OPTIMAL DESIGN OF COMPOSITE STRUCTURES

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ABSTRACT

For retrofitting and strengthening existing structures, externally bonded fiber reinforced polymer (FRP) composite have been rapidly growing. FRP composites have many advantages such as high strength to weight ratio, good modulus, excellent resistance to different environmental conditions and ease of application. The interfacial bond between FRP and concrete substrates is the weakest link in the composite system and the common failure mode is plate or sheet debonding. The maximum transferable load is obtained by numerical simulations and experimental studies using single or double shear tests. This paper focuses on the cohesive zone models (CZMs) that simulates the fracture behavior of the interface using fracture mechanics and finite element method. A comparative analysis of the results from numerical simulations and experimental data is also carried out.

The cohesive zone models are one of the methods implemented into the study of interface debonding and sliding in composites in order to simulate the interface behavior of crack initiation and growth. Cohesive laws controlling a relation between tractions and displacements at the interface represent a type of sticky glue material, which is modeled as a consequence of non-linear springs. The critical energy release rate \( (G_f) \) of the bond interface for the Mode II failure (in plane shear cracking) is an important parameter to model the crack propagation. The crack initiation is characterized with the critical shear strength \( (\tau) \) of the bond in the interface.

To simulate debonding with a CZM, the commercially available finite element analysis code package, ABAQUS, is used to model three dimensional single shear tension test of FRP and concrete substrate composites. Numerical results from the simulation are compared with the experimental data to show agreement. In addition beam flexural simulations inducing the mixed failure modes are conducted. Results show that some of the models developed in different studies are in agreement with the FEM. The interfacial fracture energy parameter \( (G_f) \) is important to produce an accurate model.