

## Recommendations

- Analysis before testing
- Records to avoid
- Different kinds of records
- Special structural behavior
- Treating variability
- Guidelines for six situations
- Understanding test results using analysis

## Analysis Before Testing

- Experimenters should test several potential records on an analytical model to confirm that the record that is selected meets the test objectives
- So it is necessary to select several records for analysis even if only one is to be used in testing

## Records to Avoid

- A single record selected for testing should not be deficient in any important frequencies (well above and below the first mode frequency), and not be abnormal in duration and phasing.

## Different Kinds of Records

- Large amplitude records
- Impulsive records e.g. caused by rupture directivity
- Short duration records
- Intermediate duration records
- Long duration records e.g. produced by large magnitudes or basin waves
- Broadband records
- Narrow band (e.g. soft soil) records
- Records with energy concentrated at short, intermediate or long periods

## Special Structural Behavior

- Some kinds of records might be important for certain types of structural behavior that are hard to capture other than empirically (e.g., cyclic degradation of strength of elements.)
- Experimenters should think about which of these characteristics' ranges could only be identified by physical testing – this may define limits to the conclusions they can get from the record they use and perhaps motivate further tests.

## Treating Variability

- Parametric studies are likely to be focused on sensitivity of behavior to variations in models under the *same* input.
- If the researcher is trying to identify *differences* in behavior between specimens (e.g., types of connections) then there are very good reasons to hold the input constant across such tests.
- Analysis may be able to measure record-to-record variability. The focus on "*best-estimates*" might even favor spectrally matched records.

## Objectives of Testing or Simulation

- Evaluate capacity of specimen to withstand specified level(s) of ground motion

*In this case, record preparation follows current best design practice and is critical to outcome*

- Verify or calibrate analytical model

*In this case, procedure for record preparation is less structured and less critical to outcome*

## Suggestions on Time History Preparation for 3 Work Scopes

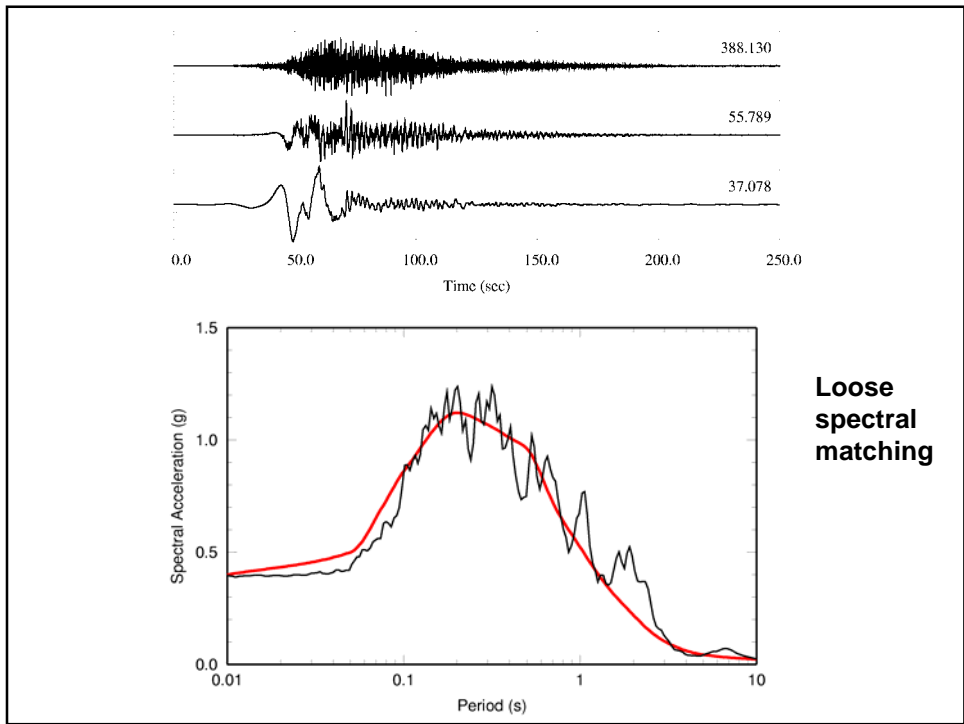
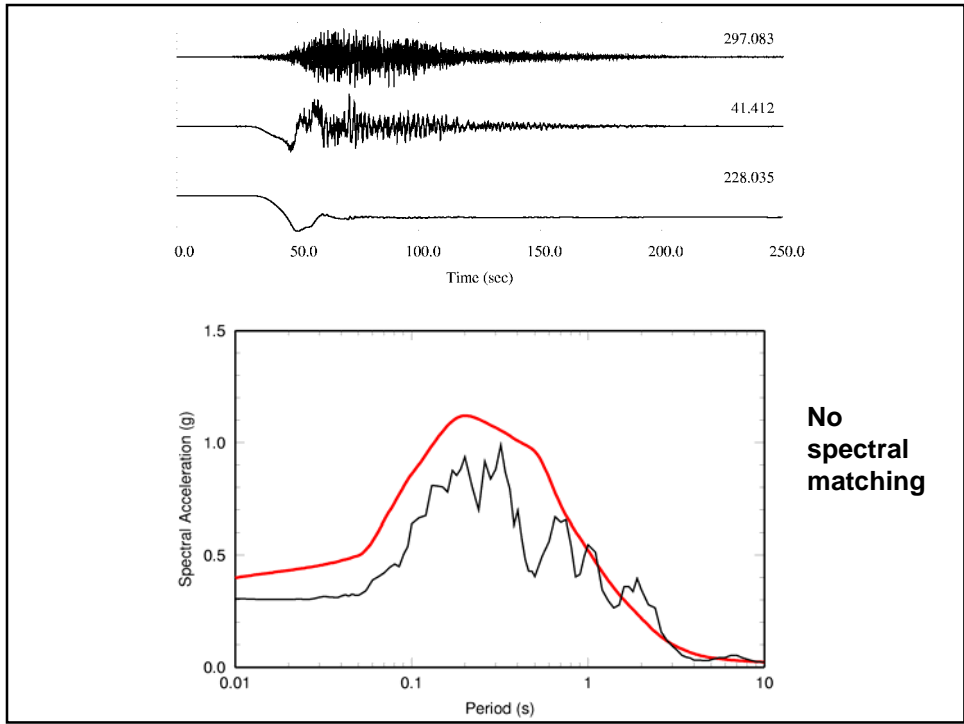
- **100 time histories** – for simulation
  - **4-10 time histories** – for lab testing
  - **1-3 time histories** – for lab testing
- for
- **Specified Site** – can be specific about ground motion characteristics; suitable for both capacity testing and verification / calibration
  - **Unspecified Site** – cannot be specific about ground motion characteristics; suitable only for verification / calibration

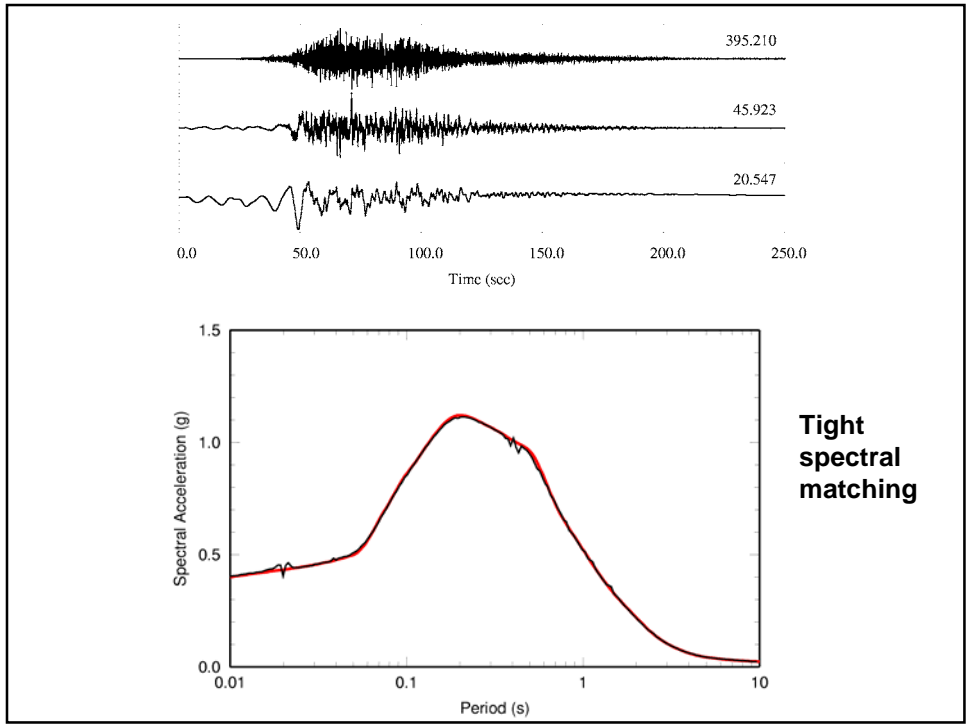
## Terminology for Specified Site

- **SCALE:** scale each record to match the target response spectrum over a period range that is significant for the structure. (The broader this range, the less important epsilon is)
- **MATCH:** spectrally match each record to the target response spectrum

## Spectral Matching

- No spectral matching, which may leave critical peaks and troughs that strongly determine nonlinear response – OK when using many recs
- “Loose” spectral matching, which makes the response spectrum approximately follow a smooth target spectrum but leaving peaks and troughs – OK when using a few records
- “Tight” spectral matching, which makes a smooth response spectrum that lacks peaks and troughs but conforms to a smooth uniform hazard spectrum - OK when using 1 record - minimizes variability but may introduce bias





## Record Selection - Specified Site

- Select annual probability level(s)
- Deaggregate probabilistic hazard by M, R,  $\epsilon$  for each level and select main contributing M, R,  $\epsilon$  combinations
- Consider possible contributors to  $\epsilon$  not included in probabilistic hazard, e.g. directivity effects, basin effects
- Select records that represent M, R, and  $\epsilon$  for each level

Total No. of Records	100	4-10	1-3
No. of probability levels	p	p	1-3
No. of M, R, $\epsilon$ combinations	c	c	3-1
No. for each combination	100/pc	4-10/pc	1
Modify	Scale	Scale	Match

## Terminology for Unspecified Site

- **SCALE:** scale each record to meet the experimental objectives
- **MATCH:** spectrally match each record to a smoothed version of the response spectrum of the record

## Record Selection - Unspecified Site

Select time histories considering a wide variety of kinds:

- Impulsive; Short duration; Intermediate duration; Long duration records
- Broadband; Narrow band (e.g. soft soil) records
- Records with energy concentrated at short, intermediate or long periods; Large amplitude records

Total No. of Records	100	4-10	1-3
No. of kinds	10	4-10	1-3
No. of each kind	10	1	1
Modify	Scale	Scale	Match

## Understanding Test Results

- Experimental tests may often use only one time history
- Parallel analytical studies may be used to understand the test results and what they mean to the range of real problems, including different ground motions
- Such analytical studies can benefit from close involvement of ground motion experts

## **SCEC-NEESR Collaboration on Time Histories**

- SCEC is funded by a 2.6 year project to provide ground motion time histories to NEESR researchers
- Will draw on resources provided by PEER-Lifelines Program
- Interested NEESR researchers should contact Paul Somerville at [paul\\_somerville@urscorp.com](mailto:paul_somerville@urscorp.com)  
626-449-7650

**SCEC-NEESR Collaboration on Time Histories:  
Representation of Spatial Wavefields by  
Time Histories**

**OBJECTIVE:**

- Provide a spatial wavefield of time histories having realistic spatial variations due to incoherence and wave passage effects

**APPLICATIONS:**

- Structures with extended foundations, including contrasts in site conditions and topography (such as dams)
- Structures with multiple supports (such as bridges)