Rapid Repair of Reinforced Concrete Bridge Columns After a Disaster

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Abstract: Rapid repair of bridge columns are important after a disaster. Several studies were done about repairing damaged columns. Those studies were summarized with results. Studies showed that grout injection and fiber reinforced polymer (FRP) wrapping are commonly used methods to restore columns capacity.

1. Introduction

Columns supporting bridge structures are expected to stand during and after disasters such as earthquakes, hurricanes and floods. Restoration of bridge columns requires repair of damaged regions which should be done rapidly to keep bridges operational. Fiber reinforced polymer is a material made of a polymer matrix reinforced with fibers and commonly used to repair concrete columns.

2. Objectives

The objective of this study was to evaluate the repair techniques for damaged bridge columns from past studies done.

3. Summary of Concrete Bridge Columns Repair Methods

Ref. #	Specimen	Damage	Repair Method	Result
1	Four hollow bridge columns	Cyclically loaded to failure	Dog-bone shape bars to replace the fractured longitudinal bars in plastic hinges and using Fiber Reinforced Plastic (FRP) wraps.	The fractured longitudinal bars can be completely repaired and the deformation capacities of the columns were enhanced by FRP wraps.
2	Four nonseismically detailed interior beam-wide column joints	Cyclic lateral displacement applied to provide the equivalent of severe earthquake damage.	epoxy and carbon-fiber-reinforced polymer (CFRP) sheets and glass-fiber-reinforced polymer (GFRP) sheets	Repair can restore the performance of damaged RC joints with relative ease.
3	40% scale circular bridge column	Shear failure during a cyclic-loading test	Epoxy and nonshrinkage mortar and carbon fiber reinforced plastic (CFRP)	The repaired and rehabilitated column develops significantly improved hysteretic responses at high displacement ductility.

4	Two 0.4-scale reinforced concrete columns	Subjected to slow cyclic loads and had failed due to low-cycle fatigue of the longitudinal bars.	Low-shrinkage, high-strength concrete grout and glass and carbon fiber reinforced polymer (FRP) sheets with fibers	The method to restore the strength was effective.
5	Several damaged columns on Highway 401 in Toronto. Built in 1960s.	Concrete was delaminated as a result of steel corrosion.	Different types of grouts and wrapping with glass-fibre-reinforced polymers (GFRPs).	The experimental results showed that the strength and ductility of the columns could be recovered by repairing them with GFRP.
6	The middle bent of a large-scale two-span bridge model	The highest repairable level (visible bars, initial buckling in some longitudinal bars, and initial concrete core damage)	Epoxy injection, unidirectional carbon fiber reinforced polymer (CFRP) jacketing	The lateral load capacity and the ductility capacity of the bent were fully restored, and the service level stiffness of the bent was restored to 87% of the undamaged bent stiffness.
Remarks	All tested columns were reinforced concrete columns	The columns were damaged to simulate conditions after disasters	Common method to repair columns were use grouts and fiber reinforced plastic (FRP)	Column capacities were recovered in most cases with the applied repair methods.

4. Conclusions

Tested columns were reinforced concrete columns which were damaged to simulate conditions after a disaster. Most commonly used methods were grout injection to fill cracks and fiber reinforced polymer wrapping to restrain the lateral expansion of the column. Studies showed that applied methods were effective to restore the original capacity of columns.

5. Acknowledgements

This work was supported by the Texas Hurricane Center for Innovative Technology (THC-IT) under grants from various industries.

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