Seismic Retrofit of Concrete Columns Using Advanced Composite Materials

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Summary

In order to develop design guidelines for seismic retrofit of existing bridge columns using prefabricated composite jackets, six large scale bridge columns (Dia.=610mm) have been tested. Three columns with lap-spliced longitudinal bars were subjected to cyclic lateral forces in a single bending mode, while the other three columns were tested to simulate shear dominated bridge columns under cyclic loading with double bending. Test results demonstrated the superior retrofit effectiveness of the composite jackets.

Test of Shear Dominated Columns

The reinforcement details of shear test model columns are shown in Fig.1, and the test setup is shown in Fig.2. One column was tested in the "as built" condition and the other two models were tested after retrofit for the full column height using prefabricated composite jackets. Fig.3 shows the installation of the individual cylindrical prefabricated composite jacket. The "as built" column suffered a sudden shear failure during the loading cycle corresponding to a limited ductility factor of 3.0. The retrofitted columns developed significantly improved seismic performance characterized by large energy absorption capacities and stable hysteretic responses up to displacement ductility factors of 12 to 14, as shown in Fig.4.

Flexural Column Testing Program

Three circular columns with lap-spliced longitudinal reinforcement were tested under constant axial load and cyclic lateral forces in a single-curvature mode. One column was tested in the "as built" condition and others were tested after retrofit for the potential hinge region using prefabricated composite jackets. The "as built" model column failed without developing its predicted flexural capacity due to severe deterioration in the lap-spliced longitudinal bars. The two retrofitted columns, one retrofitted with 5-layer individual prefabricated composite jackets and the other with 5-layer continuous jackets developed significantly improved seismic

performance demonstrating the excellent effectiveness of prefabricated composite jackets for flexural retrofit. The retrofitted columns exhibited stable behaviors until a displacement ductility factor of 8.0. Although a gradual degradation of load carrying capacity was observed during loading cycles corresponding to large deformation, the two retrofitted columns were able to develop an ultimate displacement ductility factor of 10.0.

Concluding Remarks

Current study provides methods for seismic retrofit and repair of reinforced concrete columns. Prefabricated composite jacketing can also be considered for repair and protection of column supported structures from environmental damage and exposure. Studies will be initiated in near future to address the applications of prefabricated composite jacketing in: columns subjected to freeze/thaw and deicing salt corrosion in snow belt states and countries; structures deteriorated due to water absorption of porous concrete; harbor wharf and pilings; power/telephone poles; structures damaged by fires, etc.

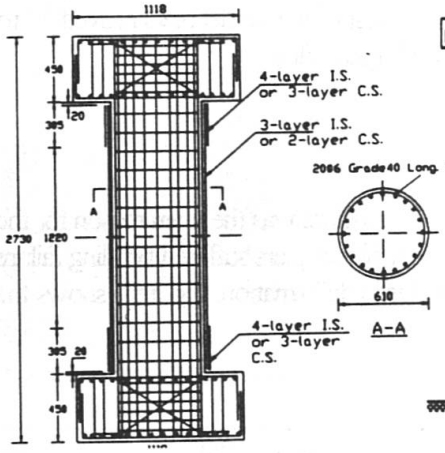

Fig.1. Shear Test Column Details

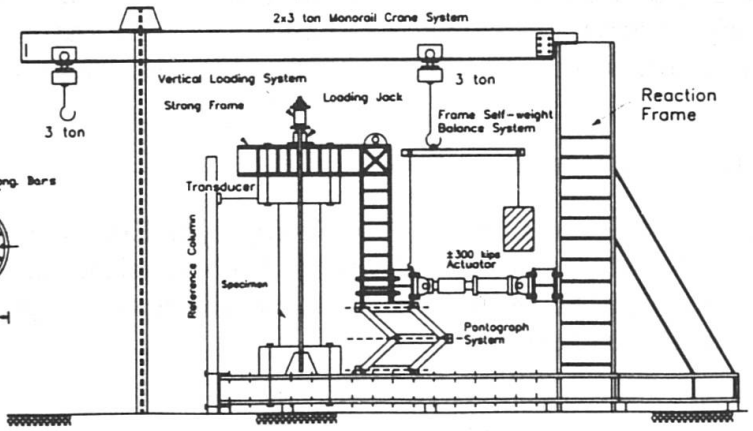

Fig.2. Shear Test Setup

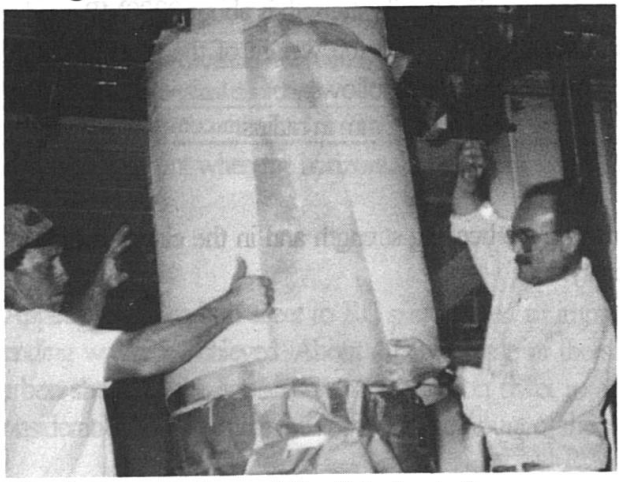

Fig.3. Installation of Prefabricated Composite Jackets

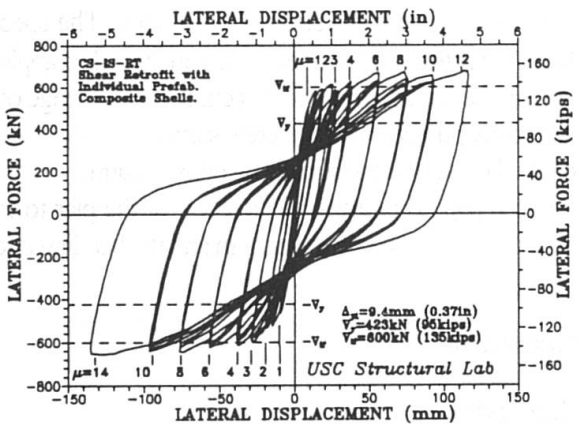

Fig.4. Hysteretic Response of Shear Column with Individual Shell Retrofit