Rotation motion and its effcts on near-fault ground motions

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Rotation motions are not yet considered in seismological and earthquake engineering analyses because of lacking of rotation records in the past. However, commercial rotation seismometers will soon be available. In the past decade, rotation seismology has significant progress and its development that related to near–fault ground motion are summarized as following:

Measurement of rotation ground motions

- A complete description of ground motions requires a cosite six-component recording (thrre–component translation and three-component rotation motions).
- Rotation motions are not recorded in translation (strong-motion) seismomogram, but their induced effects can significantly modify the translation waveforms.
- Commercial rotation seismometers for both the seimological and the engineering applications will be available soon.

Features of rotation motions

- Rotaion motions are always accompany with translation motions,
- An empirical scaling relationship based on a set of six-component data shows that the peak rotation motion grows up rapidly as the increase of translation motion

Rotation motions induced effects

- Two rotation induces effects are centrifugal acceletion and grvity effects which can be derived from a set of cosite six-component seismogram. The amplitudes of these two types of induced accelerations grow up rapidly as the increase of translation motions and therefore the induced acceleration might significantly modify the near-fault strong-motion records.
- The induced centrifual acceleration and gravity effects have asymmetric waveforms in general.
- Gravity effect is due to the ground tilt. The induced acceleration by this effect is always positive (upward) in the vertical component.

Rotation motion in near-fault ground motions

- All of the rotation motion, the centrifugal acceleration and the gravity effect might have significant contribution to the extra large and/or near-fault ground motion.
- No direct evidence from six-component seismogram can be used to show that the abnormal waveforms are due to rotation motions. However, the abnormal baseline drifts found in the integrated velocity and displacement waveforms of the 2011 Tohoku earthquake can be explained to be the gravity effects.
- Extrem cases of abnormal waveforms are found at station IWTH25 in the 2008 Iwate-Miyagi Japan earthquake and at station WTMC in the 2016 Kaikoura, New Zeland earthquake. Both cases have an over 3g PGA in the vertical component which is much larger than that the corresponding horizontal components. It also shows a strong upward asymmetry in the vertcal waveform. We also can explain these these abnormal waveforms by introducing rotation motions