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ROCKFALL ABSTRACTION MODELS

Presented by
Simon Hsiung
210/522-5209 (shsiung@swri.org)
Center for Nuclear Waste Regulatory Analyses

May 25-27, 1999
San Antonio, Texas

DOE/NRC Technical Exchange on
Total System Performance Assessments For Yucca Mountain

Legacy/main - rw

FUNDAMENTAL APPROACH

- **Estimate Size of Rockfalls**
- **Assess Damages of the Rockfalls to Waste Packages**

UNDERSTANDING OF VA APPROACH

- Approach for Estimating Size of Rockfalls
  - Sample peak ground velocities from hazard curve at a predetermined time
    - Four time periods were used
  - Calculate the drift damage levels using the peak ground velocities determined above
    - Damage level was originally developed for assessing drift damage due to rockbursts for underground mines in Sudbury, Ontario
    - Damage level is a function of rock quality
      - Higher quality rock suffers less damage

UNDERSTANDING OF VA APPROACH (CONT'D)

- Determine size of rockfall by associating damage levels with probability density function (PDF) of rock sizes
  - Distribution of rock sizes is calculated based on mapped joint spacing data from the Exploratory Studies Facility
  - The rock size PDF is not presented clearly in the TSPA-VA Analyses Technical Basis Document
  - It is not clear how the size of a rockfall for a particular damage level is determined from the rock size PDF

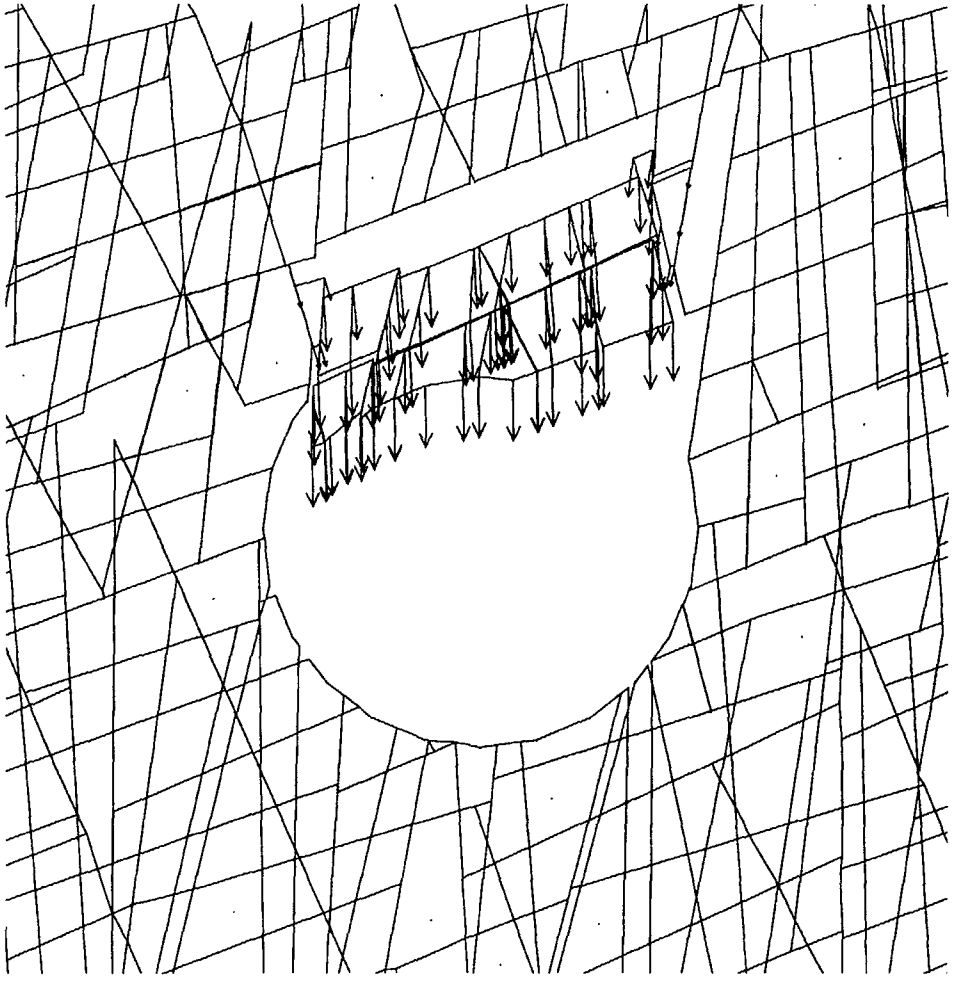
UNDERSTANDING OF VA APPROACH (CONT'D)

- **Approach For Assessing Damages to Waste Packages**
  - **Compare size of rockfall to the critical rock size that is required to damage waste package at the time of impact**
    - **Critical rock size is pre-determined using dynamic modeling of rock impact on waste package**
    - **Critical rock size is a function of waste package degradation**
    - **Crack initiation and through cracking**

NRC APPROACH

- **Approach for Estimating Size of Rockfalls**
  - **Determine time history and magnitude of peak ground accelerations**
  - **Calculate sizes of rockfall and compute impact load & stress**
    - **Volume is determined by joint spacing and height of rock blocks that can fall**
    - **Height is sampled randomly between joint spacing and height of yield zone (taking into account probability of coherent rock blocks to fall)**

UDEC MODELING RESULT INDICATING POTENTIAL FOR COHERENT ROCK BLOCKS TO FALL



NRC APPROACH (CONT'D)

- Height of rock blocks that can fall is a function of rock quality and ground acceleration
- Area of rockfall versus total available area is a function of peak ground acceleration

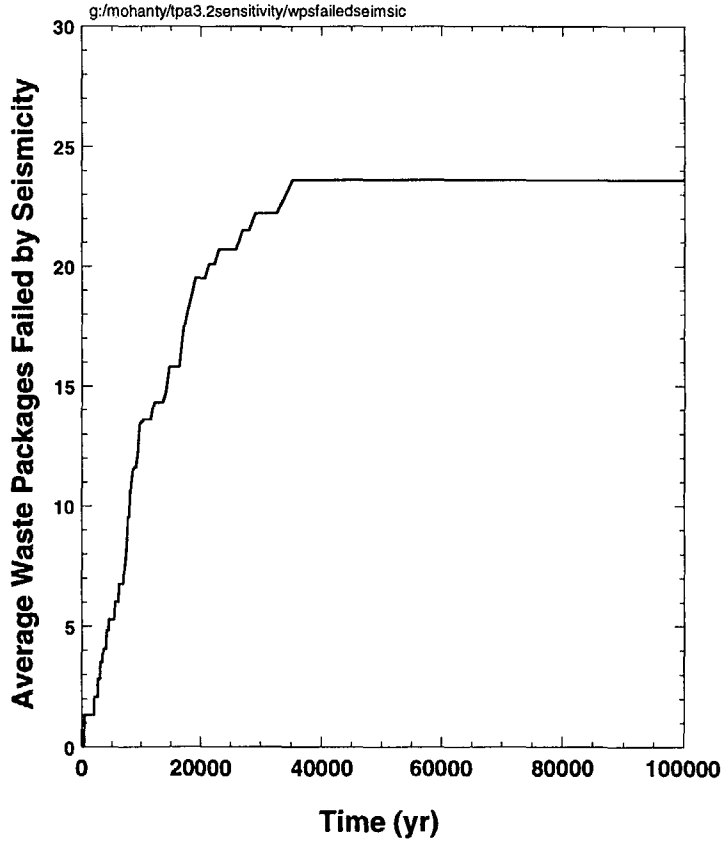
- **Approach For Assessing Damages to Waste Packages**
  - Compare rockfall induced impact stress to a pre-determined failure criterion (2% total strain)

COMPARISON OF DOE AND NRC ROCKFALL MODELS

- NRC Approach is More Conservative in Estimating Size of Rockfall
  - Potential for coherent rock blocks to fall is considered
- NRC Approach is More Conservative in Applying Failure Criterion
  - Between DOE crack initiation and through cracking criteria
- DOE Approach is More Conservative by Including Corrosion of Waste Packages
- Other Differences and Similarities Will be Discussed in a Separate Presentation

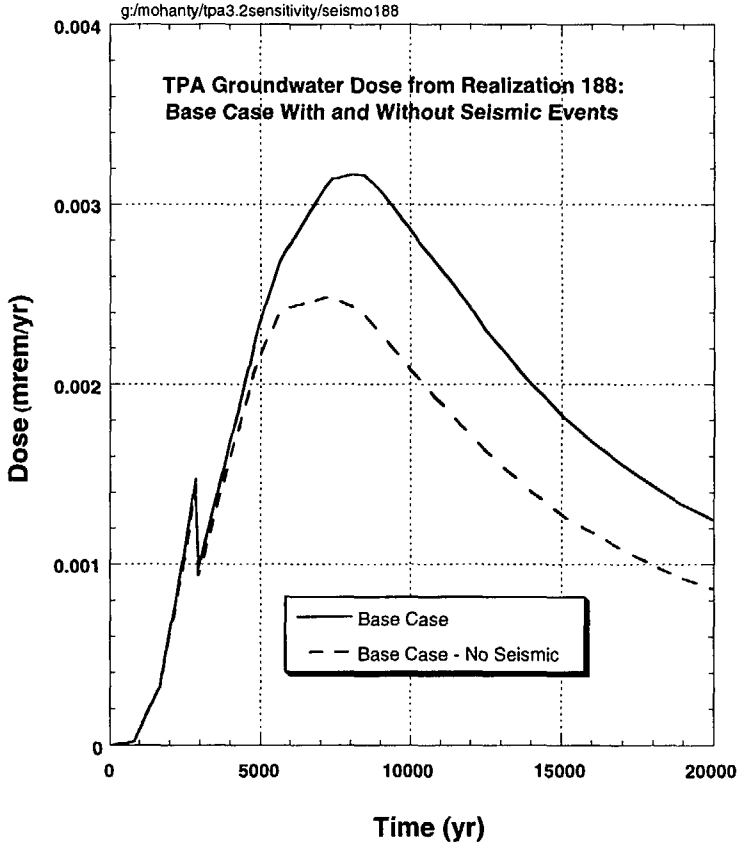
WP FAILURE DUE TO ROCKFALL

- Treated as a Part of Base Case
- Number of Realizations: 250
- 22 Realizations With Rockfall-Induced WP Failures (9%)
- 13-33 WPs Failed in the Realizations With Rockfall-Induced Failures
- Failure Time: 400-35,000 yrs
- Average Rockfall-Induced Failure (All Realizations): 2



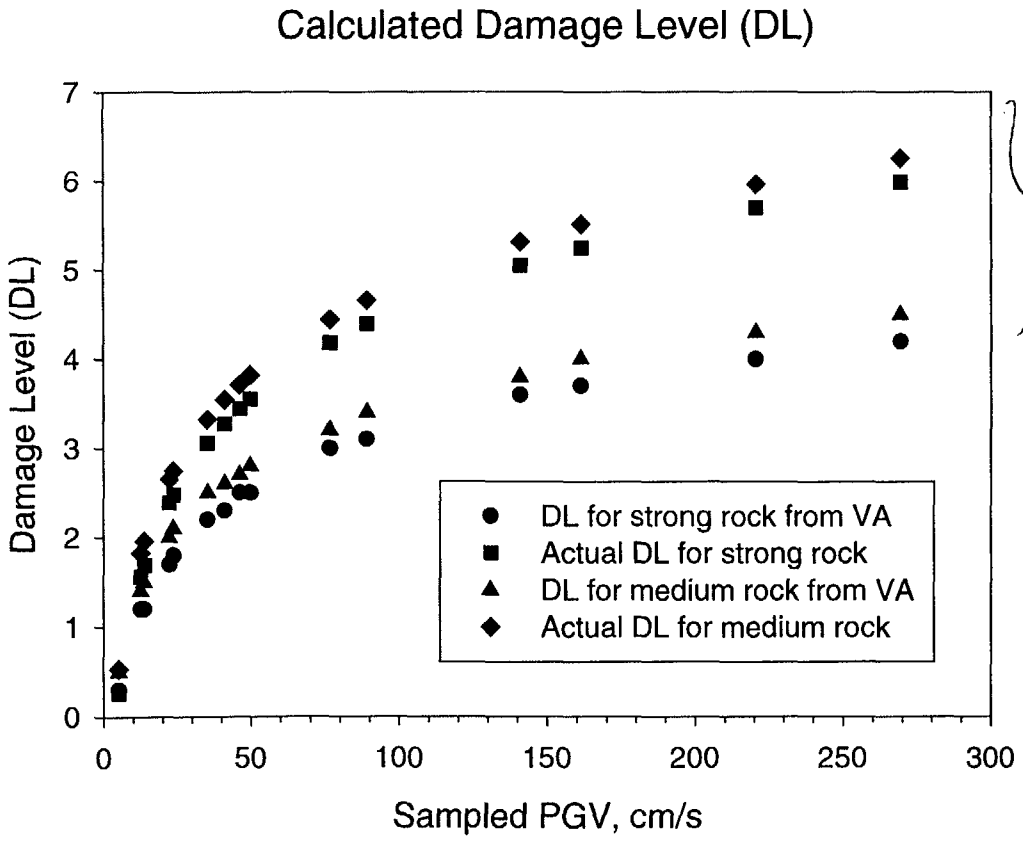
DOSE FROM ROCKFALL

- Figure Shows the Worst-Case Realization (i.e., Largest Contribution From Rockfall-Induced Failure to Dose in 10,000 yrs)
  - A peak dose of 3.17 micro-rem/yr at 8,180 yr
- Case Without Rockfall-Induced Failure
  - A peak dose of 2.48 micro-rem/yr at 7,150 yr
  - 22% difference compared to the worst-case realization



ERROR IN DAMAGE LEVEL CALCULATION?

- **Data from TSPA-VA Technical Basis Report Table 10-30a**



is this figure correct?

Correct Equation

$$DL = \frac{\ln\left(\frac{PGV}{5}\right)}{\ln(2)} - 2.33 + 1.33 * IC$$

VA used

$$DL = \ln\left(\frac{PGV}{5}\right) - 2.33 + 1.33 * IC$$

VA DL is 40% smaller than the actual value for strong rock and 30% smaller for medium rock

ROCKFALL EFFECT UNDER THE NEW ALTERNATIVE DESIGN

- Drip Shield Should Reduce and Defer the Rockfall Effect on Waste Package Integrity
- Rockfall May Effect Drip Shield Performance
- If Backfill is Considered, Rockfall Effect May No Longer be a Concern