

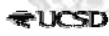
# Full-Scale Structural and Nonstructural Building System Performance during Earthquakes & Post-Earthquake Fire

A Joint Venture between Academe, Industry and Government

## *Ground Motions*

Robert Bachman

RE Bachman, Consulting Structural Engineers



Guadeloupe 1843

## Design Ground Motions

In the November 2009 Joint Meeting, we tentatively agreed on the following criteria regarding Design Ground Motions

- The building design ground motion should be based on a site in downtown with a target MCE peak spectral velocity (5% damped) of 87 inches/sec on a Site Class D soil profile
- A site specific MCE design response spectra should be developed in accordance with current building code provisions and the LA Tall Building Council recommendations.
- For design, the average of 7 time histories would be used that have been selected and scaled in accordance with current building code provisions and the LA Tall Building Council recommendations.

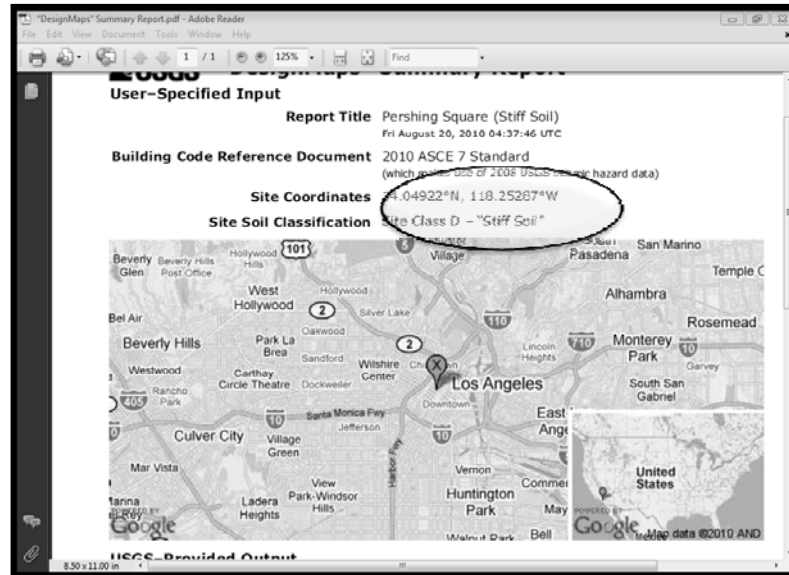
## Design Ground Motions (continued)

- The building is expected to have an MCE effective fundamental period in the 1 – 1.5 second period range
- MacTec developed a site specific spectra for site in downtown LA near Pershing Square for Site Class D ( $S_{M1} = 1.4$  gs) - slightly higher than the code mapped value adjusted for site soil conditions.
- MacTec also selected and scaled 7 time histories for the MCE target spectra consistent with current building code requirements and LA Tall Building Council recommendations.
- MacTec used spectra matching to scale the records over a wide range of periods which is current typical practice.

## Design Ground Motions at Service Level

- MacTec did not provide any site specific spectra or ground motions for the Design Earthquake since it will not be used for design.
- Design of building will be based on MCE motions and Service Level Motions. Service Level motions are defined as having a return of 43 years
- To determine service level motions, we used the UGSS website using the seismic hazard relationships used to develop the current building code maps (geomean values).
- For 43 years, the 1 second period soft rock spectral value at Pershing Square is 0.125 g and when scaled by the proper  $F_v$  (2.3) to adjust for site soil conditions you get  $S_a(T = 1.0) = 0.287$  g which is 20.5% of the MCE 1 second spectra value
- For design purposes the 43 year spectra = 0.2 x MCE spectra

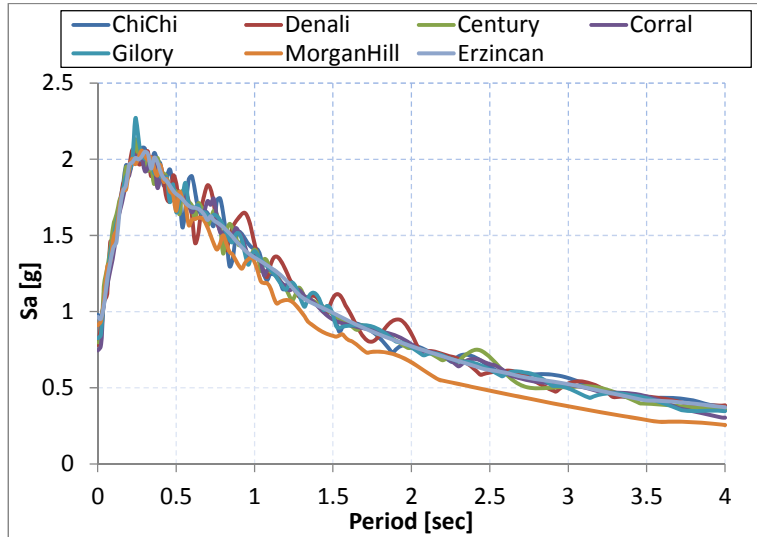
## Site Condition



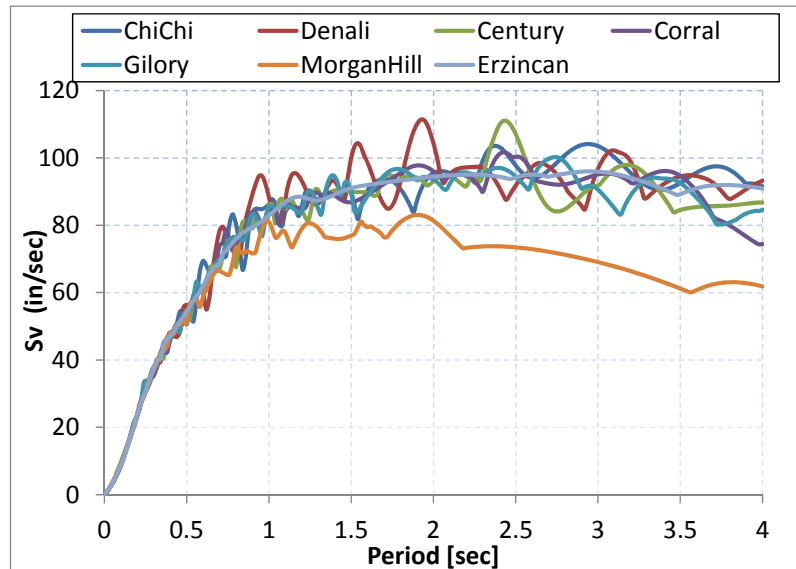
## Ground Motion Profile

Ground Motion	Eqk. Event	Year	Station	PGA	PGV	PGD	Arias Intensity	Duration	Significant Duration
				(g)	(in/sec)	(in)	(in/sec)	(Sec)	(sec)
ChiChi	ChiChi	1999	TCU 087	0.978	54.4	38.9	357.4	90	18.44
Delani	Delani	2002	Pump #10	0.781	54.1	31.8	1264.1	92.095	47.255
Century	Loma Prieta	1989	Century City	0.798	49.1	18.1	1061.2	40	21.58
Corral	Loma Prieta	1989	Corralitos	0.745	43.6	33.6	522.2	39.945	13.02
Gilroy	Loma Prieta	1989	Gilroy Array #6	0.825	56.0	19.4	918.7	39.955	20.45
Morgan	Northridge	1994	Anderson Dam	0.911	44.7	26.8	657.1	28.325	13.79
Erzincan	Turkey	1992	Pumps #9	0.965	60.3	23.7	229.2	21.31	7.445

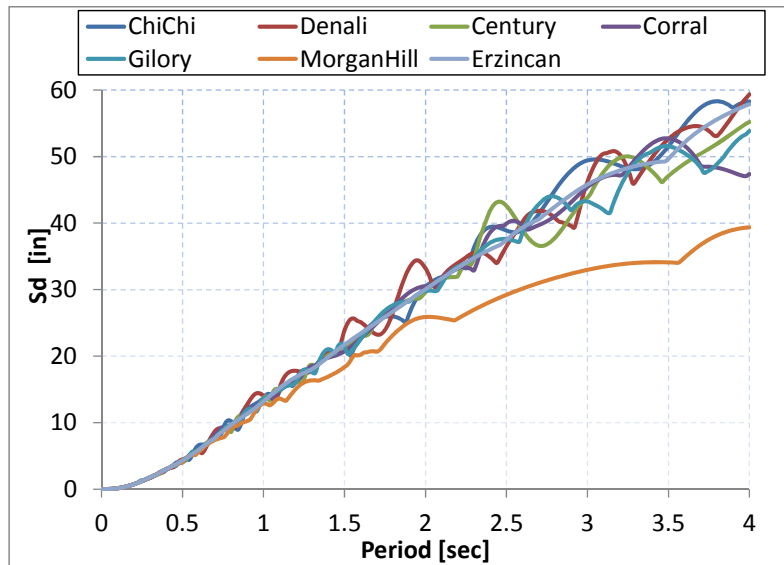
## Pseudo Acceleration Spectra



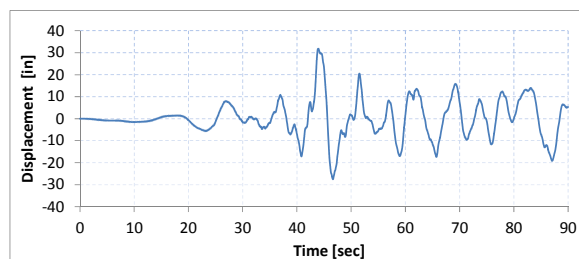
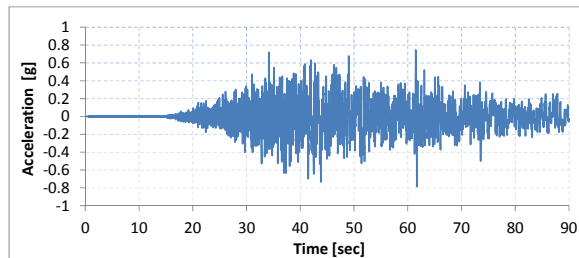
## Pseudo Velocity Spectra



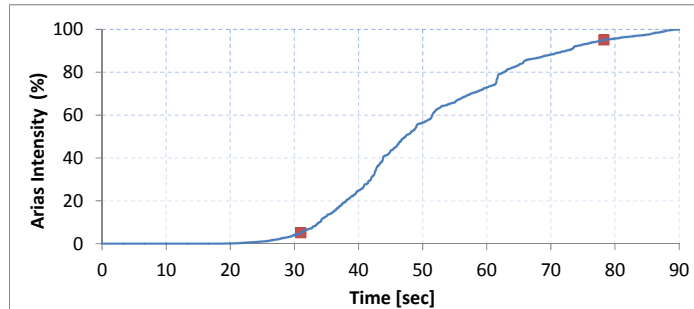
## Displacement Spectra



## Ground Motion - Denali



## Ground Motion - Denali



## Maximum Test Motion

- At this point in design, the building design team requested that a record be selected for the maximum motion that would be tested.
- After reviewing the records, it was agreed to by the Core Team that the maximum test motion would be spectral matched Denali record.
- This record had many excellent characteristics including long duration and good Arias intensity ramping.
- Final amplitude scaling of this motion will be decided later.
- Test motions at other amplitude levels will also be decided later. Cumulative damage is a consideration.