Structural Retrofitting of Buildings: Turnbuckle Exterior Post Tensioning

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Summary

Nowadays the problem of aging and deterioration of reinforced concrete buildings are eminent and due to excessive loading, the flexural performance and serviceability of structures are affected. The turnbuckle exterior post tensioning (T-EPT) is proposed as a retrofitting method wherein it was proven experimentally that it can be able to improve the serviceability and load carrying capacity of beams. A computer modeling method was developed to simulate the application of the T-EPT to full scale beam sections to determine its effectiveness with different cases. Different T-EPT configurations were modeled and the most efficient design that can be applied to structures was determined. Overall the T-EPT was effective in improving the serviceability and load carrying capacity of reinforced concrete beams.

Keywords: Exterior post tensioning, structural retrofitting, reinforced concrete buildings.

1. Introduction

The increase in demand for different infrastructures is the trend in the construction industry. Together with the construction of new structures, worldwide deterioration and aging of reinforced concrete structures are also eminent. Due to the excessive loading experienced by reinforced concrete structures, the structural performance of reinforced concrete members may be affected, where beams deflect in time whereas the flexural performance and serviceability of the beams are also affected. The study investigates the effectiveness of the turnbuckle exterior post tensioning as a method of retrofitting reinforced concrete buildings.

1.1 Objectives of the study

The study aims to determine and analyze the effectiveness of the turnbuckle exterior post tensioning in retrofitting reinforced concrete beams using SAP2000. Specifically, the study aims to; (i) analyze its effectiveness by means of testing and experimentation; (ii) evaluate the flexural strength and beam deformation characteristic of reinforced concrete beams retrofitted with the T-EPT; (iii) investigate the applicability and design of the T-EPT for buildings; and (iv) investigate the most efficient T-EPT configuration in retrofitting beams.

2. Turnbuckle Exterior Post Tensioning

The turnbuckle exterior post tensioning (T-EPT) is a retrofitting method which applies the concept of pre-stressing where a series of external tension wires and bracing resist moment from external loads applied on a beam. The only difference is that a turnbuckle mechanism would be used as the source of jacking force.

3. Methodology

The methodology of the study was subdivided into the experimental and computer modeling phase. The experimental phase was done by testing beam specimens in a beam rig test apparatus to observe the flexural performance of beams with and without the T-EPT. Form the experimental results the behavior of the concrete material was incorporated into the computer model in order to simulate the actual behavior. Several full scale beam cases was modeled and analyzed and the most efficient configuration of the T-EPT was determined.

4. Results and Discussion

Experimental results show that the beams that were retrofitted had an increase in load carrying capacity of 49.432% for the elastic stage and 47.228% for the inelastic stage in average.

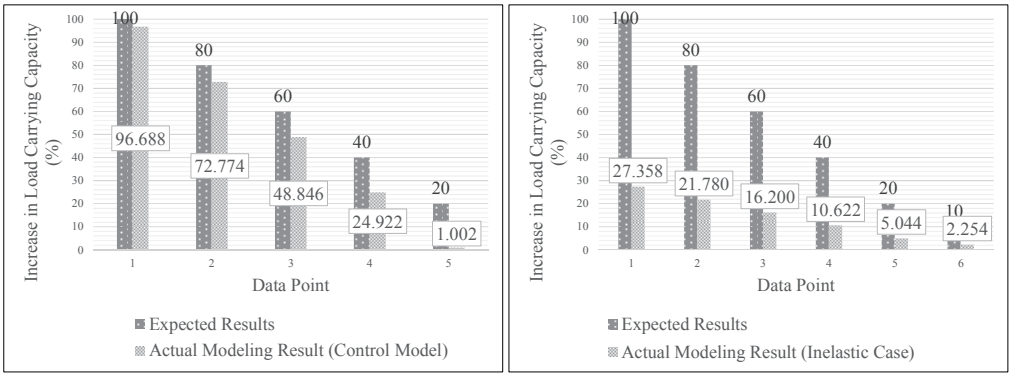

Fig. 1: Increase in load carrying capacity for elastic (left) and inelastic (right) condition

Figure 1 shows that at a certain percentage of jacking force, there is a corresponding increase in load carrying capacity. As the percent jacking force decreased, its effectiveness in giving the expected result also decreased. The results for the elastic stage yielded to significantly high increase in load carrying capacity (96.688% at 100% jacking force). Compared to the results in the elastic condition, the increase in load carrying capacity for the inelastic stage was lower (27.358%).

5. Conclusions

For the experimental phase, the beams in the elastic region were almost brought back into its original condition, and beams in the inelastic condition were only brought back up to a certain extent. However, an increase in load carrying capacity was still observed. It was difficult to retrofit inelastic beams due to excessive cracking and yielding of steel bars. The computer modeling phase proved that the effectiveness of the T-EPT decreases as the percent jacking force decreased. For the elastic condition, the T-EPT was highly effective in increasing the load carrying capacity. However for the inelastic condition, a different trend was observed compared to the experimental results, this was due to the limitation of the software to capture the elasticity of the tendons. Overall the T-EPT was effective in improving the serviceability condition and load carrying capacity of structures

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