Experimental investigation of the seismic response of repaired r.c. bridges by means of pseudodynamic tests

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Summary

Some techniques for repairing and retrofitting of specimens in scale 1:6 of the most stressed r.c. circular piers of a bridge designed according to Italian Code before 1986 severely damaged after previous pseudodynamic and cyclic tests, are described. The specimens have been repaired using epoxy adhesive, stainless steel rebars, self compacting concrete, strengthened with CFRP wrapping and again tested by pseudodynamic, under the seismic action used for first tests on undamaged specimen. In the pseudodynamic test, one repaired and retrofitted pier specimen is physically tested, while the rest of the bridge is numerically simulated using an in-house apparatus here described. Finally, the seismic behaviour of the retrofitted bridge piers has been compared to the seismic behaviour of the original piers and to the first numerical results of a detailed fiber model built in OpenSees.

Keywords: bridge, repair, retrofitting, maintenance, SCC, CFRP, fiber model.

1. Introduction

Interventions for repair and seismic upgrade of r.c. bridge piers seriously damaged by earthquake can be a valid alternative to the reconstruction of the structures. Damages such as cover crushing, longitudinal bars locally buckled, broken spiral, shear cracks, often concentrate at the base of the piers, the most stressed part of the element where also moisture deterioration is more significant.

The proposed interventions aim to repair and improve the damaged portions of the structural element only, correcting the construction defects and improving the dissipative capacity of the system under earthquakes. The functionality of the existing element is recovered with modest times of execution without modifying the size of the element and involve saving in maintenance costs over the long time. Alternative solutions like the construction of a jacket of concrete, exterior to the damaged structural element, which bears the vertical loads brought by the original element, implies longer times of construction, it can take up more space not always compatible with the existing infrastructures and it may requires more out-of-service time for construction with additional costs.

In this research campaign, eight specimen of tall or squat circular r.c. piers in scale 1:6 designed according to the previous Seismic Italian code [1] and damaged during previous pseudodynamic tests [2] have been repaired and/or strengthened using epoxy resins injections, inox rebars, self compacting concrete and discontinuous wrapping with CFRP strips and then tested again through new pseudodynamic and cyclic tests. Epoxy adhesive very fluid to saturate in depth the cracks, have been used to try improving the concrete core strongly degraded. The damaged or broken longitudinal and transversal reinforcement have been locally substituted with inox bars. The use of inox bars involves greater initial costs but allows a saving in the long period as it reduces the costs of maintenance and increases the durability of the structural elements. The welding connections between existing rebars and new stainless steel rebars, can be quickly implemented in loco but asymmetries, sometimes unavoidable for these connections, have to be investigated. The use of self compacting concrete is most interesting because it has characteristics are particularly useful in

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