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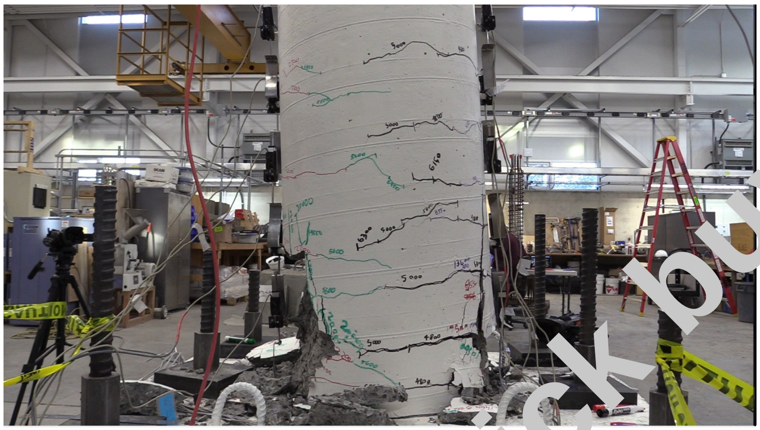

Advances in Repair/Retrofit/Strengthening, Design and Analysis of Structures

SP-358

Editor:
M Shahria Alam

American Concrete Institute
Always advancing

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With the aging and deterioration of infrastructure, the need for repair, strengthening, and rehabilitation of existing structures continues to increase. Climate change makes extending the service life of our infrastructure critical since any demolition and new construction will trigger substantial amounts of carbon emissions. Research related to repairing and strengthening existing infrastructure is seeing major developments as new green materials and technologies become available. Improved assessment and retrofit of deficient structures, and performance-based design of new structures are also in high demand. Despite the progress, there are many challenges yet to be addressed. The main objective of this Special Publication is to present results from recent research studies (experimental/numerical/analytical) on the retrofit and repair of structural elements along with the assessment, analysis, and design of structures. Several of these papers were presented at the ACI Fall Convention "Seismic Repair/Retrofit/Strengthening of Bridges at the Element or System Level: Parts 1 and 2."

The presented studies cover various aspects of structural retrofitting and strengthening techniques including the use of rubberized engineered cementitious composite for enhancing the properties of lightweight concrete elements, high-performance concrete jacketing to strengthen reinforced concrete piers/columns, and the behavior of fiber-reinforced-polymer-wrapped concrete cylinders under different environmental conditions. Additionally, the research explores the behavior of concrete-filled FRP tubes under axial compression, innovative bridge retrofit technologies, and retrofit techniques for deficient reinforced concrete columns. There is also a focus on evaluating the seismic response of retrofitted structures, designing guidelines for seismic retrofitting using tension-hardening fiber-reinforced concrete, strengthening unreinforced masonry walls with ferrocement overlays, and developing seismically resilient concrete piers reinforced with titanium alloy bars. The seismic response of a retrofitted curved bridge was also presented where elastomeric bearings of the as-built bridge were replaced by high damping rubber bearings as a part of the seismic retrofit. Recommendations for nonlinear finite element analysis of reinforced concrete columns under seismic loading are also presented to simulate their behavior up to collapse.

Overall, the presented studies in this Special Publication demonstrate the potential of new materials, methods, and technologies to improve the performance of various structural elements under different loading conditions, including seismic and environmental loads. These studies are expected to help our practitioners and researchers not only develop more effective and sustainable methods for repairing and strengthening of structures but also improve their analysis and design skills.

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Use of Rubberized ECC in repair/strengthening lightweight concrete elements

Basem H. AbdelAleem and Assem A. A. Hassan

Synopsis: This study aims to present a new technology for repairing/strengthening lightweight concrete (LWC) elements. Rubberized engineered cementitious composite (RECC) was used to repair/strengthen LWC specimens to develop a lightweight composite with superior mechanical properties and impact resistance. Two different sizes of rubber aggregate were used in RECC: crumb rubber (CR) and powder rubber (PR). The studied parameters included different RECC layer thicknesses and different cross-section locations. The tested properties were compressive strength, splitting tensile strength, flexural strength, drop weight impact resistance, and flexural impact resistance. The bond strength at the interface between LWC and RECC was also investigated. The results revealed that repair/strengthening LWC with RECC layer showed a promising lightweight composite with enhanced mechanical properties and impact resistance. Using CR in the RECC repair layer showed better enhancement in the drop weight impact resistance than using PR, while using PR was more significant in enhancing the composite's static flexural strength and flexural impact resistance. The results also revealed that the flexural impact resistance of the sample was significantly enhanced when RECC layer was placed on the tension side (bottom side), while the drop-weight impact resistance was noticeably improved when RECC was placed on the compression side (top side).

List of notations

LWC	Lightweight concrete
RECC	Rubberized Engineered cementitious composites
CR	Crumb rubber
PR	Powder Rubber
CRECC	Crumb rubber-Engineered cementitious composites
PRECC	Powder rubber-Engineered cementitious composites
MK	Metakaolin
FA	Fly Ash
C	Cement
BC	Binder content
SCM	Supplementary cementing materials
S	Normal sand
SS	Silica Sand
PVA	Polyvinyl Alcohol fibers
STS	Splitting tensile strength
f'c	Compressive strength
B-CRECC	LWC sample with a bottom layer of CRECC
B-PRECC	LWC sample with a bottom layer of PRECC
T-CRECC	LWC sample with a top layer of CRECC
T-PRECC	LWC sample with a top layer of PRECC

Keywords: Rubberized engineered cementitious composites; impact resistance; drop-weight impacts; lightweight concrete; mechanical properties; Crumb rubber; powder rubber; supplementary cementing materials.