

NOTES OF MEETING

Northwest Dam Safety Regional Forum

February 14 - 15, 2006

Portland, Oregon

A Federal Dam Owner's Perspective

Begin with the end in mind

- Assure safe operation of our dams
- Have a defensible process that supports screening and detailed assessment as required
- Address assessment and analysis of existing versus new structures
- Need to define loads in a regionally or nationally consistent manner for analysis and design.
- How bad is bad? (What load does it take to fail the dam? Or stated differently, rate the dams for seismic capacity.) This may be a better use of analysis funds to show what it takes to damage the dam instead going back every 5 or 10 years for more analysis due to increased ground motions.
- Need to convince the money managers to fund your work which often leads to Formal risk assessment process that requires frequency of occurrence or exceedance, conditional probability of performance, and consequences related to that level of performance.

Questions to address before you start

Changing Seismology (The Moving Target) – The current environment

- 28-29 March 2006 USGS workshop in Seattle – all are invited.
- New data
 - Field work and seismic monitoring
 - An event on an “inactive” fault
- New interpretation of old data
 - What is an active fault?
 - Do we use low strain rate or potentially active faults?
- Leads to
 - New sources
 - Along with the new source question are we to use suspected sources under debate, but not yet accepted by the USGS.
 - What if our consultant disagrees with the USGS?
 - New location of known sources
 - Higher (lower?) ground motions
 - Floating earthquakes

Engineering Implications/Needs

- What is required by the structural and geotechnical engineer? The requirements are different.
 - What type of structure is to be analyzed?
 - What are the site conditions?
 - Rock - Soil (type, depth, ground water)
 - Shear wave velocity (V_s) profiles
 - Shape of the valley (topography, subsurface geometry)
 - Structural geology
- Define the various seismic sources that impact the project
- Frequency content generated by different types of sources
 - Crustal faults – defined
 - Strike slip
 - Normal
 - Thrust or Reverse
 - Hidden thrust
 - Crustal – random or floating earthquakes – associated with a seismic zone
 - Inter-plate
 - Intra-plate
- Near field versus far field – what to do with this issue?
- PGA and spectral accelerations, velocities, displacements
- Duration
- Time histories

Approaches/Methods to define ground motions

- Deterministic VS Probabilistic
 - When to use the two methods
 - How to use each method
- Attenuation relationships:
 - Which one or how many?
 - Use USGS web page that weights the attenuation curves?
 - Use relationship based on specific fault types for known faults and generic relationship for the floating or random or unknown.
- PGA – which one to use?
 - Use median (50 percentile), mean of the log normal distribution (approx. 64th percentile), or mean plus standard deviation of the normal distribution (84th percentile) for ground motions?
 - Starts down the road of confidence levels & risk
- Time histories or accelerograms
 - Synthetic or scaled natural time histories?
 - Single or multiple time histories?

Exposure over time

- Clock restarts each year
Seismic zones with some annualized exposure rate
- Increased likelihood of an event over time
Active faults or known faults with high slip rates

Application of the factor of safety or “Conservatism on Conservatism”

- Source selection
- Magnitude
- MCE Recurrence - 10,000yr, 35,000yrs, +100,000 yrs)
- Attenuation (median (50 percentile), mean (approx 64th percentile), mean+SD (84th percentile)
- Example of how the conservatism can grow –
[FS (total) = Conservative EQ Source ---> then use 84th percentile on the ground motion----> then analyze structure with goal of FS of 1.2 or higher.]

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INFORMAL NOTES

- 1 Bill Christman, Chelan PUD: Initially a small group, now grown to 138 attendees. Objective is to co-mingle owners in same basin for mutual benefit. FERC will hold others elsewhere. Chose two high value tracks to start in PNW, EQ and floods. Follows previously successful collaboration of Columbia River flood management.
- 2 Ed Odom, Chelan PUD: Endorsed increased communications, cooperation and collaboration.
- 3 Bruce Mueller, USBR: Recognize the need to look outside own organizations to maintain credibility. Key issue is how to seek consistency between Fed agencies and other utilities.
- 4 Jerry Webb, USACE: Have 650 dams, many are flood control and so don't have "first filling" opportunity to test performance. \$250 million funding for O&M. Moving into risk based program planning. Main risks include: seepage and piping; seismicity in PNW; experiencing unusual 300 – 500 year hydrological events.
- 5 Ralph Archuleta, UCSB: Seismicity in PNW strongly affected by 40 mm/y movement of Juan de Fuca plate to NE. Over 500 years accumulates to 2 m. Three major sources in PNW: interface events up to $M = 9$; intra slab events such as 1949, 1965, 2001 at $M = 7+$ at 50 km depths; and smaller shallow crustal events $M < 7$ at 10 to 20 km including some thrust faults. Location of 1872 shallow crustal event is near Lake Chelan, refer to Bakun paper.
- 6 John England, USBR: Moving to risk based hydrological hazard curves. Using PMF to cap curves.
- 7 Dale Monger, USACE NWD: Need to rationalize choice of median vs median + sigma values. Noted USGS not present but are a key player. USGS Workshop in Seattle, 28/29 March addressing events east of Cascades, location of 1872 event, floating EQs.
- 8 Ed Idriss, UCD and Consultant: PEER NGA project including much new data. Review meeting to be held March 2006, finalize project by mid 2006 or so. Ground motion values all dropping. Decrease in mechanism effect (ie thrust vs strike slip events etc). Standard error term increasing. Directivity effects 10 to 15% important in near field. Also hanging wall, falling wall effect important. There is justification for reducing ground motions for dams on hard rock sites with high shear wave velocities (V_s) but data base has few cases of $V_s > 1000$ m/s.
- 9 Norm Abrahamson, PG&E and UCB: Advocates risk based approach. More active sources contribute more to risk and warrant use of higher confidence level (84 percentile) ground motion estimates. Low activity sources and contributors to risk can use median values.

- 10 Dave Pezza, USACE HQ: Various publications including EC 1110-2-301 Interim procedure for selecting ground motions. OBE is to limit damage to specified dollar levels. EM 1110-2-6050 Response spectra and seismic analysis. Engaged in portfolio risk assessment. Now into second stage screening starting in March 2006.
- 11 John Ake, USBR: Addressing ground motions. Shear wave testing, Consider Arias Intensity. Selection of time histories a major source of uncertainty. Need to use uniform hazard spectra (UHS) and several time histories so that average RS matches UHS in frequencies of interest. Focus on spectral values over natural frequency range of interest. Use risk basis for fixes, not hazard.
- 12 Des Hartford, BC Hydro: Advocates risk basis for decisions to address inherent uncertainty. Need to address how to measure safety.
- 13 Ed Idriss Moderating Open Discussion Seismic Session:
 - a. Source Issues: Need to address fault types, degree of activity, recurrence rates, magnitude
 - b. 1872 event: Defining event for Central WA; not a random event; located with respect to a significant band of faults in Wenatchee area; fault is capable; Bakun et al locate within a 95% confidence zone; appears to be a blind thrust.
 - c. Location of random EQs: Assign a reasonable distance. USACE uses M at 20 km or similar location.
 - d. Degree of activity: Definitions vary, 100,000 years, 35,000 years etc reflect different degrees of conservatism. For events with 1000 y recurrence use median values of ground motion, for events with recurrence in 100m y range use 84th percentile values.
 - e. Vertical ground motions: Phase lag exists between vertical and horizontal motions. Wave mechanics shows shift in peaks.
 - f. Deterministic vs Probabilistic approaches: Always do a deterministic analysis. Use event trees to address epistemic uncertainty in probabilistic analysis. Prefers use of median values from event trees.
- 14 Dave Pezza, Moderating Continuing Open Discussion Seismic Session:
 - a. Time histories: Use 3 as minimum for elastic analysis; use 5 to 7 for non-linear analyses.
 - b. M9 Mega Thrust: No records for M = 9 events. Use W-C white noise events? Duration for M9 event is 2 to 5 minutes.
 - c. Time Histories: Need time histories for PNW events. UCB working group on time history selection.
- 15 Ed Idriss Continuing Moderating Open Discussion Seismic Session:
 - a. Selecting time histories: Must be based on a repeatable approach.
 - b. No of time histories to be used in analysis: Would like to use 25. 3 can give a mean but is too few. 7 required for stable results and to get an indication of variability.

- 16 Ed Idriss – Strategies:
 - a. Identification of sources needs inputs from seismologists and geologists
 - b. Need to include random sources to complete region picture
 - c. Move towards picking return periods for UHS based on simple risk assessment model i=using fragility curves etc as discussed by Norm Abrahamson considering limiting risk issues to uncontrolled release. Use fragility curves and seismic hazard. Not necessary to include details of downstream consequences in first level assessment to assign reasonable hazard criteria.
 - d. There are certain key features that affect risk for dams in seismic zones, such as reliability and redundancy, that should be recognized.
 - e. Can use USGS hazard maps as basis for comparison.
 - f. Use relevant time histories. Many more are available nowadays. Consider a set of 25 time histories and then select 7 for analysis.
 - g. Develop recommendations via ICODS, USSD or other overarching organization such as NAS.
- 17 Dave Pezza – Strategies cont:
 - a. Need professional seismologist for critical structures
 - b. Use a suite of 25 time histories, 25 gives results with 20% uncertainty. Use 7 for analysis and use mean of results
 - c. Noted that if use only 3 then must use largest which may be 1.5 times mean value fro use of 7. Cost effective to do more runs.
 - d. Random sources should be associated with regional tectonics.
- 18 Dave Pezza - Seismic Working Group Tasks:
 - a. Review present state of art
 - b. Develop framework for probabilistic seismic hazard analysis
 - c. Develop suite of reasonable ground motions for use in analyses
 - d. Move more towards risk based approaches and address how to use results
 - e. Develop concept of Reliability as alternate to Risk, appropriate levels of redundancy
 - f. Relate hazard criteria to operational options, such as ability to release water etc
 - g. Seek to determine what ground motions would cause unacceptable levels of risk
 - h. Need to involve USGS. Seen as de facto standard and need to be able to compare with their data.
- 19 John England - Hydrologic Working Group Topics:
 - a. PMF – Endorse HMR 57, site specific PMPs needed, look to combine PMP and frequency analysis
 - b. Snow melt – important in PNW, inconsistencies in snow melt computations, need policies and procedures to tie to antecedent floods
 - c. Rainfall runoff modeling – variability, antecedent conditions, infiltration, develop tool box

- d. Frequency curves – Bulletin 17B ACWI, update precipitation frequency maps, improved methods at ungaged sites, CEA-DSIG multi-fractal approach
 - e. Operational issues – Forecasting floods and initial pool levels, gate operations, more frequent floods can dominate risk, debris issues, remote operations, coordination of multiple dams and gates
 - f. Hydrologic risk – no consensus on using risk analysis, need to recognize full range of floods including PMF, seek consistency between seismic and hydrologic issues
- 20 Bill Christman – Management Issues:
- a. D Binder, Lawyer - Need to address liability and exposure issues, Operational plans and EAPs, Due Diligence issues
 - b. Leon Hoepner, Grant Co PUD - Succession planning, finding staff for remote locations
 - c. Chris Church, Chelan PUD – Equipment and systems asset management, Best practices
 - d. Mike Haines, Seattle City Light – Security programs, sharing information
- 21 Bill Christman Closing Remarks:
- a. Forum was a success and should be repeated.
 - b. Continue and build on connections established.
- 22 Gus Tjoumas Closing Remarks:
- a. Norm Abrahamson to join Profs Idriss and Archuleta to assist on Chapter 13 completion and inclusion of probabilistic methods
 - b. Hydrologic group to establish a program
 - c. Management group to address security, EAPs and response plans
 - d. Other Regional Forums to come. Next may be in San Francisco LATE 2006 or early 2007.

Reported by
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