

# **SEISMIC STRENGTHENING OF SHEAR-CRITICAL SHORT COLUMNS IN REINFORCED CONCRETE BUILDINGS**

**Abstract of Ph.D. Thesis Submitted by Dr. Komathi Murugan, IIT Madras**

Damage to reinforced concrete multi-storeyed buildings reported by post-earthquake reconnaissance studies, has exposed their deficiencies to resist seismic forces. It has been observed that, column failures have led to the collapse of the entire structure. Of the various failure modes, the shear failure of short columns is brittle, leading to loss of capacity to carry gravity load. The vulnerability of the existing deficient buildings can be reduced by seismic strengthening. The research focussed on seismic strengthening of shear-critical short columns of rectangular section, by concrete jacketing. It addressed the analysis of shear strength and behaviour of jacketed columns, through experimental, analytical and numerical investigations.

First, the investigation on the shear strength of jacketed column specimens was conducted. It aimed to evaluate the increase in shear strength due to jacketing, to predict the increased shear strength of a jacketed column, and to examine the effects of selected parameters. Thirty eight beam-column specimens were tested under combined lateral and axial loads. A method to compute the shear strength of a jacketed column based on an equivalent monolithic section was demonstrated, which is suitable for professional practice.

Second, a study on the behaviour of a shear-critical column specimen was performed. It intended to obtain the lateral load versus drift behaviour of a cantilever column subjected to top displacement experimentally, and to predict the behaviour analytically based on a piecewise linear model, a generalized truss analogy and a softened truss model, and numerically from three- and one-dimensional simulations. The proposed generalized truss analogy can be used to compute the non-linear shear hinge property of a short column in a pushover analysis of a building.

Next, the investigation on the behaviour of large jacketed column specimens with different interfaces was executed. It aimed to examine the effects of three types of concrete interfaces (surface roughening, surface roughening along with insertion of dowel bars and surface roughening along with welding of bent bars) and two types of lateral loading (monotonic and slow cyclic), on their shear behaviour. Eight specimens were tested under combined lateral and axial loads. Methods to compute the shear strength of a jacketed column based on equivalent monolithic section and a strut-and-tie model were demonstrated. The piecewise linear model and the proposed generalized truss analogy were extended to predict the shear behaviour.

Finally, pushover analyses of a building with as-built and jacketed columns in the open ground storey were done. This demonstrated the modelling of non-linear shear hinge properties of the columns, based on the proposed generalized truss analogy. Certain guidelines on concrete jacketing of columns were presented, based on the experience gained during preparation of specimens. Some suggestions on improving the existing code provisions on seismic strengthening of reinforced concrete buildings, were given. The theory of the generalized truss analogy was presented in the annexure in the style of a monograph, as a standalone reference.