Influence of topographic irregularities on the amplitude and phase of strong ground motions

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Tuesday, June 26 – Friday, June 29
OBJECTIVES — SITE

- Evaluation of the influence of topographic irregularities on the amplitude and phase of ground motions using OpenSees

- 19 spans and 18 piers
- Length: around 1100 meters
- Max width: around 10 meters
- Maxi height: 120 meters close by the canyon
2D OpenSees model:
- plain strain condition;
- Four-noded, bilinear, isoparametric finite elements with 4 point of integration each;
- Modified Lysmer-Kuhlemeyer boundary conditions;
- SV wave propagation (horizontal equivalent nodal forces at base);
- Ideal mesh dimension for the wave transmission (< 1/10 λ).

**Model Verification soil deposit** (using ad-hoc Boundary Element Method - BEM):

- Homogeneous Soil ($V_s = 500$ m/s, $\nu = 0.33$);
- Dimensionless frequency: $\eta = \frac{\omega B}{\pi V_s} = \frac{2Bf_{\text{input}}}{V_s}$

<table>
<thead>
<tr>
<th>$f_{\text{input}}$ [Hz]</th>
<th>$\eta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25</td>
<td>0.5</td>
</tr>
<tr>
<td>2.5</td>
<td>1.0</td>
</tr>
<tr>
<td>3.75</td>
<td>1.5</td>
</tr>
</tbody>
</table>

$U_x = \text{horizontal component of the peak ground surface acceleration;}$
$U_y = \text{vertical component of the peak ground surface acceleration.}$
**SEISMIC RESPONSE**

<table>
<thead>
<tr>
<th>Event ID</th>
<th>Event (station)</th>
<th>$T_m$ (sec)</th>
<th>$\eta_m$</th>
<th>$D_{5-95}$ (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID1</td>
<td>M7.6 Izmit, 1999 - (IST180)</td>
<td>0.44</td>
<td>0.91</td>
<td>37.6</td>
</tr>
<tr>
<td>ID2</td>
<td>M6.2 Morgan Hill, 1984 - (Gilroy Array #1)</td>
<td>0.22</td>
<td>1.82</td>
<td>9.5</td>
</tr>
<tr>
<td>ID3</td>
<td>M6.9 Loma Prieta, 1989 - (LGP000)</td>
<td>0.50</td>
<td>0.80</td>
<td>12.8</td>
</tr>
<tr>
<td>ID4</td>
<td>M6.7 Northridge, 1994 - (NSC52)</td>
<td>0.63</td>
<td>0.64</td>
<td>26.7</td>
</tr>
</tbody>
</table>

5% structural damping ratio

$H = 3b$
$L/H=4$

$A_h = \frac{a_h}{a_{h,ff}}$  
$A_v = \frac{a_v}{a_{h,ff}}$

$a_h, a_v = PGA_h$ and $PGA_v$ at each point of the ground surface; $a_{h,ff} = $ free-field $PGA_h$.

- When $\eta_m$ decreases $A_h$ and $A_v$ increase;
- Phase shift caused by combination of topographic irregularities (reflection + refraction) and wave passage effect.
Thank you and...

...see you at the poster session!

**Poster location:** Location 074  
**Poster Session Time:** 5:15 PM - 7:00 PM  
**Poster Session Location:** Pasadena Hall (Exhibit Hall) - One Level Below Lobby