

PERFORMANCE OF AN EXTERNALLY BONDED CFRP SYSTEM FOR STRENGTHENING STEEL STRUCTURES

Mina Dawood, Murthy Guddati and Sami Rizkalla

North Carolina State University, Raleigh, USA

This paper describes the findings of a two-phase research program to study the bond behaviour and environmental durability of a CFRP strengthening system for steel structures and bridges. The first phase investigated the behaviour of the bond between CFRP strips, which is a critical factor affecting the strength of splice joints that are needed to implement the strengthening system to long-span structures. The research consists of both experimental and analytical components. The experimental program consisted of eight double-lap shear coupon tests and 10 large-scale steel beam tests. The parameters studied included the detail of the plate end, the use of mechanical anchorage near the end of the plate and the splice plate length. Three-dimensional linear and non-linear finite element analyses were also conducted to study the bond stress concentration near the plate ends for the various joint configurations tested. The findings indicate that implementing a reverse-tapered detail at the plate ends approximately doubled the capacity of the splice joints; this is due to a significant reduction of the normal (peeling) and shear stress concentrations near the end of the plate. However, increasing the length of the joint and providing mechanical anchorage near the plate ends did not significantly enhance the joint capacity for the tested beams.

The second phase of the research was designed to assess the durability of the CFRP strengthening system subjected to severe environmental conditions. The research includes a total of 52 steel-to-CFRP double lap shear coupon tests. Several techniques to enhance the moist durability of the system are considered in the study including the presence of a glass fibre insulating layer between the steel and the CFRP and the use of a silane coupling agent. The effect of the duration of exposure to severe environmental conditions and the presence of a sustained load are also considered. The findings indicate that the use of a silane coupling agent does not affect the initial joint strength. However, the presence of a glass fiber layer in the adhesive between the steel and the CFRP can enhance the average joint strength by approximately 40 percent.



Figure 1: Steel splice beam test