

# Developing a method of strengthening concrete structures: Precast Pre-stressed Concrete Braces

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## Abstract

There are multiple methods for seismically retrofitting existing concrete structures, such as adding jackets, adding concrete shear walls, or using FRP, CFRP, HFRP sheets; applying steel braces and external Frames or even applying external precast concrete. Another method is RC INFILLING, external post-tensioned cables, et al. A new method for strengthening concrete structure is Precast Pre-stressed concrete braces (PPCB), which were introduced by Watanabe. This method applies an X-shape concrete brace to the existing RC frame; this brace is consist of four legs and a middle section. Watanabe successfully applied this method in the lab on a half-scale of a four-story frame. In our research, we provided a 3D-model in ABAQUS-FEA in order to Finite Element Analysis of the PPCB. The results of the numerical analysis were in compliance with the experimental work of Watanabe. Then we modified different properties to the concrete brace in order to study its behavior. Results indicated that since the compression strength of the brace was more than two times of the existing frame, it could significantly be effective in reducing lateral displacement. In the following, we have introduced two new assemblies for concrete braces: single diagonal and V-shape braces. In The single diagonal brace, the middle section is omitted, and the brace would be installed in two consecutive frames. Results of the Finite Elements Analysis indicated that this new assembly is effective. Also, we have proposed another assembly for the PPCB, V-shape, which could be more buckle resistance because it has less length, but it adds extra force to beam in the existing frame.

**Keywords:** Concrete braces, precast Concrete, pre-stressed Concrete, Retrofitting RC structures, strengthening concrete structures, Finite Elements Analysis

## 1. Introduction

There are multiple reasons that existing buildings should be strengthened: repairing structures that are damaged in earthquakes, alteration in usage, alteration in forces, some new finding in material and buildings behaviors which leads to changes in requirements by