Rehabilitation of Appurtenant Structures and Locks

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GOAL

Provide guidance, programs, tools, and example problems to facilitate the efficient seismic design and evaluation of appurtenant structures and locks.

Seismic Evaluation & Rehabilitation of Hydraulic Infrastructure Workshop

NEEDS

1 -Linear Elastic Finite Element Analysis Towers/Locks/Gravity Dam (Not a WES Program) Guidance Examples – Products (10)

2 & 10-Definition of most appropriate finite element software. Assessment of AE proposed software tools – i.e. acceptability (3)

3-Site Characteristics ---expected strengths of materials(4)

4-Evaluation Criteria –Standards (4)

5-Guidance on hiring technical assistance of experts (scope of work assistance) (1)

6-Quantify Ductility-mass concrete-Physical models-lock structures-retaining walls (4)

BLUE – Guidance	GREEN - Software and Tools
RED – SSI	BLACK - Misc

NEEDS

7-Soil/structure interaction pertaining to retaining walls (9)

8-Tainter gates/stoplogs-Finish hydraulic steel structures - guidance examples (6)

9-Tools to evaluate AE design based on their proposed products (precast/premade)

11-Pile Foundation- How to evaluate and/or models –springs pile head fixity (10)

12-Fracture Foundation Analysis 3D soil/structure (torsional loading) (5)

13-Extension w/ a new structure at 100 year – how to remediate the existing for additional 100 year (how to evaluate) (composite structures) (3)

BLUE – Guidance	GREEN - Software and Tools
RED – SSI	BLACK - Misc

NEEDS

14 -Reliability/Risk – How to integrate (5)

15-Guidance for "pushover" analysis (2)

16-Clearing House for "good" designs (6)

17-ER 1806 Rewrite /consistent (Sliding Stability / Coefficient) Zones (4)

18- EQAS- Maintain/ Update (1)

19 - ETL – Site specific NERHP Maps (0)

BLUE – Guidance	GREEN - Software and Tools
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FOCs

Capabilities for districts to perform linear elastic finite element analyses of intake towers, navigation locks, gravity dams, and retaining walls using commercially available FE software.

The Corps would like EM's that include procedures, examples and guidance so that we can overcome the problem of developing appropriate numerical models. EM's should include guidance on input for material properties, foundation effects, hydrodynamic effects, uplift forces/pore pressures, and recommendations on evaluation criteria, assessment and interpretation and presentation of results.

FOCs

Capability for districts to analyze and design new hydraulic steel structures and to analyze and assess existing hydraulic steel structures subjected to seismic loads.

The Corps would like to see the appendices in EM 1110-2-2105 completed for various hydraulic steel structures and for the EM to be expanded/revised to specify design criteria and methods of evaluation for the OBE and MDE conditions.

FOCs

Capability for districts to develop simple dynamic models to analyze and assess pile foundations.

The Corps would like guidance, examples, and procedures that include pile cap fixity, pile group effects, reduction factors for dynamic behavior, methods for developing spring constants to represent soil and/or rock, and evaluation criteria.

The Corps would also like guidance and software to evaluate the rebound effects of piles in non-cohesive and cohesive soils to evaluate ultimate forces, final displacements during seismic events, and for the evaluation of subsequent events.

Pushover Analysis Techniques

Capability for districts to perform Pushover Analysis for lock-walls, intake towers, spillway piers, and retaining walls using commercially available software.

The Corps would like guidance to include procedures, criteria, and examples on Pushover Analyses on various structures

FOCs

Formulate Procedures, Guidance and Tools for the Safe, Economical and Functional Design of Appurtenant Hydraulic Structures.

Goal: Provide guidance to estimate expected material strengths.

- Taking site samples can be extremely costly and sometime impossible to obtain (e.g. upstream toe of a tall concrete dam).
- Drawings and specifications indicate the minimum strengths of concrete and steel. However, actual strengths may be greater due to age of concrete and steel strengths in general will exceed minimum values.
- Due to the age of the structure or deterioration, strengths of concrete and steel may be less than the original design values.
- Product: ETL with relationships of material strength versus age, deterioration, structural use and other parameters to aid in determining expected material strengths.

FOCs

Goal: Determine ductility/capacity of unreinforced and under-reinforced mass concrete sections of intake towers, navigation locks and retaining walls.

- ER 1110-2-1806 allows the use of some inelastic structural response for design of the Maximum Design Earthquake (MDE). Existing Corps guidance does not address the inelastic strength of mass concrete.
- Current codes, including ACI, underestimate the inelastic strength of concrete.
- Corps guidance requires the seismic reevaluate of seismic structures every third periodic inspection not to exceed 15 years. Current seismic loads are greater than the original design loads. Allowing inelastic behavior better represents the actual conditions and results in fewer and less costly retrofits. By allowing appropriate inelastic strengths, these structures may meet or exceed the increased seismic demand.
- Products: ETL with methodology to determine inelastic strengths of unreinforced and under-reinforced mass concrete sections for hydraulic structures.

FOCs

Determine the reliability and risk of hydraulic structures.

- The reliability of existing structures may decrease over time due to deterioration.
- When evaluating existing structures for modification and/or interaction with new structures, assumptions need to be made about the structure's ability to function as originally designed and meet any newly imposed criteria.
- An examination of case studies would aid the designers in determining the structure's adequacy and establishing hazard curves to aid in the decision making process.
- Products: EM with case studies and recommendations for evaluation.

SSI Procedures

Formulate programs, procedures, guidance and example problems to overcome the problem of seismic modeling and designing of retaining walls. Engineering procedures for predicting dynamic lateral earth pressures are not available. Lateral earth pressures are critical for all aspects of design and analysis for retaining wall structures in all seismic zones.

Fracture Foundation Analysis

Programs, procedures, guidance and example problems are required to overcome the problem of seismic modeling and designing of structures on foundations of fractured rock and weak seams.

Evaluation Criteria - Standard

Guidance is required to properly interpret the direction provided by NEHRP concerning seismic coefficients for sliding stability, life-safety and seismic zones.

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