Builders Guide to Earthquake Resistant Building Design

Course Number: CE-02-106

PDH: 5

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Module 1: Introduction to Seismic-Resistant Residential Construction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the historical background and key regulatory drivers leading to the current seismic guidance for residential construction.
- **Evaluate** the role of the International Residential Code's (IRC) Seismic Design Categories (SDCs) in determining prescriptive seismic requirements.
- **Differentiate** the concepts of strength, stiffness, and ductility as they apply to a house's response to earthquake ground motion.

Executive Summary: The primary goal of building codes, including the **International Residential Code (IRC)**, is to prevent loss of life by establishing minimum seismic resistance requirements. This course provides **above-code recommendations** (in boldface) to help Professional Engineers and builders achieve a higher performance level, significantly reducing post-earthquake damage and repair costs beyond the minimum code mandate.

1.1 Background on Seismic Guidance

The current guidance on seismic-resistant residential construction has evolved significantly since the early 1970s, driven by lessons learned from major earthquakes and changes in national building codes.

- **Post-1971 San Fernando Earthquake:** A study funded by HUD and NSF analyzed damage to residential buildings.
- **Initial Guidance:** The results led to HUD's 1980 non-engineering guidance document, *Home Builder's Course to Earthquake Design*.
- **FEMA Reissue and Update:** A federal agency reissued the manual as a joint publication in 1992. It was subsequently updated in 1998 by SOHA Engineers, still as the *Home Builders Course to Seismic Resistant Construction*, incorporating early findings from the 1994 Northridge earthquake.
- **CUREE-Caltech Woodframe Project:** This federally funded project addressed unexpected damage in woodframe structures from the Northridge earthquake, yielding crucial findings for guidance documents.
- **International Code Council (ICC):** The ICC was established in 1994 to unify previously distinct regional model building codes. The ICC published the initial editions of the **International Building Code (IBC)** and **International Residential Code (IRC)** in 2000. The *IRC* replaced the *One- and Two- Family Dwelling Code*.

This course, which retains the designation of the older manuals, is a complete rewrite initiated to incorporate these new findings and the adoption of the **2003 IRC**.

Focus of this Course

The course focuses primarily on one- and two-family detached houses of **light-frame wood construction**. The principles discussed are also relevant to houses using other materials, such as **light-frame cold-formed steel** and **insulated concrete form**.

The course explains:

- **Basic principles** of earthquake-resistant design.
- **Specific prescriptive seismic provisions** of the 2003 *International Residential Code*.
- **Results of recent research** and analysis.
- **Measures exceeding code requirements** (*above-code* recommendations) expected to reduce earthquake damage.

Limited guidance is also provided for house **additions and alterations** and for **anchoring typical house furnishings** (e.g., hot water heaters).

1.2 Above-Code Recommendations

Above-code recommendations describe construction details that are expected to result in a house performance level *above* the minimum required by the *IRC*.

- **Goal:** These techniques **reduce house deformations** during an earthquake, thereby reducing the amount of damage.
- **Format: Above-code** recommendations are presented in **boldface type** and appear, with associated discussion, in call-out boxes.
- **Cost-Benefit Analysis:** While improving performance, these recommendations will involve some added costs. The cost increase is cited as a percentage of the basic framing cost for the model house analyzed, allowing you to easily determine the associated added cost in your local area to make a reasonable **cost-benefit decision**.

1.3 The International Residential Code (IRC)

This course focuses on the **2003 IRC**, which provides comprehensive requirements for **prescriptive (nonengineered) residential construction**.

The *IRC*'s purpose is to provide minimum requirements to safeguard the public safety, health, and general welfare, focusing on affordability, structural strength, and stability, among other factors.

The *IRC* addresses multiple natural hazards, including earthquakes. When designing, you **must** consider all natural hazards presenting a risk to a specific site and formulate an appropriate mitigation strategy in accordance with the jurisdiction's building code, as details for resisting different hazards may vary.

1.4 IRC Seismic Design Categories (SDCs)

The *IRC* assigns a house to a **Seismic Design Category (SDC)** based on its location to designate the level of potential seismic hazard.

- **Categories:** The SDCs are **A, B, C, D1, D2, and E**.
    - **SDC A:** Lowest seismic risk.
    - **SDC E:** Highest seismic risk.
- **Exemptions:** All detached houses and townhouses in SDC A and SDC B are **exempt** from *IRC* seismic requirements.
- **Engineering Requirement:** SDC E regions have such a high seismic risk that houses generally fall outside the scope of the *IRC* and **must be designed using engineering principles** following the *International Building Code* or *NFPA 5000*.
- **Course Focus:** The discussion and examples in this course concentrate on houses in **SDCs C, D1, and D2**.

1.4.1 Mapping the Seismic Hazard

U.S. model building codes provide maps identifying the seismic hazard.

- **IRC Maps:** The 2003 *IRC* seismic design maps designate the SDCs for the nation. This is a simplified version of the maps referenced by the *IBC* and *NFPA 5000*.
- **Acceleration:** The legend correlates the SDC with the expected acceleration in terms of gravity (g). A value of 100% g equals the vertical acceleration effects of gravity on Earth.
- **Site-Specific Data:** You can use a CD-ROM or a federal geological survey website to input latitude/longitude or a zip code for more detailed information.

⚠️ **Safety Constraint:** Use zip codes with caution, as they may not reflect the **highest possible SDC** in the area covered by the postal code. Always verify the SDC with the local building department.

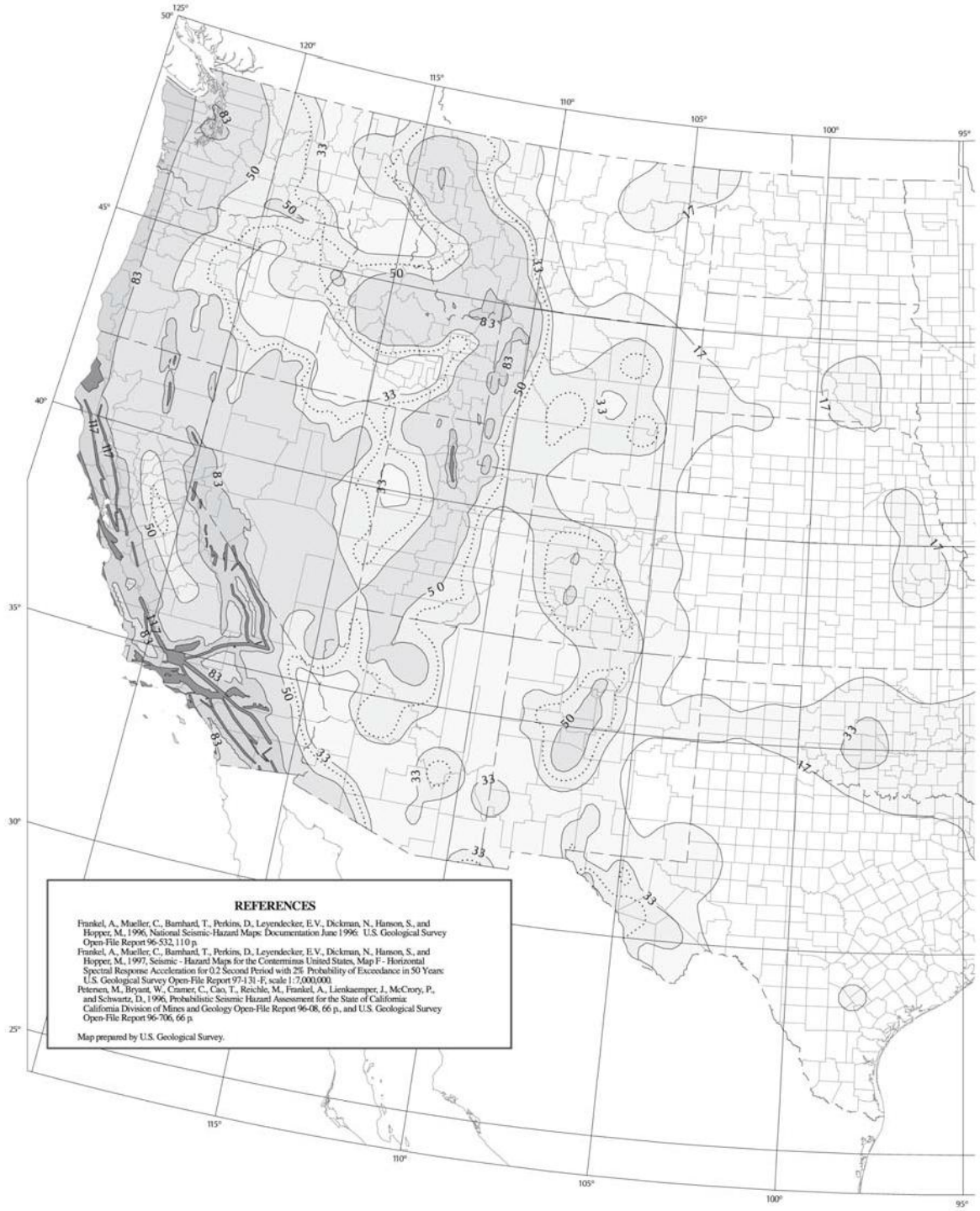

Figure 1-1 Seismic Design Categories – Site Class D.

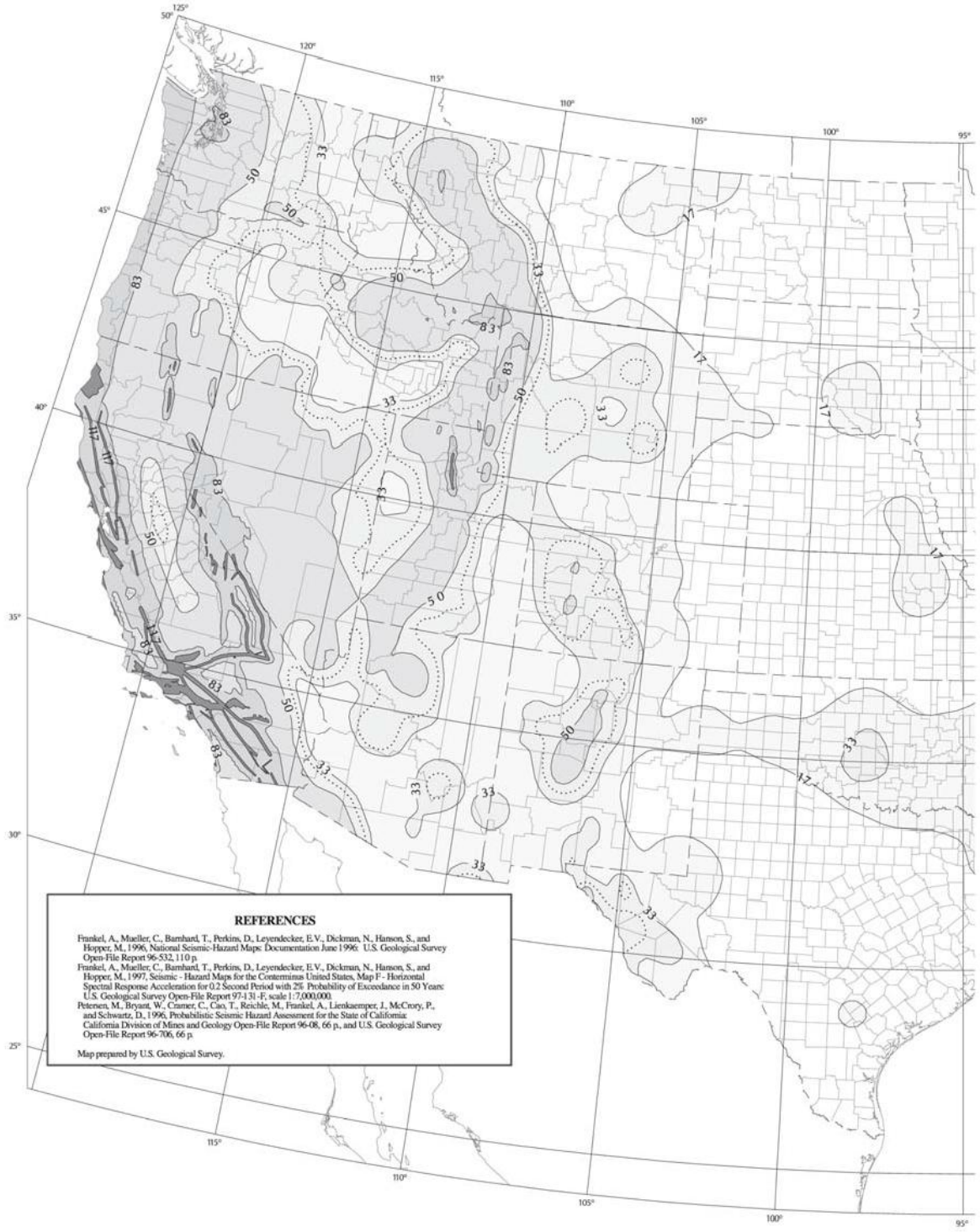

Figure 1-1 Seismic Design Categories – Site Class D (continued).

Purchase this course to see the remainder of the technical materials.