# Economic Evaluation of Earthquake Performance Standards

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# Overview of Benefit-Cost Analysis

- BCA Theory
  - Economic Evaluation and Economic Efficiency
- Step-by-Step Outline of BCA
- Key Concepts
  - Time Value of Money, Discount Rate, Present Value, Inflation
- The Current Use of BCA

# Overview (cont'd)

- Simplified BCA Example
- Critical Issues for Seismic Mitigation
  - BCA vs. Life Cycle Cost Analysis
  - Economic Evaluation of Human Life

# Application of BCA to the PBEE Framework

- Overview of Zerbe-Chang Protocol and Hypothetical Example
- Clear Illustration of How to Implement BCA in PBEE Framework
- Contributions:
  - Economic Operationalization of Performance Criteria
  - Identification of New Benefit Categories

# Application (cont'd)

- Port of Oakland Performance Criteria (from 1999 RFP):
  - 1. Establish ground motions having a 50% probability of exceedance in 50 years. The wharf and embankment system shall be designed so that under this level of shaking, only minor, repairable damage is anticipated and that operations will not be interrupted.

# Application (cont'd)

– 2. Establish ground motions having a 10% probability of exceedance in 50 years. The wharf and embankment system shall be designed so that under this level of shaking, controlled, economically repairable damage is anticipated and that operations may be limited and/or interrupted for a duration of up to 8 months.

# Performance Level

| *Performance Level* | *Abbreviation* | *Description* |
|---|---|---|
| 1 | "minor damage" | minor repairable damage and full functionality |
| 2 | "repairable damage" | Economically repairable damage and operations may be limited or interrupted up to 8 months |

# Performance Objectives: Hypothetical Example

| *Performance Objective* | *Event* | *PGA (hypothetical)* | *Achieve* |
|---|---|---|---|
| A | OLE (50%/50 yr) | 0.15g | Perf. Level 1 ("minor damage") |
| B | CLE (10%/50yr) | 0.40g | Perf. Level 2 ("repairable damage') |

# Mitigation Alternatives: Hypothetical Example

| Mitigation | Design PGA | Minor Damage Threshold | Repairable Damage Threshold | Perf. Obj. A met? | Perf. Obj. B met? |
|---|---|---|---|---|---|
| MO | Status-quo-do nothing | | | No | No |
| M1 | .15g | .15g | .28g | Yes | No |
| M2 | .20g | .20g | .38g | Yes | No |
| M3 | .40g | .21g | .40g | Yes | Yes |
| M4 | .75g | .40g | .75g | Yes | Yes |

# BCA Categories

- Costs
  - Facility Construction
- Benefits (Cost Savings)
  - Facility Repair
  - Emergency Response
  - Short-Term Revenue
  - Long-Term Revenue

# Critical Issues

- Multiple Stakeholders
  - Traditional BCA considers only the perspective of the "primary" stakeholder
  - Developing framework that incorporates the perspective of multiple groups that are differentially affected by the benefits and costs of PBEE decisions
  - Link to other projects, especially in economic group.

# Critical Issues (cont'd)

- Uncertainty
  - Analyst vs. nature (Zerbe-Chang)
  - Wilke Project

# Limitations and Applicability of BCA

- Criticisms and Limitations Discussed
  - Technical
  - Ethical
  - Process
- Resolving the Limitations
- Improving the Process