OPTIMIZING QA/QC

NUCLEAR CONCRETE

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WHAT VALUE DOES NQA-1 ADD TO ENSURE SAFETY OR RELIABILITY OF CONCRETE AND REBAR IN NUCLEAR CONSTRUCTION?

CAN WE USE AN ALTERNATE APPROACH THAT CAN SIGNIFICANTLY IMPROVE COST AND SCHEDULE WITHOUT COMPROMISING SAFETY OR RELIABILITY?

Regulatory Requirements for Nuclear Concrete

- **RG 1.136: Design Limits, Loading Combinations, Materials, Construction, and Testing of Containment Structures (ASME Section III, Div.2)**

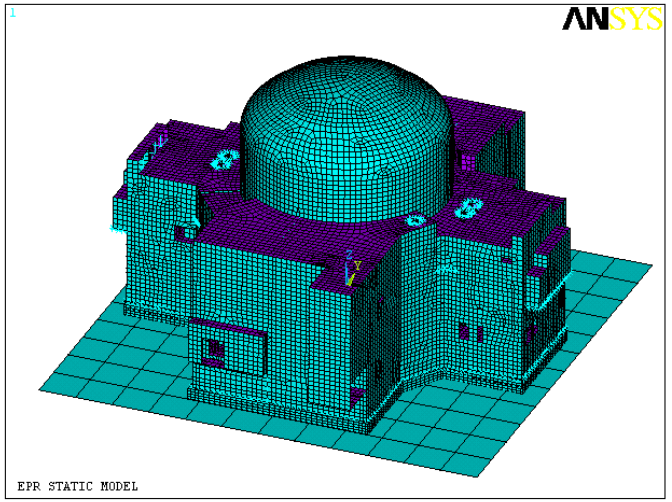
- **RG 1.142: Safety Related Concrete Structures (ACI 349)**

- **NQA-1 (QA/QC) Q-Concrete and Q-Rebar**

  Requires rigorous Q protocol for source qualification, transportation, storage, traceability, special testing by Q-labs, oversight and execution

Nuclear Concrete Design – A Holistic View

- **Robust structures**
  - **ASME Div. 2 Containment**
  - **ACI 349 Stiff Box Buildings**



- **Containment design controlled by design accident pressure and SSE – (tension/shear)**
- **ACI 349 Box buildings controlled by in-plane shear and out of plane shear**
- **Summary - Design controlled by tension/shear and reinforcement not necessarily concrete compressive strength**
- **Combination of Conservative Loads, SSI, Analysis methods, Element Based Design and Design Enveloping results in Significant Overcapacity ~3**

Parameters Critical for Safety

Strength (Compressive)

- Not very critical to design
- With low w/c ratios required for durability, concretes generally gain lot more strength vs. specified and with age

Placement/Quality – slump, unit weight (Field verification testing during production)

Durability – air, ASR, temperature (Part of QA testing and field testing during production)

Reinforcement strength and ductility

ASTM A706 or equivalent rebar (with chemistry control) generally used which has a well defined guaranteed minimum yield and ductility

Summary

Compressive strength generally exceeds and not critical to safety

Reinforcement strength and ductility quite reliable and predictable

Significant overcapacity ensures much lower demands on concrete and rebar during a DBE and BDBE resulting in sufficient safety margins and robustness at the system level

NQA-1 does not add much value in terms of safety or reliability but increases cost and schedule manifold

Both concrete and rebar are commodities that are widely produced and successfully used in the commercial industry for both routine as well as highly specialized/complex structural systems to meet a variety of performance specifications

Concluding Remarks

Replace current NQA-1 requirements for concrete and rebar with following Augmented Quality Requirements to improve RELIABILITY of performance

- **QA – Qualify concrete and rebar materials based on applicable industry standards ACI, ASTM etc using two independent 3Rd party accredited/certified labs**

- **QC – Use augmented QC for field supervision and testing during production, transportation and placement through a 3Rd Party Independent Agency with additional option of random QC testing protocol**

This will simplify QA/QC process and significantly improve cost and schedule without compromising the safety of nuclear construction

