



## IBC 2006 and ASCE 7-05

### Seismic Design of Electrical Components

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## Presentation Overview

The goal is to explain how the seismic design requirements of IBC 2006 and ASCE 7-05 affect electrical components, by answering four questions:

- Why is this an Issue?
- When is Seismic Design Required?
- What is Involved in Seismic Design?
- Who is Responsible for Seismic Design?



## Presentation Overview

### Assumptions:

- Seismic Hazard - Western Washington
- Code Compliant Design



## Why is this an Issue?

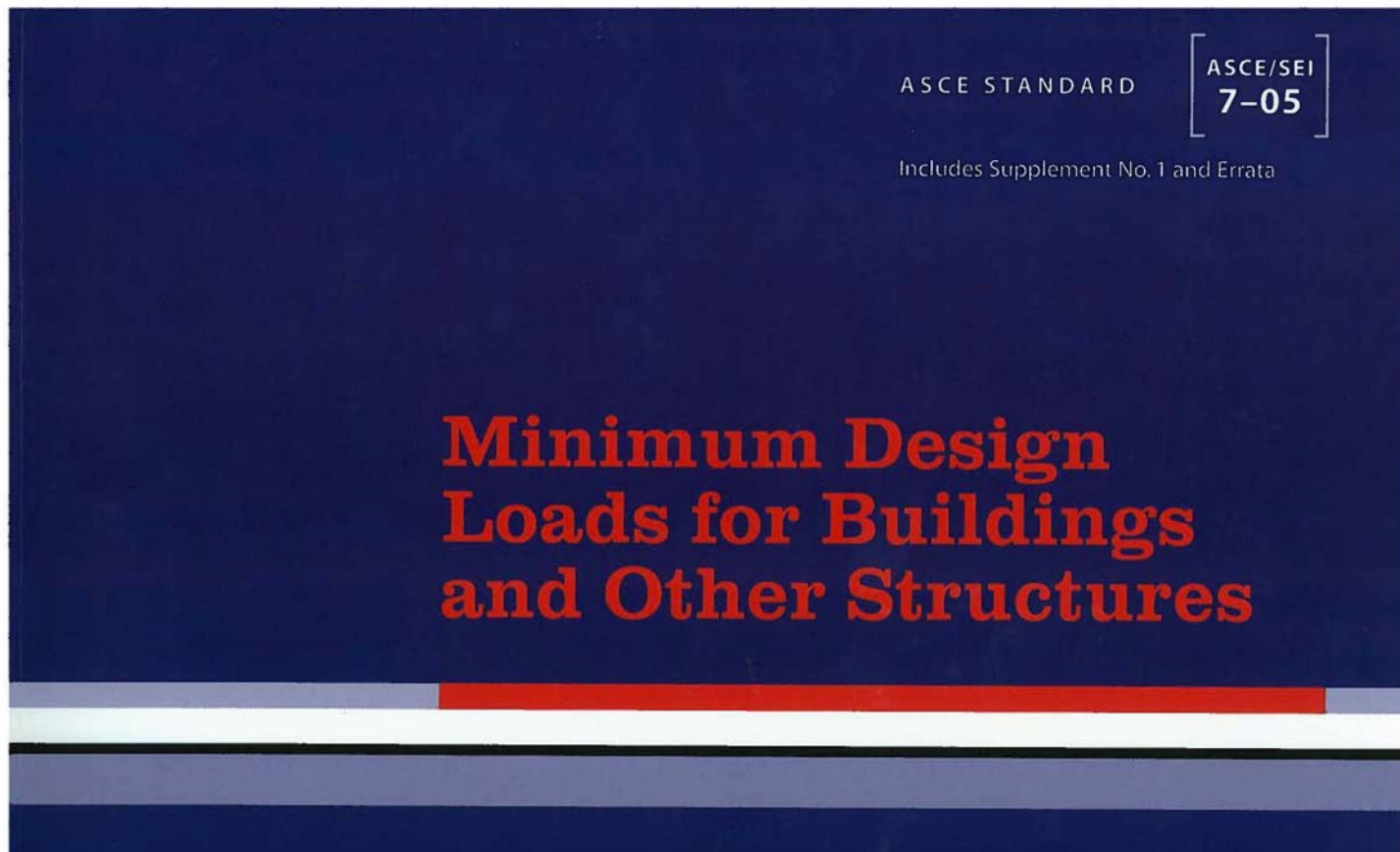


## Code History

Based on experience in earthquakes, the emphasis in the Building Code has evolved:

- 1982 UBC – ¼ Page on Non-Structural
- 1994 and 1997 UBC – ¾ Page on Non-Structural
- 2003 IBC and ASCE 7-02 – 15 Pages
- 2006 IBC and ASCE 7-05 – 10 Pages (smaller type)

# ASCE 7-05





# When is Seismic Design Required?



## When is Seismic Design Required?

Two reasons:

- Ensure that critical systems survive and remain functional following an earthquake
- Ensure that no system presents a hazard to building occupants.



## Critical Systems

### All Buildings:

- Components required to function for life safety purposes after an earthquake.
- Example: Exit Lighting

### Essential Facilities:

- Components needed for continued operation, or
- Components whose failure could impair operation.
- Example: Emergency Generator for Hospital



## What are Essential Facilities?

- Hospitals with surgery or emergency treatment
- Fire, rescue, ambulance, and police stations
- Emergency shelters
- Facilities required for an emergency response
- Public utility facilities required in an emergency
- Aviation control towers, air traffic control centers
- Water storage and pumping facilities for fire suppression



## Hazards to Building Occupants

### Components Tipping Over:

- Weigh more than 400 pounds

### Components Falling Down:

- Mounted more than 4 feet above the floor, and
- Weigh more than 20 pounds, or 5 pounds per foot.



# What is Involved in Seismic Design?

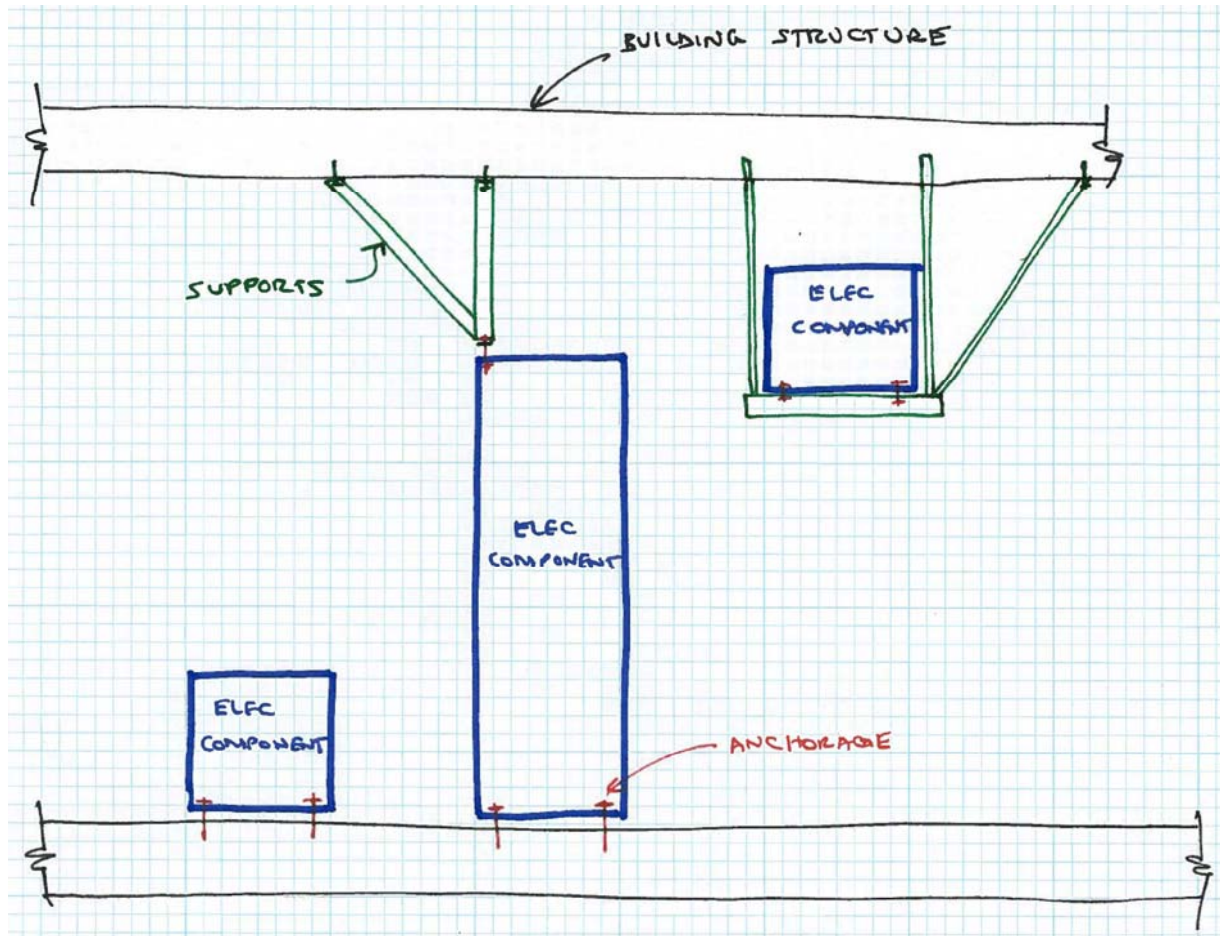


## What is Involved?

Three aspects to answering this question:

- What elements require design?
- What do these elements need to be designed for?
- How can these elements be designed?

# What Elements Require Design?





## What do these elements need to be designed for?

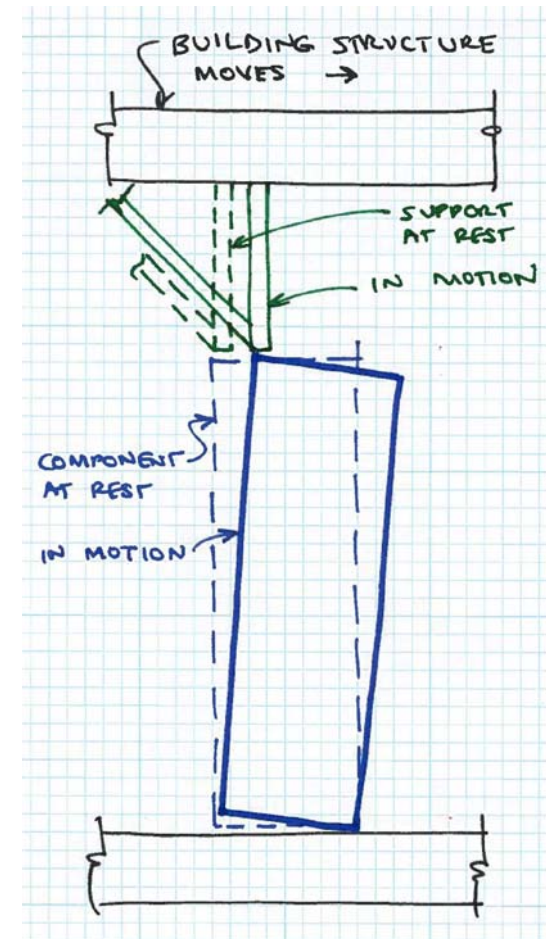
### Load and Displacement:

- Assumed Earthquake: 500 Year Event
- Loads
  - Ground motion induces forces in building components
  - Loads are dependent on height of installation
  - Loads are dependent on flexibility and ductility of component

Electrical Components	$a_p$	$R_p$
Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials	1.0	2.5
Communications equipment, computers, instrumentation, and controls	1.0	2.5
Lighting fixtures	1.0	1.5
Other electrical components	1.0	1.5
<b>Distribution Systems</b>		
Electrical conduit, bus ducts, rigidly mounted cable trays	1.0	2.5
Suspended Cable Trays	2.5	6.0

## What do these elements need to be designed for?

- Displacements
  - Floors move relative to each other
  - Design needs to allow for these movements





## How can these elements be designed?

### Ordinary Components:

- Project specific design by a registered design professional
- Manufacturer's Certification
  - Analysis
  - Shake table testing
  - Experience



## How can these elements be designed?

### Operable Components:

- Manufacturer's Certification
  - Shake table testing
  - Experience
- Must show equipment still works after shaking
- Evidence must be reviewed and approved by a registered design professional



## How can these elements be designed?

### Supports and Attachments:

- Project specific design by a registered design professional



# Who is Responsible for Seismic Design?



## Who Could be Responsible for Seismic Design?

### Design Team:

- Architect
  - Structural Engineer
  - Electrical Engineer

### Construction Team:

- General Contractor
  - Electrical Subcontractor
    - Component Manufacturer
    - Registered Design Professional



## How Does the Design Team Address their Responsibilities?

### Design Team:

- Conundrum
  - Responsible for defining what is required to construct a code compliant building.
  - Does not have all the necessary information to provide a design.
  - Fee and schedule pressures.
- Typical solution is to require the contractor to provide the design.



## How Does the Design Team Address their Responsibilities?

### Structural Engineer:

- Code Requirements are in “Structural” sections – Chapter 16 and 17 of the IBC, and ASCE 7-05.
- Needs to define load and displacement requirements.
- Needs to provide requirements for attachment to structure.
- Can be helpful by providing guidance on acceptable fasteners, especially for attachment to concrete.



## How Does the Design Team Address their Responsibilities?

### Electrical Engineer:

- Needs to define systems that must work after an earthquake.
- Needs to require contractor to provide seismic design.
- Needs to require Manufacturer's Certificates.



## How Does the Construction Team Address their Responsibilities?

### Construction Team:

- General Contractor
  - Responsible for coordination between trades
- Electrical Subcontractor
  - Responsible for purchasing equipment with the appropriate certifications.
  - Responsible for hiring a Registered Design Professional to design supports and attachments, and review Manufacturer's Certificates for critical equipment.



# Presentation Review



## Presentation Review

- Why is this an Issue?

- Experience has shown that the performance of non-structural systems is critical to building performance in earthquakes.
- As a result, the building code and building officials are placing increasing emphasis on the seismic design of non-structural components.



## Presentation Review

- When is Seismic Design Required?
  - When components present a hazard to building occupants by tipping over or falling
  - When components need to work after an earthquake



## Presentation Review

- What is Involved in Seismic Design?
  - Components, supports and attachments
  - Loads and displacements
  - Manufacturer's Certificate for components
  - Engineered design for supports and attachments



## Presentation Review

- Who is Responsible for Seismic Design?
  - Design team needs define responsibility
  - Typically, a specialty structural engineer working for the electrical subcontractor.



## Discussion



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