Strengthening of Beam-Column Joints with Steel Reinforced Polymer (SRP) Sheets for Earthquake Loads

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Introduction

Multi-storey frames that were built in the 1960´s do not meet current design codes and behave in a non-ductile manner. The lateral load carrying capacity of these structures is not sufficient due to non-ductile reinforcement detailing including joints without transverse reinforcement.

In this study the results of a comprehensive experimental program are presented, which aimed to provide a fundamental understanding of the behavior of shear-critical exterior reinforced concrete (RC) joints strengthened with steel reinforced polymers (SRP) under simulated seismic load.

Steel Reinforced Polymer

Fig. 1 Application of SRP

Steel reinforced polymer (SRP) is a composite which consists of steel wires forming cords that are assembled into a fabric and embedded within a resin matrix.

Fig. 2 Used Cord Type

The cords are formed by twisted steel filaments.

Experimental Program

Four 2/3-scale reinforced concrete frame connections were constructed and tested. All the specimens were of identical dimensions. The joints represented an exterior joint of a reinforced concrete frame structure. They were reinforced such that they would represent a poorly detailed joint. One control specimen designated CNTL and three SRP-strengthened joints were tested under a cyclic load applied at the beam tip.

Three different configurations of applying SRP were investigated (SRP-C1-2, SRP-C2-3, SRP-C3-4). Cxïndicates in this case configuration number x. The last number instead is showing the amount of layers on each side of the joint. Furthermore SPR-C2-3 and SPR-C3-4 were wrapped in diagonal direction within the joint.

Observed Behaviour

Strength and dissipated energy increased considerably with - but not proportionally to - the number of SRP layers.

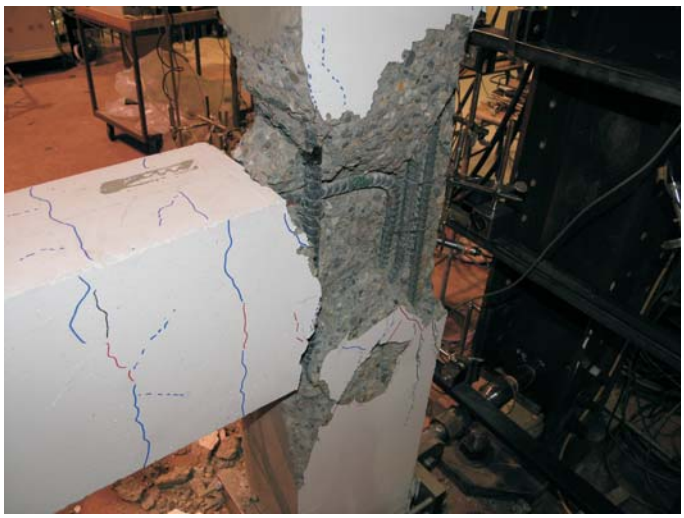

Fig. 3 Final failure pattern for unstrengthened shear-critical exterior RC joints

The composite sheets showed to be less effective if oriented in the column and beam direction, and more effective if oriented diagonal in the joint. In general, the strengthened joints showed a more favorable failure mode.

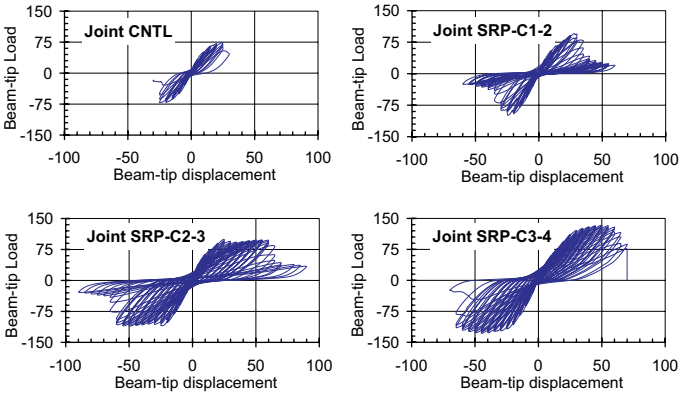

Fig. 4 Hysteresis Loops for examined configurations in kN and mm