

ACI-ASCE Committee 445—*Shear and Torsion*
Spring 2010 Meeting Minutes
2:00 p.m.–6:00 p.m., Monday, March 22, 2010
Sheraton Chicago, Chicago, Illinois—Parlor C Room

1. Welcome of visitors and Introductions (Kuchma)—Agenda attached

Voting members present: Dan Kuchma (Chair), Robert Barnes (Secretary), Perry Adebar, Bob Anderson, Mark Aschheim, Oguzhan Bayrak, Zdenek Bažant, Evan Bentz, Hakim Bouadi, Walter Dilger, Robert Frosch, Gary Greene, Neil Hawkins, Gary Klein, Adolfo Matamoros, Y.L. Mo, Carlos Ospina, Karl-Heinz Reineck, David Sanders, James Wight

Voting members not present: N. Anderson, Bonacci, Belarbi, Brown, Collins, Darwin, Eberhard, French, Hsu, Ma, Mitchell, Novak, Pantazopoulou, Polak, Ramirez, Valluvan

Associate members present: Scott Alexander, Neil Hammill, Matthew Huizenga, Paul Kourajian, Ralph Oesterle, Carin Roberts-Wollmann, Tom Schaeffer, Lesley Sneed, Asif Wahidi, Widiyanto, Alan Wiley

Visitors: Matthias Andermatt (U of Alberta), Min-Yuan Cheng, Xiaohu Fan (U. of Michigan), Amgad Hussein, Boyan Mihaylov (U. of Toronto), Menthian Sethit (U. of Michigan), Jason Varney (U. of Texas), Mike Wesson (Purdue U.)

2. General Announcements (Kuchma)

Chairman Kuchma called the meeting to order. Attendees introduced themselves.

3. Approval of Minutes of Fall 2009 ACI-ASCE 445 Meeting held in New Orleans (Kuchma)

The minutes for the previous meeting were approved (Bayrak, Klein).

4. Review of Agenda (Kuchma)

Kuchma reviewed the planned order of agenda items. The agenda is attached to these minutes.

Bažant stated that ACI 446 submitted a report to ACI 318 on revision of Chapter 11. He further stated that ACI 318 submitted this report to ACI 445 for review three years ago. Kuchma stated that he was unaware of this report, but ACI 445 would be pleased to review it, particularly in light of the potential reorganization of ACI 318.

Carlos Ospina noted the passing of Sven Kinnunen of KTH, Stockholm, Sweden, who performed valuable research in the area of punching shear.

5. ACI 318-E Actions (Wood)

No report from ACI 318-E at this meeting.

6. Subcommittee Reports

a) 445-A Strut and Tie (Reineck)

The ACI 445-A subcommittee meeting was well attended. The subcommittee focused on the presentation and discussion of final drafts of design examples. Many of the examples will be presented in two technical sessions on Tuesday. Reineck invited all to attend the sessions.

Publication of the anticipated SP has been delayed. The subcommittee aims to finish as soon as possible before the next convention. Most of the review comments were accepted by the authors, only a few responses required further discussion with the reviewers. A few examples remain to be reviewed. Reineck thanked all the example reviewers.

The subcommittee may move on to produce a document describing the application of STM because much of the instructional material may soon be removed from ACI 318R commentary.

Kuchma thanked the subcommittee for its efforts devoted to the sessions and SP.

b) 445-B Seismic Shear (Kuchma)

ACI 445-B held a short subcommittee meeting on Sunday. Their short-term activity will focus on the production of a technical note on shear strength and deformation capacity of columns. This could include evaluations of ACI provisions for strength using the database of experimental results, a brief presentation of models for behavior, and evaluation of deformation capacity of columns in the database.

Potential long-term activities include continued mining of column test data and establishment of a wall database, for which there is significant need.

There were no further suggestions when Kuchma invited input on other topics for subcommittee work.

c) 445-C Slab Shear (Ospina)

The ACI 445-C subcommittee meeting was held on Sunday.

There are 528 test results in the punching shear databank thus far. Reineck provided feedback regarding databank format (to maximize consistency with the beam shear databank) and making the “collected” databank available only to qualified researchers. The subcommittee plans to develop a “selected” databank for general distribution after implementation of databank acceptance criteria (DAC).

Julio Ramirez is leading group (ACI 318-E TG-1) to evaluate punching shear issues that need to be considered by ACI 318-E for the code reorganization effort. The current code equation has been criticized for not explicitly addressing slab flexural reinforcement ratio and size effects. Ospina presented some figures indicating the effect of slab reinforcement ratio (ρ) on punching shear capacity. Slabs with ρ less than 0.8% indicate a shortcoming relative to the current code equation. Wight and Ospina discussed differentiating flexural failures from shear failures; currently a 1.15 value of the V_{test} to V_{flex} ratio is used to differentiate within the databank. There was further discussion of the complexities associated with this determination, as well as the identification of bond failures.

Ospina reviewed the history of ACI 318 punching shear equation (evolution of the work of J. Moe [1961]) and showed how the resulting equation is unconservative for $\rho < 0.8\%$. Therefore, the subcommittee is thinking of using a transition from 2 to 3.5 for the coefficient in the equation (instead of the current value of 4). In addition, there is a discrepancy between the current equation and test results with effective depth (d) greater 200 mm (8 in.). The subcommittee proposes that any code changes account for ρ effect and size effect.

The committee engaged in a general discussion of the code-change process and implications for slab and footing design. Kuchma thanked Ospina for the report and the opportunity for committee input.

d) 445-D Beam Database (Reineck)

The ACI 445-D subcommittee met Monday. The main item of discussion was the database for tests of RC beams without stirrups subjected to concentrated loads. The target date for distribution to the committee is June 2010. Work will continue on the other databases, including prestressed concrete (PC) without shear reinforcement, RC members subjected to distributed loads, as well as RC and PC members with stirrups.

A report on “Extended databases with shear tests on structural concrete beams without and with stirrups for the assessment of shear design procedures” was published in March 2010. A copy can be obtained from Kuchma for \$50 (translation and reproduction costs). The evaluation database is available (print and spreadsheet). The collected database is only available to researchers, who should report back any changes to ACI 445 (so that a single, uniform database can be maintained).

- e) **445-E Torsion** (Belarbi)
Belarbi reported that the committee-approved report on torsion is going through some minor revisions prior to publication. This work should be complete before Fall 2010 meeting. Future activities will focus on development of guidance for application of torsion design principles.
- f) **Ad hoc committee on prestressed concrete shear issues** (Matamoros)
Matamoros reported that the a code-change proposal was presented earlier in the day to ACI 423 (Prestressed Concrete). Precasters will require a very clear explanation of the consequences of proposal. The goal is to prepare a document that presents the proposed code changes with an explanation. This document will be circulated to ACI 445 and ACI 423.

7. Strut and Tie Design Provisions and Guidance

- a) **Incorporation of STM Provisions within the Main Body of ACI 318** (Wight)
During the previous ACI 318-E meeting, Klein made a strong case for different outlines of the main code that would include STM in main body. Wight's understanding is that code reorganization is now proceeding with the assumption that STM will be in the main body of ACI 318. Bažant asked if this was "regardless of concerns about size effect" with STM. Wight replied affirmatively. Klein and Kuchma pointed out that only reorganization (not technical changes) are being considered at this time.

Bažant expressed concern about size effect in struts in large members. A brief discussion of size effect in STM ensued. There is disagreement about whether size effect is justified in STM. Kuchma stated that ACI 445-A will entertain any related proposal as new business.

- b) **445 Committee Report on "Application of the Strut-and-Tie Method for the Design of Discontinuity Regions"** (Kuchma)

ACI 318-E has requested that ACI 445 develop a document on "Application of the Strut-and-Tie Method". Kuchma listed several potential areas for guidance with STM:

- Selection of model shape
- Selection of relative member stiffness (in statically indeterminate models)
- Design for multiple load cases/reversals
- Determination of nodal zone geometry
- Determination of necessary design checks
- Serviceability, minimum reinforcement limits
- Validation of ACI code-calculated capacity
- Other design requirements

Kuchma plans to produce a detailed outline of a committee report on this topic for committee review and feedback. The goal is to have this document ready by publication of ACI 318-14.

Sanders asked whether ACI 445-A will be responsible for development of the document. Kuchma responded that this would be a good task for 445-A. There was general agreement from the committee that this would be a valuable and timely effort.

8. ACI 445 Technical Committee Input into Shear Provisions of ACI 318-14

Kuchma presented the proposed timeline for adoption of ACI 318-14. Sharon Wood (318-E) would like to receive change proposals as soon as possible. ACI 318-E would need to process these proposals by the Spring 2011 meeting (Tampa).

A one-way shear task group (Sanders) is tasked with proposing changes to the current material in the first four sections of ACI-318 Chapter 11. Essential elements of the process have been identified:

- Common database of test results for evaluation of proposals
- Proposer must evaluate required amounts of shear reinforcement for “design case scenarios” that will be provided.
- Proposer must clearly indicate the range of application of proposed relationships (“design process flowchart” suggested)
- Proposals will be reviewed by the task group, and feedback will be provided to the proposers.

Kuchma introduced an outline of a proposed ACI 445 report. “Review of the ACI 318-08 Shear Provisions and Suggested Changes” to aid in the development of change proposals. The goal would be to create this document by Pittsburgh.

Wight noted that this is a noble, but ambitious effort. He suggested that the focus be placed on identifying the shortcomings of the current codes and the best route that 318-E should take—this is most important. The other information could follow.

Kuchma noted that a number of people volunteered to serve on this effort at the last ACI 445 meeting.

9. Technical Sessions

The technical sessions honoring Tom Hsu in New Orleans were very well attended.

Ospina proposed that the committee sponsor a session related to punching shear. Kuchma agreed that this would be a good time to review the outcome of the subcommittee work and ACI 318-E task group work.

Future sessions include

ACI Spring Convention, March 21–25, 2010 (Chicago)

Design using the Strut and Tie Method: Examples and Approaches (two sessions)

ACI Fall Convention, October 16–20, 2011 (Cincinnati))

Symposium Honoring James Jirsa's Legacy in Structural Concrete: A Time to Reflect: Shear Issues

Proposals for technical sessions at future ACI conventions are welcome. Future convention dates/locations:

Spring 2012 (Dallas), March 18–22

Fall 2012 (Toronto), October 21–25

Spring 2013 (Minneapolis), April 14–17

Fall 2013 (Phoenix), October 20–24

Spring 2014 (Reno), March 23–27

10. Technical Presentations

Jason Varney, University of Texas at Austin, “Tests on Beams with Improperly Anchored Stirrups”

Carlos Ospina, “Post-Earthquake Inspection of Port Facilities in Chile after Feb. 27, 2010 Earthquake”

11. Adjournment

Meeting adjourned at 4:48 p.m.

Minutes submitted by Robert Barnes on October 17, 2010.

AGENDA – SPRING 2010 MEETING
Joint ASCE/ACI 445 – SHEAR AND TORSION
CHICAGO, ILLINOIS
March 21-25, 2009

Meetings

445 Shear & Torsion Mon 2p-6p – PARLOR C
445-A Shear & Torsion-Strut & Tie Sun 10:30a-1:30p MISSISSIPPI
445-B Shear & Torsion-Seismic Shear 8a-9a PARLOR G (Shortened)
445-C Shear & Torsion-Punching Shear Sun 1p-3p PARLOR G
445-D Shear and Torsion-Database Mon 10a-12p PARLOR B
~~445-E Shear & Torsion-Torsion Sun 12:30p-2p PARLOR F (Cancelled)~~
~~423-445 Adhoc Grp on Shear in Prestress Conc Sun 3p-5p PARLOR G (Cancelled)~~
318-E Shear & Torsion Wed 8:00a-1:30p MISSISSIPPI
318-G Prestressed Precast Wed 8:00a-1:30p ERIE

1. Introductions (Kuchma)

2. Approval of the Minutes – Fall 2009 ASCE/ACI 445 Meeting held in New Orleans
(Posted on 445 Website) (Kuchma)

3. ACI 318-E Actions (Wood / Kuchma)

Change Proposals – Current
Change Proposals – Future
Code Reorganization

4. Subcommittee reports

445-A Strut and Tie (Reineck)
445-B Seismic Shear (Kuchma)
445-C Slab Shear (Ospina)
445-D Beam Database (Reineck)
445-E Torsion (Belarbi/Kuchma)
Ad hoc committee on prestressed concrete shear issues (Matamoros)

5. Strut-and-Tie Design Provisions and Guidance

Incorporation of STM Provisions within Main Body of 318-14
445 Committee Report on Application of the STM for the Design of Discontinuity
Regions (Kuchma)

6. 445 Technical Committee Input into Shear Provisions of ACI 318-14

Discussions of One-Way Shear Task Group (Sanders/Kuchma)
Future Activities

7. Technical Sessions

Past ACI Fall 2009 New Orleans

Thomas T.C. Hsu Symposium, Part 1: Recent Advances in Seismic Shear of
Wall-Type Structures, Monday 9a-12p SALON B
Thomas T.C. Hsu Symposium, Part 3: Five Decades of Progress in Shear and
Torsion, Tuesday 9a-12p SALON B

ACI Spring 2010 Chicago

Design Using the Strut and Tie Method: Examples and Approaches, Part 1

Tuesday, March 23, 9:00 AM - 12:00 PM, SHERATON 2

Moderators: Karl-Heinz Reineck & Lawrence C. Novak

1. The STM Design Process and ACI Requirements, Daniel Kuchma, University of Illinois at Urbana-Champaign
2. Bridge Pier - Hammerhead Bent Cap, Robin Tuchscherer, Datum
3. Design of Deep Pile Caps with Tension Piles, Widiyanto, ExxonMobil Development Company
4. Foundation Grade Beam, Leonard De Rooy, Calvin College
5. Stepped Beam, Matthias Andermatt, University of Alberta
6. Dapped-end Double T-beam with Curved Bar Nodes, Gary Klein, Wiss Janney Elstner Associates
7. Evaluation of Prestressed Dapped Girder Ends With Cazaly Hangers, Katrin Habel, AECOM
8. Guideline Documents for Using Strut-and-Tie Models, Karl-Heinz Reineck, University of Stuttgart

Design Using the Strut and Tie Method: Examples and Approaches, Part 2

Tuesday, March 23, 2:00 PM - 5:00 PM, SHERATON 2

Moderators: Lawrence C. Novak & Karl-Heinz Reineck

1. Propped Cantilever with Opening, Daniel Kuchma, University of Illinois at Urbana-Champaign
2. Design of a Link Beam at a Roof of a Medium-Rise Building, Hakim Bouadi, Walter P Moore & Assoc
3. Diaphragm for a Segmental Concrete Bridge, Richard Beaupre, URS Corporation
4. Diaphragm for Extradosed Cable Stayed Bridge, Trevor Kirkpatrick, URS Corporation
5. Importance of Reinforcement Detailing, Denis Mitchell, McGill University
6. Strut-and-Tie Models for Beams Versus Shear Design?, Karl-Heinz Reineck, University of Stuttgart
7. Future of ACI STM Provisions and Guidelines, Daniel Kuchma, University of Illinois at Urbana-Champaign

Future Sessions

Future Conferences: Fall 2010 (Pittsburgh), Spring 2011 (Tampa), Fall 2011 (Cincinnati), Spring 2012 (Dallas)

8. Other Business

Technical Presentations (10 Minutes Each) - Please let me know if you are interested in presenting prior to the start of the 445 meeting

Jason Varney "Tests on Beams with Improperly Anchored Stirrups", University of Texas at Austin

Minutes of the meeting in Chicago, II of ACI 445-A: Strut-and-tie models

Sunday 21 March 2010, 10.30 - 13.30 h

Attendants: 13 members; 9 guests

Members: Karl -H. Reineck (Ch.), Bob Anderson, Robbie Barnes, Ozzy Bayrak, Attila Beres, Hakim Bouadi, Karin Hebel, Matthew Huizina, Adam Lubell, Gary Klein, Dan Kuchma, Denis Mitchell, Larry Novak

Visitors: Matthias Andermatt, Leonard, De Rooy, Dick Furlong, Gamel Ghoneim, Bassile Rabbat, Brandon Ross, Boyamm Mahaylou, Malte von Ramin, Widiyanto

Agenda:

1 Approval of agenda

The approval was given after welcomes and introductions.

2 Approval of minutes of the meeting in New Orleans

The approval was given by Kuchma and seconded by Bayrak

3 Further examples for the use of strut-and-tie models – Status report of SP

Reineck gave summary of progress of the special publication. Due to various factors, there had been a slip in the schedule and the SP was now targeted to be submitted to ACI in mid-summer 2010. There still could be reviews and edits to several of the papers.

Anderson and Bayrak volunteered to help speed the process. Reineck recommended Novak also to help.

There were sub-committee members that were disheartened to hear of the delay and expressed concerns and some frustrations were voiced.

4 Presentation of final drafts for the examples

The following final draft examples were presented during the sub-committee meeting and general discussion regarding each was undertaken by the attendees.

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|--------------------------------------------------------------------|--------------------|
| - Design of Deep Pile Cap with Tension Piles | Widiyanto |
| - Foundation Grade Beam | Leonard De Rooy |
| - Stepped Beam | Matthias Andermatt |
| - Evaluation of Prestressed Dapped Girder Ends with Cazaly Hangers | Katrin Habel |
| - Design of Linked Beam for Medium High Rise Building | Hakim Bouadi |

5 Strut-and-tie models for earthquake design

Laura Lowes was not able to attend and no discussion was made regarding this topic.

6 Next meeting

No discussion

7 Other items

Kuchma discussed possibilities of a new sub-committee direction and document after the 2nd SP for examples was published. The 318 main committee is considering different options included embedding the strut-and-tie provisions into the code. Jim Wight is working on the embedding. Committee 445 may be working on the textbook provisions of the application of the strut-and-tie method. One example is direct strut versus indirect strut and this was discussed. The sub-committee members were both challenged and encouraged to think about new ideas for future work and the new mission of the sub-committee.

Anderson asked committee for opinions regarding:

- The checking of serviceability limits for reinforcing with the strut-and-tie modeling procedure.
- Stress limits for struts crossing post-tensioning ducts.
- For both the above topics, there was not enough time left in the committee meeting to fully discuss these issues.

K. - H. Reineck, R. B. Anderson 23 April 2010