This information will be beneficial for future tests as the temperature inside of the bolt can be determined without the use of a thermocouple in future experiments. In subsequent tests, bolts will be loaded to failure once the bolt inside temperature reaches 500°C and 550°C. The results of the loading tests at elevated temperatures will be compared to the ambient loading

test results to examine the differences in behavior. The experimental data from both the thermal and mechanic tests will be used in future tests that will study the thermal and structural performance of steel connections.

Research advisor Amit Varma says, “The fire resistance of building structures depends on the strength of its components and connections at elevated temperatures. The focus of this experimental research study is the elevated temperature (500–600°C) shear strength of high-strength steel bolts utilized in steel building connections. The study is being conducted using a specially designed and constructed test setup at Bowen Laboratory.”



Throughout the project, the test specimen (left) was used for full-scale experimental tests as well as the heaters (top right), together forming the full test setup (bottom right).

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