Earthquake Safety and Mitigation for School Buildings

Providing Protection to People and Buildings

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Overall purpose of course

To provide school district decision makers with a framework and information to make informed decisions about investing in earthquake risk management using a cost-effective, incremental approach.

Based on FEMA 395: Incremental Seismic Rehabilitation of School Buildings

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Learning Objectives

At the end of this course, you will be able to:

- Determine if your school buildings are located in a seismic zone
- Identify school buildings which may be vulnerable to earthquakes
- Initiate strategies to reduce the earthquake risk to vulnerable school buildings

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Agenda

- Understanding earthquake ***hazards***: where, when, and how big
- Recognizing earthquake ***vulnerabilities*** in school buildings
- Reducing earthquake ***risk*** in vulnerable buildings
- The ***incremental seismic rehabilitation*** approach
- Recommended ***actions*** for District leadership

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INTRODUCTION – SCHOOLS, EARTHQUAKE RISK AND LIABILITY

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Introduction

- School administrators face a wide array of risks daily
- Risks due to earthquakes are difficult to understand and anticipate
- Earthquakes are low probability, high consequence events

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Introduction

- Earthquake-threatened communities need earthquake-resistant schools
  - To provide safe buildings for children and staff
  - To maintain public education
  - To provide emergency shelters
  - To avoid major disruption to community life

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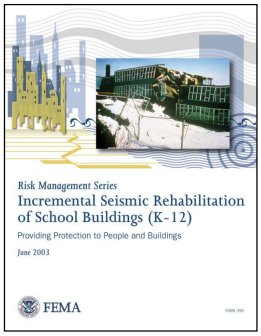
Introduction



- FEMA 395 provides a framework and information for managing school earthquake risks
- The Incremental Approach – reducing earthquake vulnerability at the most appropriate time in the building life cycle

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IS THERE AN EARTHQUAKE HAZARD FOR YOUR SCHOOLS?

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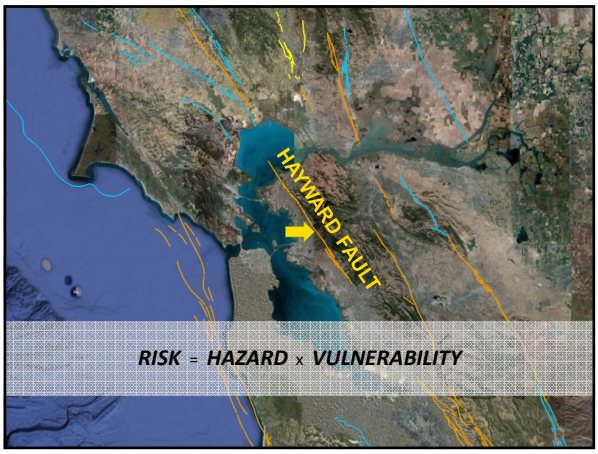

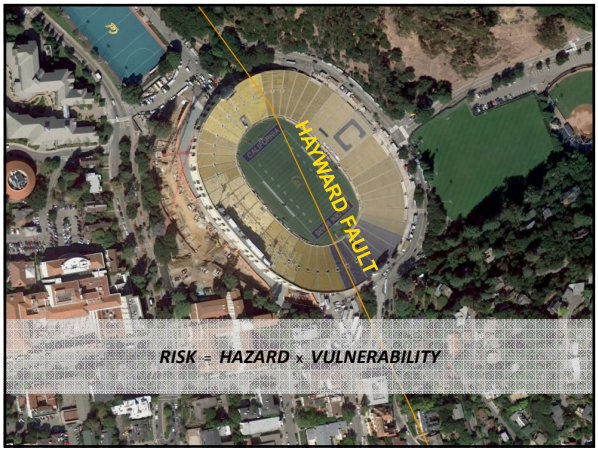

Types of Earthquake *Hazards*

- Strong ground shaking
- Fault rupture
- Reduced soil bearing capacity
- Landsides
- Tsunamis

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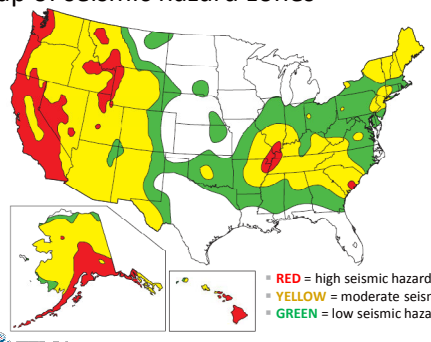
The U.S. Geologic Survey provides a map of seismic hazard zones



- **RED** = high seismic hazard zone
- **YELLOW** = moderate seismic hazard zone
- **GREEN** = low seismic hazard zone

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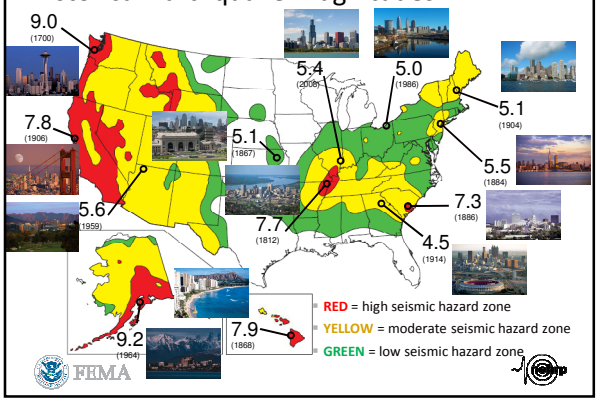
Historical Earthquake Magnitudes



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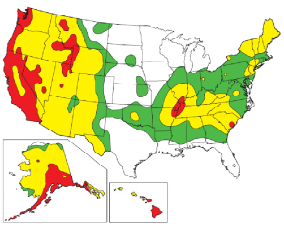
If your School District is in a **RED** zone



Earthquakes are a **significant risk** to facilities and occupants

- Implement a comprehensive facilities and site seismic assessment
- Include assessment of non-structural falling hazards
- Engage a structural engineer experienced in the seismic evaluation of existing buildings
- Develop a plan to replace or rehabilitate vulnerable buildings as soon as possible

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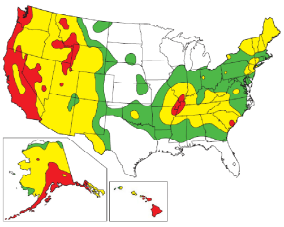
If your School District is in a YELLOW zone



Earthquake risks to facilities and occupants are **sufficiently high enough to warrant action**

- Take steps to initiate a comprehensive facilities seismic assessment
- Include identification of major nonstructural falling hazards
- Engage a structural engineer experienced in seismic evaluations in regions of moderate seismicity
- Develop a plan to replace or rehabilitate vulnerable buildings

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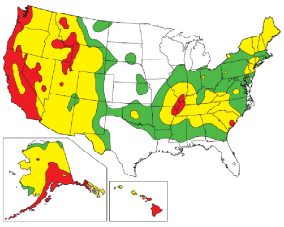
If your School District is in a GREEN zone



Earthquakes are a less likely risk to facilities and occupants, but low-cost mitigation should be implemented for **vulnerable** buildings

- Perform a rapid visual screening of buildings for seismic vulnerabilities
- District facilities staff may be able to perform this evaluation
- Focus attention on school buildings designated as emergency shelters
- Implement low cost mitigation strategies which protect occupants; consider protection of community investment in the facilities

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ARE YOUR SCHOOL BUILDINGS SAFE?

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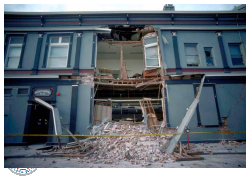
Building seismic *vulnerability* depends on many things



- Type of structure: materials, system and configuration
- Building use
- Contents
- Age and condition of the structure

Building codes and seismic safety

Long Beach 1933

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- Buildings constructed to a code **without** seismic design standards are likely to be vulnerable to earthquakes
- Buildings designed to a code with **obsolete** seismic standards are also likely to be vulnerable to earthquakes
- Building codes have evolved significantly in the past 25 years and include **substantially** improved seismic safety provisions

Near Misses at **Schools**: Long Beach 1933, Montana 1935, Alaska 1964

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Earthquake losses on campus and beyond

- Injuries and loss of life
- Damage to school buildings
- Damage to building contents
- Disruption to school operations
- Disruption to the community
- Inability to provide emergency shelter
- Legal liabilities

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Two options to estimate Seismic Vulnerability

- Rapid Visual Screening
  - "Rough Estimate"
  - Expected level of structural damage
  - Expected levels of content damage
  - Risk to safety of building occupants
- Detailed engineering analysis of individual buildings
  - National standard: ASCE 31-03 "Seismic Evaluation of Existing Buildings"

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WHAT CAN BE DONE TO REDUCE EARTHQUAKE RISK IN VULNERABLE SCHOOL BUILDINGS?

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Responsible Option: Proactive Earthquake Risk Mitigation

- PLAN
- ASSESS
- IMPLEMENT

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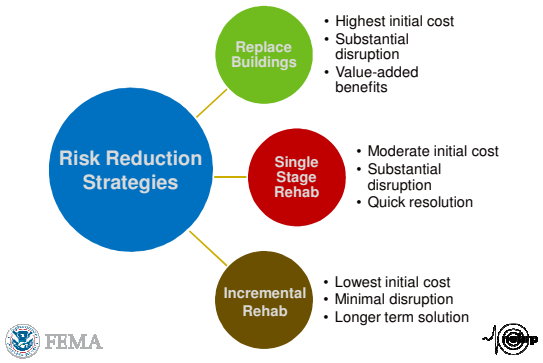
Strategies to reduce earthquake risk



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Essential Elements of a Seismic Rehabilitation Program integrated with School facility management

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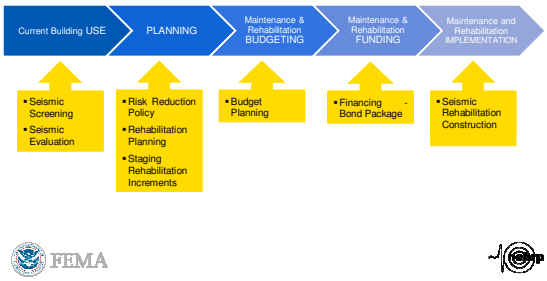

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Seismic Rehabilitation Costs

- Engineering and architectural design services
- Project management services
- Permit and inspection fees
- Construction costs
- Disruption of school operations
- Temporary swing space
- Communication with all stakeholders

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Seismic Rehabilitation Benefits

- Reduced risk of injuries and deaths
- Reduced building damage
- Reduced damage to contents
- Reduced disruption to school operations
- Reduced liability to District leaders
- Increased value and lifespan of the buildings
- Preservation of historic buildings

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Additional Elements of a Comprehensive Earthquake Safety Program

- Building Content Safety
  - Anchorage of tall bookcases
  - Fastening desktop equipment
  - Bracing of heavy suspended objects
  - Secure storage of chemicals
- Earthquake Safety Drills
- Post-EQ Response Plan

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INCREMENTAL SEISMIC REHABILITATION OF SCHOOLS

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Advantages of Incremental Rehabilitation

Single-Stage Rehabilitation

- All costs are concentrated in a short time period
- Construction is disruptive to school operations
- Requires temporary space during construction to house displaced students and staff
- All seismic vulnerabilities are mitigated in a single phase of work
- Seismic Rehabilitation work is generally performed independent of future maintenance and remodels

Incremental Rehabilitation

- Costs are distributed over multiple fiscal years
- Construction can be phased to occur during summer breaks to minimize disruption to school operations
- Students and staff are not displaced
- Seismic vulnerabilities are mitigated in a phased approach, beginning with the most severe vulnerabilities first
- Seismic mitigation can be integrated with other scheduled maintenance and remodel projects

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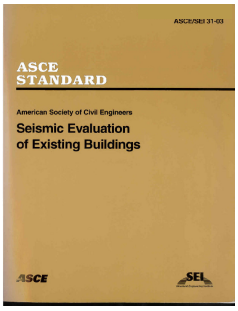
Assessment of Seismic Vulnerabilities



- Follow an accepted national standard, such as ASCE 31-03, "Seismic Evaluation of Existing Buildings"
- In **High** and **Moderate** seismic regions, engage structural engineering professionals
- In **Low** seismic regions, may be performed by knowledgeable District facilities staff

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Assessment of Seismic Vulnerabilities

- Systematically review the District building inventory, by campus and by building
- Group reviews of similar campuses and buildings together for efficiency
- Identify specific vulnerabilities
  - Structural
  - Contents and systems
- Prioritize the vulnerabilities for incremental rehabilitation

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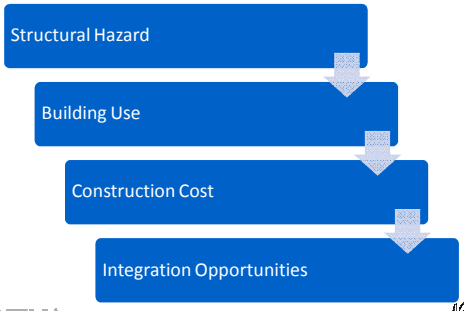
Considerations for Prioritizing Rehabilitation Increments



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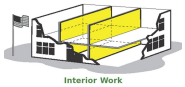
Integration Opportunities

- Roof work

- Exterior wall work



- Interiors

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Incremental Seismic Rehabilitation

- Develop a plan for incremental seismic rehabilitation
  - Specific campuses
  - Specific buildings
  - Building types
  - By level and area
- Reduce risk for both structural vulnerabilities and nonstructural falling hazards
- Document a District-wide plan to help leaders maintain focus and follow-through on the overall rehabilitation goals

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Case Study Example

- Background
  - California School District
  - 16 Elementary and 4 Middle School campuses with over 120 buildings
  - Most campuses dated to 1940's and 1950's
  - District staff included a Director of Facilities Improvement Program
  - District Policy set direction for Seismic Safety

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Case Study Example

- Discovery
  - Engaged experienced structural engineering firm
  - Comprehensive District-wide screening
  - Detailed seismic evaluation of potentially at-risk buildings
  - Deficiencies identified, qualified and prioritized
  - ROM cost estimate

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Case Study Example

- Planning
  - District Architect integrated seismic rehab into Facilities Master Plan
  - Rehabilitation vs. Replacement of buildings
  - Budgets established
  - Financing plan – capital bonds
  - Bond Campaign and Election

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Case Study Example

- Execution
  - Master Phasing Schedule developed for Incremental approach
  - A/E team prepared Construction Document packages, obtained regulatory approvals
  - Contractors prequalified
  - Bidding
  - Construction

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RECOMMENDED ACTIONS FOR SCHOOL DISTRICT LEADERS

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Recommended Actions

- Communicate to District leaders the importance of assessing your District's potential seismic risks
- Initiate a program to assess the seismic risk of your school buildings
- Develop and implement a strategy to mitigate identified seismic vulnerabilities
- Consider Incremental Seismic Rehabilitation as a cost effective strategy which minimizes disruption

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Review

- Application questions:
  - In which zone is your School District located?
    - Red, Yellow, Green, White
  - Do you have buildings which may be vulnerable to earthquakes, such as unreinforced brick buildings or other buildings constructed before 1973?
    - Yes/No
  - What is the next step you will take to lead your district in mitigating your seismic hazard?
    - Discuss with your District executive team; hire an engineer; nothing… ??

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Summary

- Earthquake hazards are present in over 2/3 of the United States
- Earthquake risk mitigation is most successful with a thoughtful, systematic and proactive strategy.
- FEMA 395 is an excellent resource to help navigate the process of seismic rehabilitation.
- Incremental Seismic Rehabilitation is an affordable option with minimal disruption to school operations.

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Resources

- Federal Emergency Management Agency
  - FEMA 395 – "Incremental Seismic Rehabilitation of School Buildings", June 2003
  - FEMA P-420 – "Engineering Guideline for Incremental Seismic Rehabilitation", May 2009
  - FEMA 547 – "Techniques for the Seismic Rehabilitation of Existing Buildings", 2006
  - FEMA 154 – "Rapid Visual Screening of Buildings for Potential Seismic Hazards", Second Edition, 2002
  - FEMA E74 – "Reducing the Risks of Nonstructural Earthquake Damage", September 2010
- American Society of Civil Engineers – ASCE 31-03 "Seismic Evaluation of Existing Buildings", 2003
- Guide and Checklist for Nonstructural Earthquake Hazards in Schools, California Division of the State Architect, January 2003
- US Geologic Survey – Earthquake Hazards Program
  - http://earthquake.usgs.gov

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Resources

- FEMA Grants and Financial Assistance
  - **NEHRP Earthquake State Assistance Program:** Cooperative agreement funding available to fund seismic mitigation plan, risk analysis, property inventory and seismic safety inspection, building codes adoption and enforcement, and earthquake outreach.
  - **Pre-Disaster Mitigation Grant Program:** Grant funding for hazard mitigation planning and the implementation of multi-hazard mitigation projects prior to a disaster event (i.e. construction, seismic rehabilitation, non-structural mitigation, etc.)
  - **Emergency Management Performance Grants:** Grant funding to support, maintain, and enhance all-hazards emergency management capabilities, which can be used for planning activities, risk analysis, emergency management staffing, equipment, training, and exercises, and for the construction or renovation of local critical emergency management facilities.
  - **Hazard Mitigation Grant Program:** Available during a presidentially declared disaster. Funds may be used to fund projects that will reduce or eliminate the losses from future disasters such as acquisition, seismic rehabilitation, etc.
  - **Other FEMA Grants:** http://www.fema.gov/government/grant/index.shtm
  - **Other Non-FEMA Grants:** http://www.grants.gov/

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Additional Questions?

- Send via email to Bill Andrews, bandrews@walterpmoore.com

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