ADVANCED PRECAST CONCRETE DUAL-SHELL STEEL COLUMNS

PEER Transportation Systems Research Program

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Introduction

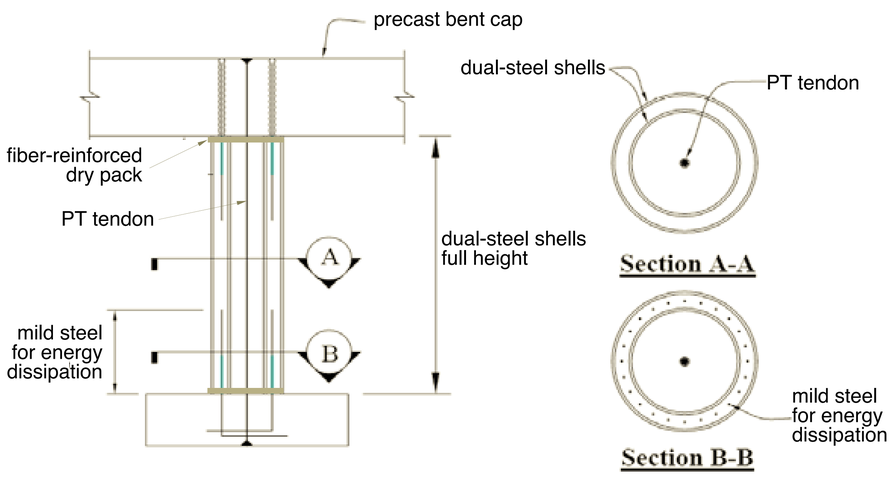
While the notion of structural damage is accepted in design, resilient communities expect bridges to survive a moderately strong earthquake with no disturbance to traffic. This implies that partial or total bridge closures are tolerated with uneasiness, particularly by communities in heavily congested urban areas of the state. This has prompted the need to research into advanced technologies that: (i) Reduce cumulative damage to the main structural elements; (ii) Encompass self-centering properties allowing the structural system to return to its original position after an earthquake; and (iii) Are economically viable when compared to existing technologies.

Caltrans, through a FHWA initiative[1], is moving forward towards developing accelerated bridge construction (ABC) technologies. This is prompted by the advent of a large number of new or replacement bridges in the state. Most of these bridges will be built in heavily congested urban, and/or environmentally sensitive areas. The ABC initiative is chiefly aimed at (i) Reducing of on-site construction time; (ii) Minimizing traffic impacts, including traffic accidents; (iii) Improving work zone safety; (iv) Decreasing environmental disruption, (v) Enhancing constructability; (vi) Increasing quality; and (vii) Lowering life-cycle costs.

This research project is developed in response to current issues, needs and initiatives. The main trust in this project is to develop a self-centering A*dvanced Precast Concrete Dual-Shell Steel Column,* whose joints open and close during strong seismic demands with little, if any, noticeable damage. The goal of this technology is to reduce the weight of the column, to eliminate the use of a reinforcing cage, to maximize constructability, and to minimize structural damage.

The columns in this project are an extension of the steel jacket concept used by Caltrans for retrofitting deficient columns, of Caltrans funded research work on Cast-In-Steel-Shell piles[2], the development of precast post-tensioned rocking systems that stemmed from the PCI funded PRESSS research program[3], and research work on self-centering precast walls performed in New Zealand[4].

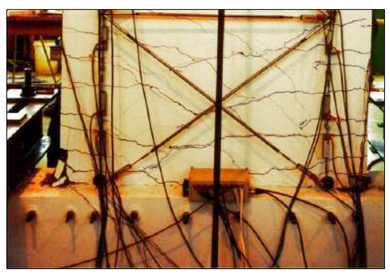
Dual-Shell Precast Technology

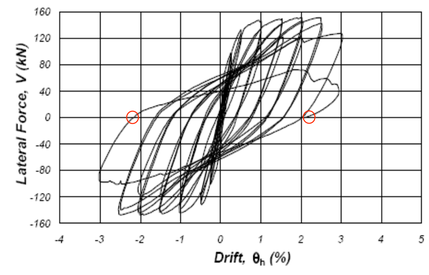


Advantages
- Precast construction with permanent formworks (shells)
- Reduced column weight (hollow section)
- No reinforcing cage needed
- Reduced construction time

Self-Centering Rocking Systems

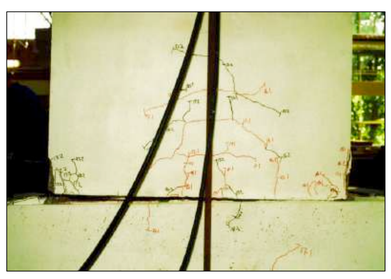
Monolithic system

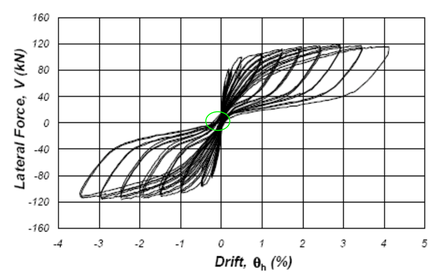




(shear-wall test results by Restrepo, Mander, Holden)

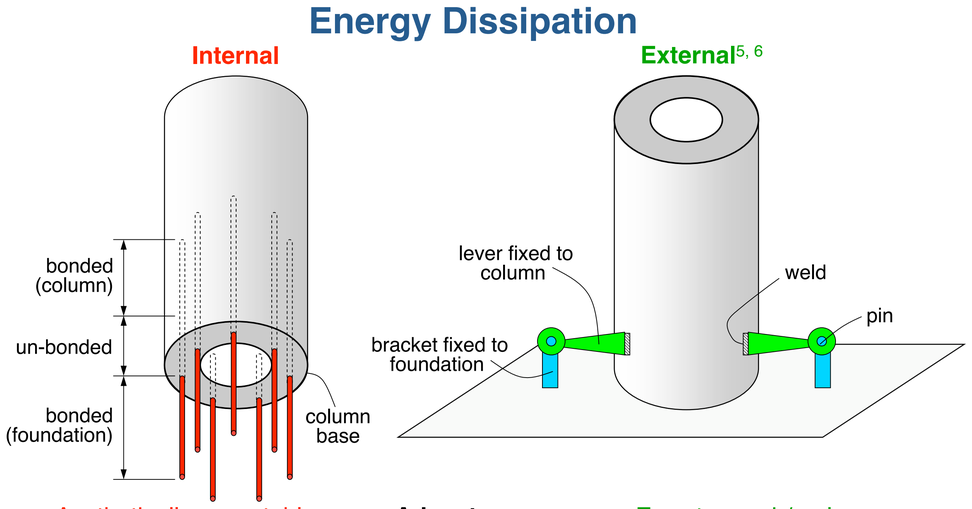
Self-centering system





Advantages
- Limited structural damage
- Small residual displacements
- Energy dissipation by specific devices
- Operability right after strong shakes

Energy Dissipation



Aesthetically acceptable	**Advantages**	Easy to repair/replace
Hard to repair/replace	**Drawbacks**	Aesthetic mitigation required

Project Tasks

Project starting this quarter (Fall 2009)

1. Prototype bridge
- 2-span ordinary skew bridge
- Modified DBD by Panagiotou & Restrepo[7], T_R = 475 years

2. Analytical modeling
- TH analyses (OpenSees) with 7 scaled records
- Selection of bi-directional test protocol
- FE analyses (Abaqus) of external energy dissipators

3. Experimental tests
- Design of two units: inetrnal vs. external energy dissipators
- Hysteretic characterization of external energy dissipators
- Construction and test of the two units

4. Final report

References

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7. Panagiotou, M. and Restrepo, J.I. “A Displacement-Based Method of Analysis: Application to the 7-Story Full Scale Building Slice Tested at UC San Diego”, Submitted for Review, ASCE J. of Structural Engineering, 2009.

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