# ACI COMMITTEE 336
# FOOTING, MATS AND DRILLED PIERS
***Fall 2011 Convention – Cincinnati, OH***
***Sunday, October 16, 2011***
***1:00 – 5:00 P.M.***
***M-PAVILION B***

1. **Introductions**
    1.1. Sign-in sheet
    1.2. Introductions

2. **Administrative Items**
    2.1. Additions or changes to agenda?
    2.2. Meeting will adjourn at or before 5:00 p.m.

3. **Approval of Minutes**
    3.1. Spring 2010, Chicago, IL
    3.2. Fall 2010, Pittsburgh, PA
    3.3. Spring 2011, Tampa, FL

4. **Membership Roster Update**
    4.1. Current roster – 16 voting members (40% = 7, 50% = 8), 15 consulting/associate members
    4.2. Changes to membership

5. **Status of Current Documents**
    5.1. 336.1R – Specification for Drilled Piers
        5.1.1. A. Ramme delivered proposed revisions; other subcommittee members (B. Oliver, L. Schuler) need to review and comment
        5.1.2. Discussion: ballot the format, reference specification versus guide to writing a specification?
    5.2. 336.2R – Suggested Analysis and Design Procedures for Combined Footings and Mats
        5.2.1. Working session under item 8
    5.3. 336.3R – Design and Construction of Drilled Piers
        5.3.1. Assistance with edits?
        5.3.2. TAC Submission schedule and strategy
    5.4. 336.4R – Alternative Method for the Analysis and Design of Footings using Load and Resistance Factors

6. **TAC Updates**

| Activity | ACI Spring Convention Dallas, TX March 18-20, 2012 | TAC Summer Meeting Gleneden Beach, OR July 10-13, 2012 |
|---|---|---|
| **Final 30-day letter ballot issued** | November 11, 2011 | March 6, 2012 |
| **Committee-approved document submitted to staff for editorial review** | December 16, 2011 | April 10, 2012 |
| **Document submitted to TAC and external reviewers** | February 10, 2012 | June 5, 2012 |
| **TAC Review Group conference calls** | March 7-9, 2012 | July 3-5, 2012 |
| **TAC meeting** | March 16-18, 2012 | July 10-13, 2012 |

**ACI 351**, Chair David Kerins
**Request**: Provide design guidance and examples for massive foundations.
**Response**: ACI 351 will work on the recommendations to provide design guidance and examples for massive foundations along with ACI 336, Footings Mats and Drilled Piers, and ACI 355 Anchorage to Concrete. We will engage other committees as needed. Mukti Das will be leading the effort. Next steps will be to discuss with ACI 351-0D, Design Provisions for Heavy Industrial Concrete Structures, including turbine pedestals, to see if there are synergies with their mission.

## 7. Action Items

## 8. Working Session: 336.2R

- 8.1. Subcommittee progress report (Bill Brant? Jason Draper?)
- 8.2. Subcommittee progress report (Rudy Frizzi)
- 8.3. First ballot
  - 8.3.1. Ballot by chapter, outline and at least one chapter
  - 8.3.2. Discussion: Is mission statement/audience description needed?
  - 8.3.3. Discussion: Which chapter(s) are ready?
- 8.4. Subcommittee working sessions
  - 8.4.1. Subcommittee organization
  - 8.4.2. Add/revise chapter summary bullets
  - 8.4.3. Subgroups
    - 8.4.3.1. Chapter revision subgroups per outline
    - 8.4.3.2. Piled raft subcommittee

## 9. Open Discussion of Current Issues in Construction (Footings, Mats, or Drilled Piers)

## 10. Future Agenda Items

## 11. Adjourn (5:00 p.m.)

# ACI 336.2R-xx

Proposed revised contents/outline
03 April 2011

## Target Audience:

The primary target audience is either geotechnical or structural professional with at least a BS degree in Civil Engineering (geotechnical or structural specialty), practical engineering design and construction experience, and professional licensure, but little or no practical experience in the design of combined footing or mats. Another potential audience is less experienced engineers in a design firm who need background for a new task of designing a combined footing or mat. Finally, some senior engineers may need a refresher on the implications to design that have resulted from the new generation of codes. ACI documents are an invaluable aid in these cases.

The primary focus should be structural design, with basic coverage of geotechnical issues. The intention should not be to make the reader capable of geotechnical design, but rather to inform them sufficiently to provide a sound basis for collaboration with their geotechnical engineer.

## Chapter 1–General

1.1 Scope
1.2 Introduction
1.3 Teamwork

## Chapter 2—Notation and Definitions

2.1 Notation
2.2 Definitions

Do we want to keep definitions such as combined footings, continuous footings, strip footings, grid foundation, mat foundation?
Strive to eliminate as many definitions as possible, especially where terms have become obsolete.
Note ACI requires units (where applicable) in the variable notation section.

## Chapter 3—Loading

3.1 General
3.2 Load Types
3.3 Loading Combinations
3.4 Stability

### David Hartmann

The old version of ACI 351.2R-10 *Report on Foundations for Static Equipment* was written when building codes were small and ASCE 7 did not yet exist. When this document was updated we deleted lots of stuff and TAC had us take out even more.  There was a strong desire to not replicate anything in the codes but to only include items that augment the codes.

- Remove as much loading information as possible from document; do not include any specific criteria that will end up at odds with the building codes.
- Identify what general design load information to give context to the analysis and design recommendations that will follow.
- Identify any areas where combined footings and mats would be different than typical definitions of any loads and identify any loads that are uncommon or unique to footings and mat.
- Include a section on stability; specifically, note that the old concept of a factor of safety on either overturning or sliding has been left behind with the current family of International Building Codes in favor of satisfying the Load Cases in which the dead load and really any resisting forces are included at a reduced value.  Probably the best case in point would be the Service Load Combination for Wind from ASCE 7-05 which has 0.6D + W + H.  In the old definition this gives a required factor of safety of 1.67.

# Chapter 4—Soil Structure Interaction

4.1 General
4.2 Soil structure interaction factor
4.3 Allowable pressure
4.4 Foundation rigidity
4.5 Estimating the subgrade response

### Jason Draper, Ed Ulrich

Geotechnical considerations, determining rigidity/flexibility, springs, etc.
Find a home or a use for the equation in Chapter 2, for soil stress-strain modulus
Modulus of subgrade reaction; pseudo-modulus; elastic response

# Chapter 5—Design Considerations

5.1 General
5.2 Building mat foundations
5.4 Heave
5.5 Time-dependent considerations
5.3 Design procedure

### Bill Brant

- Design procedure has been moved to the end of the chapter.
- Chapter includes design considerations (besides those covered in Chapter 4); consider additional sections.

# Chapter 6—Rigid foundation analysis

6.1 General
6.2 Straight-line distribution of soil pressure
6.3 Distribution of soil pressure governed by the subgrade reaction
6.4 Grid footings and mats

### Adam Ramme, Larry Schulze

- Soil pressure distribution, stability (update to modern codes).
- Convert to 2d lateral loading (i.e. P/A + Mx/Sx + My/Sy).
- Add reference to books with charts for cases where the resultant is outside of the kern.
- Address biaxial eccentricity, resultant base pressure

## Chapter 7—Flexible Foundation Analysis

7.1 Design procedure for flexible foundations
7.2 Simplified procedure for flexible foundations (referenced as the old ACI 336 method)
7.3 Traditional methods for flexible foundations
7.4 Computer analysis for flexible foundations
  Finite difference method
  Finite grid method
  Finite element method
7.5 Column loads
7.6 Symmetry
7.7 Node coupling of soil effects
7.8 Consolidation settlement
7.9 Computer output
7.10 Two-dimensional or three-dimensional analysis
7.11 Mat thickness
7.12 Parametric studies

### Johnny Kwok, Jason Draper

- Consider removing finite differences and finite grid.
- Modify references of computer expense to designer effort and computer efficiency
- Update for bricks vs plates. Consider different types of plates, such as ones that consider shear deformation
- Consider Twisting Moments in Two-Way Slabs, see Concrete International July 2009 (James Deaton et al).
- Non-linear springs (GTSTRUDL), non-linear analysis SAFE (CSI-Berkley), PCAmat
- Removed edge springs

## Chapter 8— Mats on deep foundations

### Rudy Frizzi, Ed Ulrich

Piled rafts, bearing in combination with deep foundation support, provide guidance on the effect of deep elements on stiffness of subgrade for bearing; Consider including: ground-stiffening elements (not piles), soil improvement (deep soil mixing, stone columns/rammed aggregate piers, etc.), pile caps.

This proposed insert deals with the design of mat foundations, often referred to as raft foundations in some regions, supported by deep foundation elements. These foundations are called piled mats. Geotechnical and subgrade-structure interaction concepts are presented along with the structural aspects of the analysis. The engineer performing the analysis should focus on the important interrelation and collaboration between Geotechnical and Structural professionals in connection with the analysis of such foundations. Due to the unique subgrade-structure interaction and compatibility requirements between the mat and underlying piles, ultimate subgrade strength and deformation design concepts are presented for both the geotechnical and structural analysis.

## Chapter 9—Construction considerations

### Luke Schuler, Bernie Hertlein

Constructability considerations, joint placement and design, pour sequence, form and bar placement details, mud mats/excavation drainage/excavation protection, etc.

- ACI 351.2R-10 Report on Foundations for Static Equipment has a similar chapter.

## Chapter 10—Summary

## Chapter 11—References