Directionality of response spectral ordinates in the 2023 Kahramanmaras, Türkiye earthquake doublet

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What is horizontal ground motion directionality?



How do we currently treat spectral intensities at a site?



But what intensity should we use?



Orientation of maximum intensity

- Current code approach considers two cases:
 - For sites near-fault (i.e., within 10-15 km of the surface projection of faults), the orientation of maximum intensity is fault-normal
 - For sites not near-fault, the orientation of maximum intensity is assumed to be random



Past studies have historically focused on studying orientation of maximum intensity with a reference orientation that is the same for all recording stations

Orientation of maximum intensity

- Recent findings by others:
 - More recently, Poulos and Miranda (2023) found that the orientation of maximum intensity for ground motions in the NGA-West2 database depends on the faulting mechanism
 - For strike-slip earthquakes, they found that the orientation of maximum intensity occurs close to the epicentral transverse orientation, which they attributed to the polarization of S-waves

The 6 February Türkiye generated one of the most extensive collections of strong-motion data recorded from strike-slip earthquakes with $M_w > 7.4$ and provides an exceptional opportunity to validate and further study the observations of Poulos and Miranda (2023)

So, what does it look like for the Türkiye doublet?



Bidirectional response



Bidirectional response - normalized





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Orientation of maximum spectral response

Maximum slip transverse – a better estimator?



Empirical distribution



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Summary and Conclusions

- Ground motion intensity can vary significantly with changes in horizontal orientation
- There are certain orientations that current GMMs over or under-estimate
- For strike-slip earthquakes, we have found that we can predict where these over and under-estimations occur
- More specifically, the orientation of maximum spectral response for strike-slip earthquakes occurs generally close to the epicentral transverse orientation
- For large-magnitude strike-slip earthquakes (such as the M_w 7.8 Kahramanmaras), the maximum slip transverse may be a better predictor of orientation of maximum spectral response

If you are interested in more...

Turkey Special Issue - Research Paper

Directionality and polarization of response spectral ordinates in the 2023 Kahramanmaras, Türkiye earthquake doublet

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Türkiye Special Issue - Research Paper

Directionality of FIV3 ground-motion intensities during the 6 February 2023 Kahramanmaraş, Türkiye earthquake doublet



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