Presentation

• Background
• New Structure/Content
• New Technical Sections/Provisions
• Revision Cycle

ASCE Is moving towards a 5 year revision cycle
Background

• ASCE 4 - 86 - Original Working Group
  – First published in 1987
  – Provided general guidance in dynamic analysis of structure

• ASCE 4 - 98 – First Major Revision
  – Published in 1998
  – Major update of 86
  – Moved to targeted demand levels (90% Nep based on 84% input)
  – Primarily aimed at elastic analysis – discusses some nonlinear methods but provides little guidance other than pointing to references.
  – Provided guidance on analysis using standard techniques (response spectrum methods, time history methods, complex frequency and equivalent static)
  – Provided guidance on SSI, subsystem, and special structures

• ASCE 4 – 16 – 2nd Major Revision (In Publication)
  – Nonlinear response methods now included
  – Criteria for analysis of sliding and rocking of unanchored components
  – Major update to criteria on base isolated structures

You too can provide suggestions for improvement
Content

1. General/Introduction
2. Seismic Input
3. Modeling of Structures
4. Analysis of Structures
5. Soil-Structure Interaction Modeling and Analysis
6. Input for Subsystem Analysis
7. Buried Pipes and Conduits
8. Dynamic Soil Pressures on Walls
9. Vertical Liquid-Storage Tanks
10. Distribution Systems
11. Dynamic Sliding and Uplift Analysis
12. Seismic Isolated Structures

Appendix A – Seismic PRA and Seismic Margin Assessments

Appendix B – Nonlinear Time Domain Soil-Structure Interaction Analysis

- Seismic Quality Provisions
- Performance-Based Ground Motion
- Probabilistic SSI
- Deterministic SSI to simulate probabilistic SSI
- Nonlinear Response Methods
- Sliding and Rocking of Unanchored Components
- Seismically Isolated Structures
Seismic Quality Provisions

• **Seismic Quality Provisions**
  – Most of the Seismic QA provisions in ASCE 4 are high level requirements.
  – Corporate QA programs designed to meet ASME NQA-1 or DOE O 414.D will have provisions that address the requirements, but it is recommended that project or corporate QA contacts review ASCE 4 to identify holes.

• **Three specific requirements are called out in ASCE 4-16**
  1. Analysis verification and documentation
  2. Load path study
  3. Independent peer review
Performance-Based Design Motions

• Chapter 2 of ASCE 4
  – Presents acceptable procedures to incorporate local site effects (site response) into calculation of ground motion at different elevations in a soil profile
  – Starts with UHRS developed based on a probabilistic seismic hazard analyses at the annual frequency of exceedance appropriate for seismic design category (ASCE 43)
  – Can be used to generate surface and foundation-level spectra

• Provisions
  – Probabilistic site response evaluations (2.3)
  – Strain-Compatible Soil Properties (2.4)
  – Design Response Motions (2.5)
  – DRS-Compatible Time Histories (2.6)

• Number of time histories
  – One or more*
    – Five are required for linear elastic analysis (2.6.1)

• Structures Sensitive to Low-Frequency Motions
  – Additional criteria for structures with fundamental modes $f < 0.5$ Hz.

• Alternate Definitions (2.8)
Probabilistic SSI

• Section 5.5 is new and presents methods for probabilistic soil structure interaction analysis
• Aim is to produce distribution on response - response can vary from moment, axial loads on components but probably most common is a probabilistic response in-structure response. 80% demand is targeted for use with ASCE 43 and will result in HCLPF exceeding the design basis motion
• Random variables include structures stiffness, structure damping, soil stiffness and damping and input motion (time history seeds).
• Soil profiles are consistent with strain-iterated developed in PSHA
• Input motions are either N acceleration time series or N response spectra sets.
• 200 Simulations required when Monte Carlo methods are used.
  Minimum of 30 simulation considered when Latin Hypercube Sampling is done.
Deterministic SSI to Simulate Probabilistic

- Probabilistic SSI is preferred, however, deterministic methods similar to ASCE 4-98 are still allowed
- Target non-exceedance probability remains 80% response to achieve performance prescribed in ASCE 43
- Fixed base analysis are permitted in some cases
- Effects of structure-soil-structure interaction should be considered for light structures in proximity to massive structures
- It is acceptable to account for uncertainties in SSI by varying the high-strain soil shear modules
  - Best Estimate soil shear modulus
  - Lower bound \( \frac{G}{1+C_v} \)
  - Upper bound \( G \times (1+C_v) \)
  - Note that minimum \( C_v \) is 0.50 and 1.0 “if insufficient data are available to address uncertainties in soil properties”
- Methods used to perform SSI analysis shall be validated (5.1.11)
- ISRS and 80% demand is obtained as an envelope of the UB, LB, BE soil cases. Peak clipping and broadening is permitted (6.2.3)
Nonlinear Response Methods

• 4-16 Includes additional criteria on the use of nonlinear methods to compute structure response

• Nonlinear Response History Analysis (4.7)
  – Required for analysis and design of seismically isolated nuclear structures
  – May be used for evaluation of unanchored components
  – Numerical models of components shall be based on test data
  – Requires a minimum of five time history analysis
  – Seismic response is taken as the average from five analyses

• Approximate Inelastic Response Spectrum Analysis (4.8)
  – \( D_{NL} = \frac{D_{elastic}}{F_{\mu}} \)

• Nonlinear Static Analysis (4.9)
  – Subject to limitations of ASCE/SEI 41-06
  – Target displacements are computed using either coefficient method of ASCE/SEI 41-06 or capacity spectrum method of FEMA 274
• Sliding and Rocking of Unanchored Components

• Earthquake experience has demonstrated that anchored components generally perform well – anchoring is preferred

• If estimated sliding or rocking displacements can be tolerated without loss of function, then anchoring is not necessary

• Design values of sliding and rocking are provided in 43-05

• $\Delta_{\text{design}} = 3.0 \times \bar{\Delta}$, where $\bar{\Delta}$ is best estimate of sliding

• $\phi_{\text{design}} = 2.0 \times \bar{\phi}$, where $\bar{\phi}$ is best estimate of rocking angle

• ASCE 4 suggests two methods are available for computation of sliding displacements and rocking angles
  – Nonlinear response history analysis
  – Approximate methods
Seismically Isolated Structures

- Criteria for design of seismically isolated structures has been greatly expanded.
- Written for application to power plants and structures
- Limited to horizontal isolation only
- Two levels of design demand are required (DBE and 1.5xDBE)
- Stop is required at 90% displacement demand at 1.5xDBE input
- Qualification of isolators and isolation system require dynamic testing
- Design and analysis provisions are presented
- Peer review of isolation system and related test programs are required.
Proposal Process for Change

• Create and Submit Proposed Change
  – Any person shall be permitted to submit proposed standard provisions at any time to the Chair with a request that the proposed provision be considered by a letter ballot of the Committee

• Submit to DANS Committee
  – salmon@lanl.gov,
  – gabatt@becht.com
  – nstoeva@vecsa.com

• Ballot and appeals process
  – Appeals are filed to ASCE, Codes and Standard Committee (CSC)
  – jneckel@asce.org
  – jesslinger@asce.org

Email Proposal Subject Line Must Say: "Propose Change ASCE 43-05"
Summary

- ASCE 4-98 has been revised, ASCE 4-16 is in publication
- ASCE 4-16 has a significant amount of new content that may be helpful in updating PRAs for 10CFR 50.54 evaluations (Fukushima) and DOE Evaluation of older facilities subjected to updated seismic hazard curves
- You can help improve by review and submittal of changes that you feel are needed
- We are moving to a 5 year revision cycle (3 years accepting change proposals, 2 years balloting and processing through ASCE)