# Discussion Forum

## Investigations on a distressed reinforced concrete building and its rehabilitation

Dear Sir,

The authors of the paper "Investigations on a distressed reinforced concrete building and its rehabilitation", published in the March 2010 issue of ICJ, have provided us good information on the subject. Such problems are common occurrences for RCC buildings.

They have informed that the jacketing the RCC columns, does not necessarily increase the strength; with respect to both capacities and stiffness. Their study for vibration behaviour for RCC building helps us assess the strength of the structure. Jacketing increases mass or more precisely robustness and protects the core of the concrete from further deterioration.

It would be appreciated if the authors can throw some light on repairs of RCC columns with other alternatives such as:

1. Structural steel at 4 corners with suitable sections of angles. According to Chinese Aseismic Design code for Building, RCC structure strengthened with encasing steel angels on 4 corners provide the advantages of both steel and RCC structures; stiffness characteristics are better than steel structure and deformation capacity is greater than RCC structure. Further, in the case of damaged frame structures, even with serious damage, their load carrying capacities can be restored to the original levels or raised to certain degree, through appropriate rehabilitation for example by strengthening with encasing steel angels. Strengthening with steel sections can reduce the damage due to shear, and improve the deformation capacities and ductility of the structures. A reasonable strengthening of different parts can control structural failure.

2. Providing additional support like RCC column or steel column at suitable place so as to reduce the stresses on damaged columns.

These alternatives may give us more option to repairs damaged RCC members.

Thanking you,

Yours sincerely,

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## The authors' reply

Dear Sir,

The authors thank Er. Deepak Dave for the interest in the paper.

The investigations on the ambient vibrations of the structure before and after repairs indicated that the enhanced column sections were not effective. The new concrete jacketing the column, despite the provision of shear connectors and grouting of the columns with epoxy, does not share the loads on the columns immediately. The loads may be transferred to the enhanced column sections gradually in due course of time due to creep.

Retrofitting by means of angles at the four corners of the column sections is a possible alternative. However, such an encasement may strengthen the stem of the columns, but does not enhance the moment capacity at the joints, and by implication overall performance of the structure. A scheme of repair and retrofitting commonly adopted is indicated in Figure A. Unlike the scheme discussed in the paper (Figure 4), no shear connectors to ensure composite action between the old and new concretes are provided; the reinforcement (bars or angle sections) does not continue into the footing below or beam-column joint above to increase moment capacity at the joints.

**Figure A. Inadequate strengthening of columns**

Providing additional steel or RC columns between the existing columns is not generally desirable unless no alternative scheme is feasible; such a scheme may affect the aesthetics of the structure and the performance of the beams. The beam reinforcement detail may not match the new column locations, and the beams may require external (negative) reinforcement at the locations of the new columns.

The authors may be permitted to add another conclusion based on the NDT results on the columns mentioned in the paper. Schmidt rebound hammer measures only the surface hardness, and provides no indication of the internal cracks or delamination of concrete. Ultrasonic pulses penetrate concrete, and the propagation is affected by internal cracks. Ambient vibration characteristics indicate the overall performance of the structure, and any changes in the structural stiffness.

Thanking you,

Yours sincerely,

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