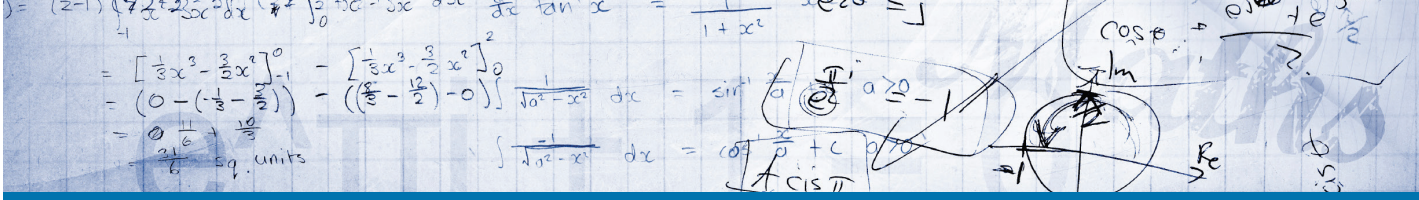

Discussion

Novel Use of Buckling-Restrained Braces in Precast Concrete Frames

"Novel Use of Buckling-Restrained Braces in Precast Concrete Frames" by Jeffrey D. Viano and Thomas C. Schaeffer published in the September–October 2017 issue of *PCI Journal*[1] needs to be commended for sharing the experience of using braced frames in precast concrete structures.

Extrapolating code provisions to areas that are not covered should be carefully substantiated to allow a reader to understand the logic behind engineering judgment calls. Although the phrase "sound engineering principles" is repeated three times in the paper, the information on ductility requirements, which is of most interest to a journal reader, is missing. Vague phrases such as "may remain elastic in a seismic event" mean something when discussing performance-based design, time histories, and the like but mean nothing in the context of equivalent lateral force procedure. Perhaps the authors meant the design for seismic load effects including an overstrength factor, but what would that factor be: 2½, 5, or 8? The use of the first one is required by ANSI/AISC 341-10,[2] so it cannot be "in addition." If it's a greater one, why would such high strength be required while ductility requirements are not even mentioned? Another confusing aspect is the use of the term *overstrength*. The adjustment factors for strain and strength are indeed material overstrength factors. However, ANSI/AISC 341-10 deliberately steers away from its use applied to material properties so as not to be confused with the system overstrength factor Ω_0.

The beam-to-column connection shown on the figures indicates a choice of simple connection per F4.6b(a) of ANSI/AISC 341-10, which is common for steel. However, this choice appears contrary to the requirements of F4.5a and D1.1a. The latter references section 21.6 of ACI 318[3] for detailing requirements of the concrete sections, which in the case of precast concrete components would mean section 21.8. It implies the use of moment connections at beam–column joints. Regardless of the connection type, what detailing was required for the braced frame precast concrete components for this project? For a seismic-force-resisting system that uses the greatest response modification coefficient (R factor) afforded by the building code, ductility is paramount. The only concrete seismic-force-resisting system with the same R factor is the special reinforced concrete moment frame, and the reason for that is the requirements of section 21.8.

Another interesting aspect that is not mentioned in the paper is the selection of a design approach for members not designated as part of the seismic-force-resisting system. Were those members subjected to design displacement, or were they detailed using the prescriptive requirements of section 21.13.4 of ACI 318?

ACI 318 is conspicuously absent from the list of references at the end of the paper. Hopefully, this is not an indication that the requirements of chapter 21 were not considered for the braced frames.

Again, kudos for publishing a paper that covers the topic of braced frames in precast concrete structures. Kudos to the authors for specifying the system. If we all learn and agree on how to do it as an industry, a broader acceptance, future applications, and eventually a formal codification might follow.

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References

1. Viano, Jeffrey D., and Thomas C. Schaeffer. "Novel Use of Buckling-Restrained Braces in Precast Concrete Frames." *PCI Journal* 62 (5): 28–34.
2. AISC (American Institute of Steel Construction). 2010. *Seismic Provisions for Structural Steel Buildings*. ANSI (American National Standards Institute)/AISC 341-10. Chicago, IL: AISC.
3. ACI (American Concrete Institute). 2011. *Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary (ACI 318R-11)*. Farmington Hills, MI: ACI.

I want to commend the authors on their paper "Novel Use of Buckling-Restrained Braces in Precast Concrete Frames"[1] and for sharing the possibility of using this system with precast concrete construction. The only cited basis for having this system comply with the requirements of ASCE 7-10[2] was the statement "designed using sound engineering principles." Although it certainly appears that the use of the system could readily be defended based on this, this does not, in itself, satisfy the code requirements for use of systems not explicitly listed in Table 12.2-1 of ASCE 7-10. Similarly, there is a statement that "the engineer of record stipulated specific detailing requirements for the precast concrete members." Can the basis of these engineer of record–specified requirements for the precast concrete members be shared as they become a critical part of using this system?

Without more elaboration regarding how code compliance was achieved and a basis for the added precast concrete detailing requirements, we are all missing out on a great opportunity to use this system on future projects.

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1. Viano, Jeffrey D., and Thomas C. Schaeffer. "Novel Use of Buckling-Restrained Braces in Precast Concrete Frames." *PCI Journal* 62 (5): 28–34.
2. ASCE (American Society of Civil Engineers). 2010. *Minimum Design Loads for Buildings and Other Structures*. ASCE/SEI (Structural Engineering Institute) 7/10. Reston, VA: ASCE.

Authors' response

The authors want to thank Alex Mihaylov and Timothy Salmons for their comments on "Novel Use of Buckling-Restrained Braces in Precast Concrete Frames."[1] Our objective in writing this paper was not necessarily to discuss every design decision and every assumption made but to introduce buckling-restrained braces to the readers of *PCI Journal* and to illustrate some of the challenges in the design and construction of a precast concrete structure with buckling-restrained braces. Based on some of the questions in these letters, the authors would like to make the following comments:

- The phrase "remain elastic in a seismic event" used in the second paragraph of the paper refers to the requirement that the precast concrete beams and columns comply with the detailing requirements of ACI 318 chapter 21.[2]
- The system overstrength factor Ω_0 used in the design of this building was 2.5 in accordance with ASCE 7-10.[3]
- The authors used the phrase "overstrength factor" several times in reference to the buckling-restrained braces and their connections. When this phrase was used, it referred to the adjustment factors R_y, β, and ω as defined by ANSI/AISC 341-10.[4] The phrase does

not refer to Ω_0. The authors understand how this may be confusing, and "adjustment factor" might have been a better phrase.
- Although ACI 318 was used in the design of the precast concrete elements, it is not specifically listed as a reference because this code is not directly cited in the text.

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1. Viano, Jeffrey D., and Thomas C. Schaeffer. "Novel Use of Buckling-Restrained Braces in Precast Concrete Frames." *PCI Journal* 62 (5): 28–34.
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3. ASCE (American Society of Civil Engineers). 2010. *Minimum Design Loads for Buildings and Other Structures*. ASCE/SEI (Structural Engineering Institute) 7/10. Reston, VA: ASCE.
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