

## An innovative solution for strengthening of old R/C structures and for improving the FRP strengthening method

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**Abstract.** In this study a new innovative method of earthquake-resistant strengthening of reinforced concrete structures is presented for the first time. Strengthening according to this new method consists of the construction of steel fiber ultra-high-strength concrete jackets without conventional reinforcement which is usually applied in the construction of conventional reinforced concrete jackets. An innovative solution is proposed also for the first time that ensures a satisfactory seismic performance of existing reinforced concrete structures, strengthened by using composite materials. The weak point of the use of such materials in repairing and strengthening of old R/C structures is the area of beam-column joints. According to the proposed solution, the joints can be strengthened with a steel fiber ultra-high-strength concrete jacket, while strengthening of columns can be achieved by using CFRPs. The experimental results showed that the performance of the subassemblage strengthened with the proposed mixed solution was much better than that of the subassemblage retrofitted completely with CFRPs.

**Keywords:** steel fiber ultra high-strength concrete; reinforced concrete jackets; fiber reinforced polymers; beam-column joints; columns; cyclic loads

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### 1. Introduction

Damage incurred by earthquakes over the years has indicated that many reinforced concrete (R/C) buildings, designed and constructed during the 1960s and 1970s, were found to have serious structural deficiencies today. These deficiencies are mainly due to lack of capacity design approach and/or poor detailing of the reinforcement. As a result, lateral strength and ductility of these structures were minimal and hence some of them collapsed (Paulay and Park 1984, Park 2002, Karayannis *et al.* 1998). One of the most popular pre-and post-earthquake retrofitting methods for columns, beam-column joints and walls is the use of reinforced concrete jacketing. In retrofitting building columns, b/c joints and walls with outer R/C jackets, the usual practice consists of first assembling the jacket reinforcement cages, arranging the formwork and then placing the concrete jacket (Karayannis *et al.* 2008, Rodriguez and Santiago 1998, Tsonos 2002, Tsonos 2010, UNDP/UNIDO 1983). Shotcrete can be used in lieu of conventional concrete in the repair works and, in some cases, offers advantages over it, the choice being based on convenience and cost (Tsonos 2010).

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