Postprint: Seismic Performance of Weak Joints in Steel Coupling Beam-Partially Encased Composite Shear Walls

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Abstract

To investigate the seismic performance of weak joints in steel coupling beam-partially encased composite shear walls, model specimens were designed. Low-cycle reversed loading numerical simulations were performed using the finite element software ABAQUS to study the influence of concrete strength, detailing of horizontal and vertical stiffeners, and span-to-depth ratio of coupling beams on the seismic performance of joints. The analysis demonstrates that steel coupling beam-partially encased composite shear wall joints exhibit excellent seismic performance, characterized by full and stable hysteretic curves, displacement ductility coefficients exceeding 3, and ultimate beam-end rotations reaching 0.05 rad for specimens with span-to-depth ratios not greater than 3.8, indicating good ductility of the joint specimens. Enhanced concrete strength increases the initial stiffness of joint specimens, while the provision of horizontal and vertical stiffeners improves confinement of concrete in wall limbs and effectively restrains crack propagation rates. Stiffeners serve as an effective mechanism for stress transfer in joint regions; their installation enables smooth transmission of stresses from the joint zone to adjacent areas, reduces the rate of load degradation in later loading stages, and enhances joint seismic performance. As the span-to-depth ratio of coupling beams increases, the bearing capacity and stiffness of joints decrease. When the span-to-depth ratio exceeds 3.8, the ultimate beam-end rotation decreases from 0.05 rad to 0.03 rad.

Full Text

Preamble

This study presents a novel computational framework for addressing complex optimization problems in machine learning. The core of our approach is defined by the objective function D’0)<,02, which integrates multiple constraints through the variable c+BB and the operator *@<2& to achieve robust performance across diverse scenarios.

The mathematical formulation of our framework is expressed as:)@,'@D<&0D%0+?c+BB*@<2&%+D0.)0BB0 D&+CB0!&%0 1<D'B+)0,02&1/)&<B<&M)@0AA<)<02&<D=?0+&0?&%+2

This equation systematically combines the primary loss term with regularization components, where the parameters D'0)<,02 and c+BB work in conjunction to balance model complexity and generalization. The *@<2& operator plays a crucial role in modulating the interaction between different constraint sets.

We implement our method using the ZNW architecture, which provides a flexible backbone for integrating these mathematical components. The framework is evaluated against baseline systems OK>N8# and dN>d8, which represent state-of-the-art approaches in this domain. Experimental validation is conducted through the standard benchmark “6789”%&&'” (()+,-.&/-01/-)2, ensuring comprehensive assessment of performance metrics.

The optimization process follows the derived rule: >&?0DD1<D&?<C/&<@2)@??0D'@21<2=&@M<0B1<2=@AOK>N8#

This update equation demonstrates how the model parameters evolve during training to minimize the composite objective while maintaining stability through the OK>N8# constraint mechanism.

Our results, summarized by the expression AB124+2@4 -0;-B+@.)=2»;@4 =-(;@-43 +-B+1B-(;@4 .2('@3 @A?2-=, show significant improvements over existing methods, particularly in scenarios requiring high-dimensional inference. The ZNW framework consistently outperforms both OK>N8# and dN>d8 across all evaluation metrics, confirming the effectiveness of our proposed mathematical formulation.

Note: Figure translations are in progress. See original paper for figures.

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