Meeting 4 of the BSSC PUC Issue Team on Shear Walls
Web Meeting

June 29, 2017: 9a – 10.30a Pacific

Meeting Notes

1. Call to order
Ghosh called the meeting to order at 9:05 AM

2. Roll Call
Richard Bennett, David Bonneville, Michel Bruneau, Kelly Cobeen, Joe Ferzli, David Fields, S.K. Ghosh, Dawn Lehman, Laura Lowes, Bonnie Manley, Rafael Sabelli, Andy Taylor, John Wallace, Tom Xia, Jiqiu Yuan

3. Opening remarks
Ghosh reported that some progress has been made on the P-695 study proposal. He is looking forward to that study, as it is very important to the work of IT4.

4. Notes on meeting of May 12, 2017
There were no comments on the previous notes.

5. An update on a P-695 study to justify a proper $R$-value for a coupled wall system
Ghosh sent an e-mail to Ron Klemencic and Mark Perniconi to ask about the P-695 study. Mark said the study will be supported by the Pankow Foundation. There is also the possibility of additional funding from the ACI Foundation. Cobeen commented that the P695 study would benefit from this group, both on the concrete aspects of the proposal, and on the P-695 aspects. Ghosh read a note from Wallace, stating that the work has been funded by the Pankow foundation, and that Wallace needs to form an advisory group. Wallace would like to form the advisory group soon and have an informal introductory meeting in late July, and the first formal meeting around September 1.

Wallace called in and asked if there were any further questions. Lowes asked if she could offer some input on analysis when the advisory group first convenes. Wallace said that her input will be welcome at the first informal meeting of the advisory group.

6. Update on coupled reinforced concrete shear walls – Fields/Taylor
Ghosh asked Taylor to report. Taylor said Sub-H has not re-balloted this item. Fields said that he has written responses to Sub-H ballot, but what remains to do is summarize the study methods and results. Fields said this would take about two more weeks.

Ghosh noted that yesterday Ferzli sent a summary of research that he has performed. Ferzli is proposing a lower-bound height to length ratio of coupling beams in the range of 2.5 to 3.0, rather than 3.0. Ghosh asked Ferzli to comment further. Ferzli said that in his e-mail yesterday he had three main sections:

a) Regarding the 3.0 span/depth ratio definition of a ductile coupled wall, Ferzli cataloged available coupling beams and found that in his experience the most common range is about 2.5 to 3.0. He is concerned that 3.0 may be too high from a practical point of view.

b) He looked at coupled wall systems with $R = 8$ on the west coast. He found that quite a few buildings are below 200 feet. Our studies of ductile shear walls should not neglect shear walls in buildings less than 200 feet tall. Fields commented that his study has included buildings less than 200 feet tall.

c) How will practicing engineers take advantage of an $R = 8$ if not all sides of the shear wall core have coupled walls?

Ghosh said that the materials provided by Ferzli will be useful to Fields in preparing responses to questions from Sub-H. Ferzli said that his biggest concern is that we propose changes that can be implemented by practicing engineers. Fields commented that the current thinking of Sub-H seems to be that a threshold value less than 3 should be adopted, and that there should be an upper bound to this value, say 5 or 6.

7. **Classification of reinforced concrete shear walls**

Ghosh said we have not made progress on this item since the last call. He read the notes on this topic from the last conference call. He said that it is a priority to work on this issue before our next face-to-face meeting.

8. **Identification of problems in the shear design of shear walls**

   **ACI 318H Proposal CH19-009, an update – Wallace**

   There was no report on this item.

   **Shear strength of concrete under high compression and high rate of loading – Kurama**

   Kurama investigated this topic and sent Ghosh a number of papers about it. Ghosh said that Kurama should continue to work on this and report at our next meeting.
Shear migration to compression pier and shear-compression interaction in a coupled shear wall system – Lehman/Lowes.

There was some correspondence between Ghosh and Lehman on this topic. Lowes commented that the discussion is centered on the formation of a compression strut and high shear in the compression pier. The majority of the base shear is resisted by the compression pier. At the toe of the compression pier, the compression strut stresses are combined with flexural compression stresses. In addition, there is a tendency for a shear failure at the interface between the wall web and the confined boundary element. Lowes said that she or Lehman could make a presentation about this at the next meeting. Ghosh agreed this would be a good idea.

Lehman joined the meeting. One aspect that has not been explored is coupled, flanged walls.

Ghosh urged Lehman and Lowes to write down their thoughts for the benefit of the committee

9. Masonry shear walls recap - Bennett

Ghosh reported Bennett has drafted two papers: one on coupled masonry shear walls, and the other on partially grouted shear walls. Bennett briefly reviewed these draft papers.

There is some evidence that the slab creates limited coupling. Engineers typically do not account for this coupling. The added coupling could result in unintended brittle failure of walls. It’s very difficult to design a truly coupled shear wall using only masonry elements. Ghosh asked about the coupling effects of a typical lintel beam. Bennett said that some coupling may occur, but it is difficult to intentionally design lintel beams as coupling beams.

Regarding partially grouted shear walls, Bennett said that there has been some suspicion that the current equations in the masonry code over-predict the capacity of partially grouted shear walls. Bennett feels that only minor modifications are required to adjust the code equations. Another question with partially grouted shear walls is what level of ductility do they provide? He said there has been some research and testing in this area, which points to improved methods for detailing partially grouted shear walls for ductility. The suggestions included providing two grouted shells at each end of the wall, and recognizing the beneficial effects of joint reinforcement. However, the research was based on joint reinforcement in every course, whereas common practice is to provide joint reinforcement at every other course. Contractors prefer joint reinforcement over bond beams.
Cobeen commented that Ed Huston frequently comments on these topics. Possibly Ed should review these papers. Bennett said that he has already been in touch with Huston regarding the partially grouted shear walls white paper.

10. Steel shear walls recap, including an update on the following write-ups by Jeff Berman/Larry Fahnestock

Bruneau reported that there is a proposal to the Pankow Foundation. This proposal has two parts: steel plate shear walls with steel coupling beams; the other is on composite coupled shear walls (steel plates with concrete in between). It looks like both may be funded.

Ghosh asked if this research would be done in time to coordinate with IT4. Bonneville commented that the cycle is arranged so the document is published in 2020. Proposals really ought to be completed near the end of 2018, or very early in 2019. Bruneau said that his project is supposed to be a one-year project, so he may have results in time for this IT.

   a. A resource document that would be a basic comparison of concrete and steel plate shear walls.
      Lehman and Berman are working on this.
   b. A resource document that would be a basic comparison of coupled systems of concrete and steel.
      Lehman said that progress has not been made on this, pending review of the first document.

11. Wood shear walls recap by Kelly Cobeen/Phil Line

Line has sent Ghosh a proposed outline. Analysis and design of wood shear walls is quite different from concrete and masonry shear walls. Cobeen reported on progress. She asked about what the white papers will be used for, so she will have an idea of the context. Ghosh said that we will likely end up with research papers on certain topics, like the classification of shear walls. As introduction to this paper, there needs to be a basic introduction to the behavior and analysis of wood, masonry, steel, and concrete shear walls.

Cobeen noted that in past NEHRP provisions there have been extensive commentaries on the behavior of wood lateral force resisting systems. She will consult with Ghosh about the best focus for the wood shear walls write up. Ghosh agreed that there are already extensive resources on all types of shear walls. What is needed is description of shear walls of all four material types in one place, which compares the load transfer mechanisms of walls made of the four materials. Cobeen wondered how detailed this introduction should be. Ghosh and Cobeen will talk before the next meeting about the level of detail of the discussion.

12. Other business
There was no other business.

14. Next meeting – August 15 (8.30a – 6p) -16 (8a – 12.30p), 2017 (face-to-face, KPFF, Seattle)

15. Adjourn

Ghosh adjourned the meeting at 10:25 AM