October 2016 ABC-UTC Graduate Student Seminar: Emerging Alternatives for ABC in High Seismic Zones

Q&A Session

Featured Presentation #1 by Mehrdad Mehraein, Ph.D.: Performance of Bridge Column-Pile-Shaft Pin Connections for Application in ABC	
Compare this new design with the conventional one in terms of dollars, considering construction and future maintenance.	The exact savings are based on the project. Use of pins in the structures reduces the costs of construction in two ways: First, smaller foundations are needed because of the reduction of the demand. Second, construction facilitates by removing the need for holding the column reinforcing cage during cast of pile-shafts, even without using precast elements. No special maintenance is needed for these connections.
Discuss about liquification on existing structures.	The effects of soil-structure interactions were out of the scope of this study. However, use of pins at the base of columns reduces the demand on the foundation, which will help design for liquefaction.
What are the alternatives?	We proposed two pin alternatives for connections between precast columns and pile-shafts as well as a moment-resistant pocket connection between precast column and superstructure. The pocket connections can also be used between a CIP column and precast cap beam.
How does these methods compare to grout sleeves for the individual bars?	The proposed pocket detailings are easier to assemble and construct because the problems with the grouted sleeves (such as mismatching between bars and sleeves, and small clearance between ducts in column with large number of longitudinal bars) are not presented in this detail.
How do you compare the performance of the rebar-pin and pipe-pin?	Both pins significantly reduced base shear compared to a bent with fixed connections. The pipe-pins underwent less damage than the rebar-pins. Furthermore, the pipe-pins can be designed to remain elastic during a large earthquake and such a method was developed in this study.
The tests were conducted in the transverse direction of the bridge. Would pocket connections perform safe in the longitudinal direction of the bridge?	In the transverse direction of bridges with box girders, the girders add to the confinement of the pocket connection and improve the resistance of the cap beam.
Have key joints been designed as part of the pin design element?	The rebar-pins are similar in details with column keys, we use the different terminology of rebar-pins.

Featured Presentation #2 by Sebastian Varela, Ph.D.: Design for Disassembly: Towards the Resilient and Sustainable ABC of the Future	
Any case examples constructed ?	This study was of an exploratory nature and there is still substantial work to be done before the new DfD system can be implemented in the field. However, ECC and SMA (Nickel-Titanium) are being incorporated in a new cast-in-place bridge being built in downtown Seattle by the Washington State DOT through a grant from FHWA. This project will be key to showcase the advantages of using novel materials.
How does the cost of these novel materials compare to conventional concrete and steel rebar?	Advanced materials are more expensive than concrete and steel rebar at the moment. However, any meaningful cost-benefit evaluation needs to also account for the improved performance and potentially better durability that novel materials would provide, and since the cost of the substructure is only a fraction of the cost of an entire bridge, the cost increase is expected to be 20% at most. Furthermore, CAM SMA is substantially less expensive than Nickel-Titanium SMA, which can be fundamental to reduce costs. Lastly, as the production and use of novel materials becomes widespread in the future, the cost is expected to decrease. A good example are fiber-reinforced-polymers (FRPs), which were developed for aerospace applications and were very expensive to use in bridges several years ago. Now they are widely produced and used for the retrofit and construction of existing and new structures, respectively.
How is the durability of these novel materials?	Unlike steel rebar, SMA is not suceptible to corrosion, which would make it more durable. The durability of ECC over time is yet to be assesed but observations from minor existing applications such as sidewalks and deck overlays show that ECC is highly durable. The bridge being built in Seattle, Washington will be a unique opportunity to assess the durability of ECC and Nickel-Titanium SMA as part of an actual structure.
The test video for the bridge shows the substructure is relatively flexible, what would be the performance of this system under service loads such as wind, vehicle braking, and temperature changes?	The new DfD system takes advantage of increased flexibility to reduce seismic forces and dissipate energy with minimal damage. The bridge model in the video had pipe-pins at the top of the columns, which were used to allow the bridge to experience higher drifts and also because incorporating plastic hinge elements at the top of the columns was not feasible due to funding. In an actual bridge, the substructure would be engineered to provide rigidity under service loads and control the displacements under extreme loads. In addition, plastic hinges would typically be utilized at the top and bottom of the columns, which would lead to a stiffer fixed-fixed confirguration compared to the fixed-pinned configuration in the bridge model.

How does the new DfD system compare to existing protective systems such as isolation and rocking?	Similarly to exisiting protective systems, the new DfD system takes advantage of increased flexibility to reduce seismic forces and dissipate energy with minimal damage. However, lower spectral accelerations typically lead to higher spectral displacements, and therefore it is necessary to provide enough damping to control the displacements of a bridge during a strong earthquake. One of the unique aspects of the new DfD system is that the components can be disassembled and reassembled, and although this could be done in other protective systems, it is most likely not to be technically feasible since those systems are not designed for disassembly.
What kind of work is needed before this system can be implemented in the field?	Further large-scale testing suplemented by computational studies is needed along with the development of practical design guidelines. This study demonstrated the potential of the new DfD system, but further investigation is needed to establish a better understanding of the behavior under other loading conditions and the implications of refinements that could be made to the system.
Using this plastic pin method why are we not using steel columns?	The study was developed as an ABC alternative primarily for reinforced concrete bridges, thus steel elements were not within the scope of the investigation.
Using the plastic hindges I would think recessing the uint into the bent/cap would allow for failure if it were to happen seating the base of the column.	The plastic hinges were attached at the base of the column and were not meant to be recessed into neither the bent cap nor the footing.
How did you come out with the high of the plastic hinge?	The height of the plastic hinge was selected to provide enough rotational capacity to allow the columns to experience a maximum drift of 5% with minimal damage, permanent drift, and loss of capacity. This drift ratio was arbitrary, but was deemed to be reasonable based on previous studies. Further information about the design criteria can be found in the journal publications listed in the project website: http://wolfweb.unr.edu/homepage/saiidi/NSF-PFI/index.html