SeabrookLANPEm Resource

From: Greene, Joshua <Joshua.Greene@nexteraenergy.com>
Sent: Wednesday, June 07, 2017 11:05 AM
To: Poole, Justin
Subject: [External_Sender] FW: deformation RAIs
Attachments: DeformationRAIs_draftResponse_001.pptx

From: Ryan M. Mones [mailto:RMMones@sgh.com]
Sent: Wednesday, June 07, 2017 10:53 AM
To: Greene, Joshua
Subject: deformation RAIs

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Ryan M. Mones
Staff II - Structures

SIMPSON GUMPERTZ & HEGER
| Engineering of Structures and Building Enclosures

41 Seyon Street, Building 1, Suite 500
Waltham, MA 02453

781.907.9000 main
781.907.9263 direct
781.907.9009 fax
www.sgh.com

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Sent Date: 6/7/2017 11:04:40 AM
Received Date: 6/7/2017 11:04:48 AM
From: Greene, Joshua

Created By: Joshua.Greene@nexteraenergy.com

Recipients:
"Poole, Justin" <Justin.Poole@nrc.gov>
Tracking Status: None

Post Office: nexteraenergy.com

Files	**Size**	**Date & Time**
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DeformationRAIs_draftResponse_001.pptx	316622	

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Draft Response and Talking Points for Deformation Draft RAIs

June 2017

ACI 318-71 Sections Referenced in Draft RAI

- ACI 318-71 Section 8.6:
  - This section is related to redistribution of negative bending moment in a continuous member – it is not directly applicable to the CEB wall. However, this section will be used for other Seabrook structures conforming to this requirement.
- ACI 318-71 Section 19.3.1:
  - In the CEB analysis, demands are first computed using elastic analysis with uncracked section properties, consistent with 19.3.1.
    - Thin shells are typically defined by their membrane (in-plane) behavior when away from supports and geometric complexities. However, the loading on the CEB causes out-of-plane deformation, and localized moment redistribution related to out-of-plane effects are considered.
    - The moment redistribution used in the CEB evaluation simulates local nonlinear behavior and cracking. Chapter 19 of ACI 349-01, -06, and -13 permit use of nonlinearity.
    - ACI 318-71 Section 8.5.3.1 allows cracked section stiffnesses to be used. This is not considered in the CEB analysis.

ACI 349-01, ACI 349-06, ACI 349-13

19.2—General

19.2.1 Methods of analysis that are based on accepted principles of engineering mechanics and applicable to the geometry of the structure shall be used.

19.2.2 Elastic behavior shall be an accepted basis for determining internal forces, displacements, and stability of shells. Equilibrium checks of internal forces and external loads shall be made to ensure consistency of results.

19.2.3 The redistribution of forces in a statically indeterminate structure shall be considered.

R19.2—General

R19.2.1, 19.2.2, and 19.2.3 Nonlinear analysis may be necessary when a cracked concrete section due to load combinations of thermal, earthquake, and others listed in Section 9.2.1 is considered and the redistribution of stresses takes place in relationship to the depth of cracks. Tensile resistance of the cracked concrete is not relied on. The cracks could occur in meridional, hoop, or other directions depending on the reinforcement patterns and loadings.

The Code does not intend to require the nonlinear crack analysis for all possible cracked conditions, but requires the engineer to review the possibility of the resulting redistribution of forces and initiate analysis if deemed necessary.

Displacement Controlled Loading

- ASR demands are displacement controlled. These demands are self-relieving. This means that the demands reduce as the structure deforms. This self-relieving effect is not accounted for in an elastic analysis.
  - For the CEB:
    - Internal ASR expansion is simulated as an imposed strain of the CEB wall. This strain is restrained by other regions of the wall with less ASR expansion and external boundary conditions.
    - the ASR of concrete fill imposes a displacement-controlled out-of-plane movement which is simulated by a pressure in the analysis.

Moment Redistribution Validation

- Validation of the moment redistribution method is documented in Appendix L of the CEB evaluation.
- The validation compares the moment redistribution approach used in the evaluation to a more detailed approach using nonlinear spring elements.
- Example problems are specific to the CEB structure.
- The validation shows that the method used in the CEB calculation matches well with the more detailed approach.

Ductility Evaluation

- The ductility of the reinforcement at locations of moment redistribution is checked using moment curvature evaluations in Appendix O.
- The highest ductility demand is 3.5, corresponding to a reinforcement strain of 0.7%. This is well below the strain limit of 7.0% for Grade 60 bars at fracture (ASTM Standard A615-78).

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- A minimum threshold factor of 1.2 is initially targeted for practicality of threshold monitoring.
- The extent of moment redistribution is based on ACI 318-71 Section 8.6 for continuous members.
- For other cases of moment redistribution, reinforcement strains are compared to a strain limit of 7% per ASTM Standard A615-78.