

Seismic 101

Water Infrastructure Seismic Design Considerations
Pacific NW AWWA Section Conference
Boise, ID May 4, 2016

Matthew Perkins



MWH

BUILDING A BETTER WORLD

Structural Engineering 101



(c) Charlie Borland

Pseudo seismic forces

pseu·do

/ˈsōdō/ 

adjective

not genuine; sham.

"we are talking about real journalists and not the pseudo kind"

synonyms: bogus, sham, phony, artificial, mock, ersatz, quasi-, fake, false, spurious, deceptive, misleading, assumed, contrived, affected, insincere; [More](#)



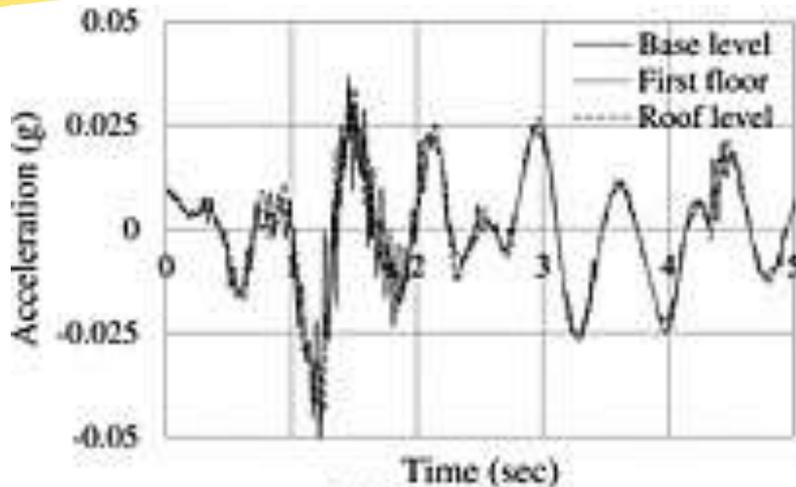
Translations, word origin, and more definitions

Newton's second law

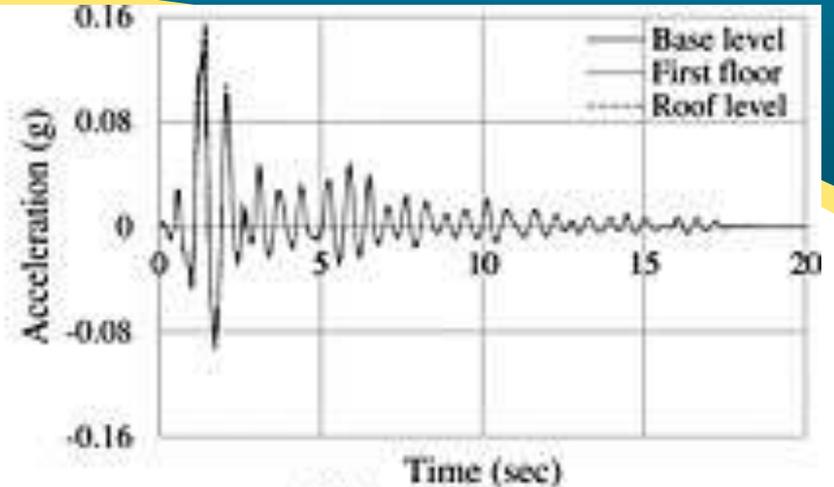
- Force = mass x acceleration
- $F = ma$
- To get pseudo force find pseudo acceleration

$$C_s = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)}$$

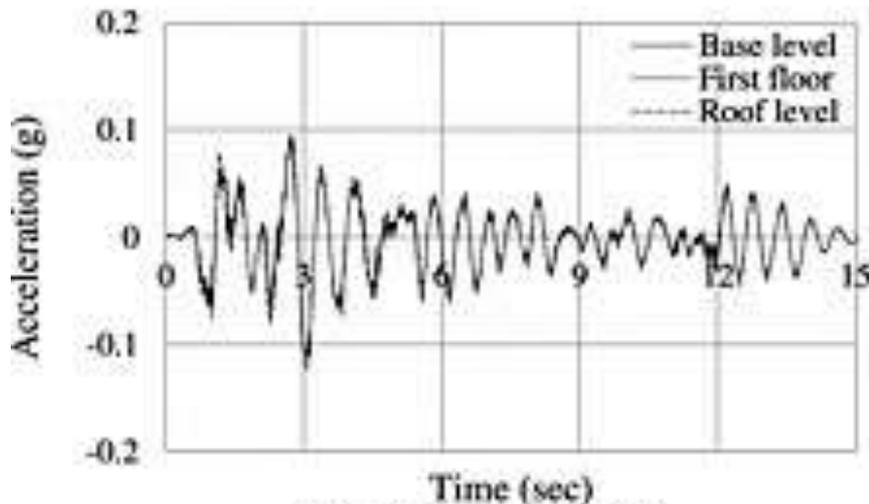
Pick your seismic event



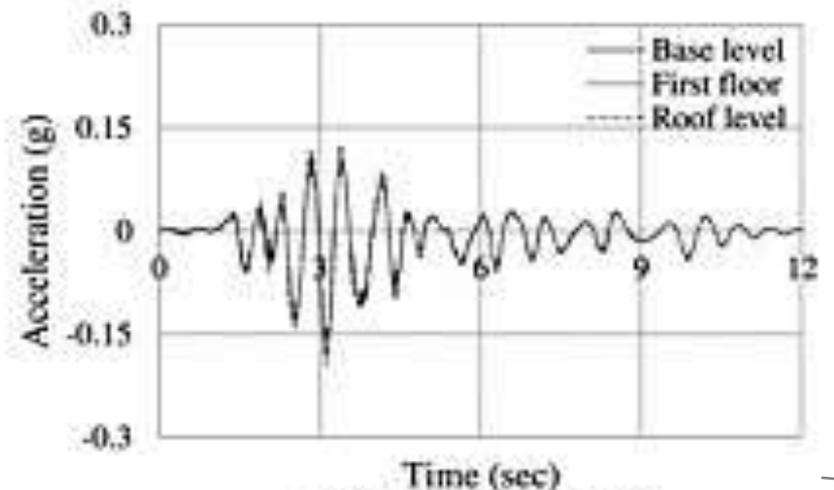
(a) Koyna (1967)



(b) Parkfield (1966)



(c) El Centro (1940)

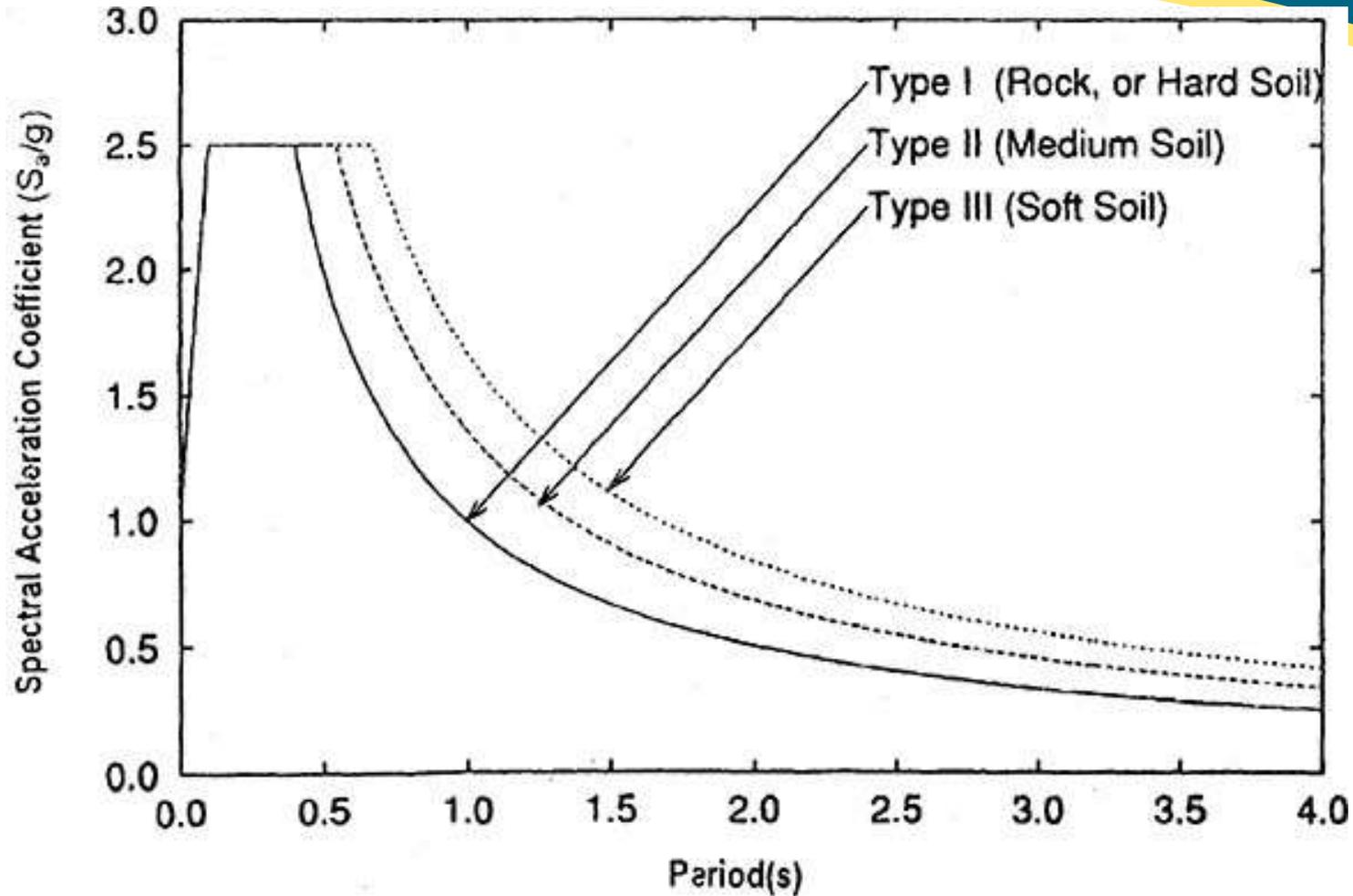


(d) Victoria (1980)

The “Big One”

- Cascadia Subduction Zone Earthquake
- Magnitude 7 – 9
- 10 - 30% chance in the next 50 years
- Intense shaking for 4 minutes

Response Spectra



Buried Concrete Reservoir R = 3



Buckling restrained braces $R = 8$



New Construction

- Code Requirements
 - International Building Code (IBC)
 - ASCE 7 provides minimum design loads
- Code minimums are designed to protect human life, they are not intended to protect assets.

Owner Expectations

- Supply water for fire suppression?
- How long until production of water may resume?
- Recent estimates in Oregon for water systems to be fully operational in 1 month – 1 year after event.

Public Expectations

- OR and WA are creating seismic resiliency plans
- Plans based on economics, health, and environment

How does the facility fit into the code?

OCCUPANCY CATEGORY	NATURE OF OCCUPANCY
III	Water treatment facilities for potable water.
IV	Designated earthquake, or other emergency shelter. Water storage facilities and pump structures required to maintain water pressure for fire suppression.

What is the benefit of designing facilities with OC IV?

- Structural elements are 20% more resistant to seismic loads.
- Equipment is tested for seismic loads.
- Less components meet requirements to be exempt from seismic design.

Another option

- Use code minimum OC III
- Select specific criteria
 - Increase seismic importance factor
 - Specify seismic design for critical elements which the code provides exemptions

The little things



Existing Treatment Facilities

- When originally designed, what was the desired performance level after a seismic event?
- What is the desired performance level after a seismic event now?
- Generally structures built before 1990 are expected to perform poorly (75% of water infrastructure).

Existing Structures and the Code

- ASCE 41
 - Seismic Evaluation and Retrofit of Existing Structures
- Basic Performance Objective Equivalent to New Building Standards (BPON).
 - 2% probability in 50 years -> Cascadia Eq “The Big One”

The Easy Fixes

The screenshot shows the Home Depot website interface. At the top, there's a navigation bar with the Home Depot logo, a store locator for Broomfield #1524, and various utility links like 'Tool & Truck Rental' and 'Get It Installed'. A search bar is prominently displayed with the placeholder text 'What can we help you find?'. Below the search bar, there are dropdown menus for 'Shop By Department' and 'Project: How-To'. The main product area features a large image of the 'Watts Galvanized Steel Water Heater Strap Kit' on the left. To the right of the image, the product title is followed by model and internet numbers. Below this, there are social media sharing icons, a star rating, and buttons for 'Write The First Review' and 'Ask a Question'. The price is listed as '\$10.43 /EA-Each'. A shipping notice states that the item cannot be shipped to AK, GU, HI, PR, and VI. Shipping and pickup options are provided, including 'Ships FREE with \$45.00 Order' and 'Buy Online, Pick Up In Store Today'. At the bottom of the product section, there are tabs for 'Product Description', 'Specifications', 'Customer Reviews', 'More Info', and 'Shipping Options'. On the right side of the page, there are two vertical panels. The top one contains a quantity selector set to '1', an orange '+ ADD TO CART' button, a 'CHECK STORE INVENTORY' button, and another '+ ADD TO MY LIST' button. The bottom panel is titled 'CUSTOMERS WHO VIEWED THIS ITEM PURCHASED...' and features a smaller image of the product, the price '\$11.97', the text 'Stainless Steel Water Heater Straps', a star rating of '(1)', and an orange '+ ADD TO CART' button.

THE HOME DEPOT

Tool & Truck Rental | Get It Installed | For the Pros | Gift Cards | Help 

Your Store: Broomfield #1524 (Change) | Store Finder | Local Ad | Credit Center | Savings Center

Shop By Department What can we help you find? Project: How-To

Home



Watts Galvanized Steel Water Heater Strap Kit

Model # TSE-25 | Internet # 202266006 | Store SKU # 437846

★★★★★ | [Write The First Review](#) | [Ask a Question](#)

\$10.43 /EA-Each

This item cannot be shipped to the following state(s): AK, GU, HI, PR, VI

 Zoom

 Ships FREE with \$45.00 Order

 Buy Online, Pick Up In Store Today
[Check Store Inventory](#)

Product Description | Specifications | Customer Reviews | More Info | Shipping Options

COLLECTIONS (2)

Quantity:

CUSTOMERS WHO VIEWED THIS ITEM PURCHASED...



\$11.97

Stainless Steel Water Heater Straps

★★★★★ (1)

Questions?

Presented by: Matthew Perkins matthew.perkins@mwhglobal.com