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Evaluation of random errors of displacements and velocities from strong motion records

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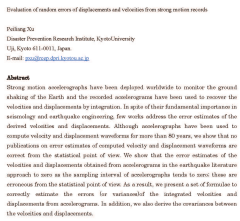
Strong motion accelerographs have been deployed worldwide to monitor the ground shaking of the Earth and the recorded accelerograms have been used to recover the velocities and displacements by integration. In spite of their fundamental importance in seismology and earthquake engineering, few works address the error estimates of the derived velocities and displacements. Although accelerographs have been used to compute velocity and displacement waveforms for more than 80 years, we show that no publications on error estimates of computed velocity and displacement waveforms are correct from the statistical point of view. We show that the error estimates of the velocities and displacements obtained from accelerograms in the earthquake literature approach to zero as the sampling interval of accelerographs tends to zero; those are erroneous from the statistical point of view. As a result, we present a set of formulae to correctly estimate the errors (or variances)of the integrated velocities and displacements from accelerograms. In addition, we also derive the covariances between the velocities and displacements.


Evaluation of random errors of displacements and velocities from strong motion records

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Abstract

Strong motion accelerographs have been deployed worldwide to monitor the ground shaking of the Earth and the recorded accelerograms have been used to recover the velocities and displacements by integration. In spite of their fundamental importance in seismology and earthquake engineering, few works address the error estimates of the derived velocities and displacements. Although accelerographs have been used to compute velocity and displacement waveforms for more than 80 years, we show that no publications on error estimates of computed velocity and displacement waveforms are correct from the statistical point of view. We show that the error estimates of the velocities and displacements obtained from accelerograms in the earthquake literature approach to zero as the sampling interval of accelerographs tends to zero; those are erroneous from the statistical point of view. As a result, we present a set of formulae to correctly estimate the errors (or variances)of the integrated velocities and displacements from accelerograms. In addition, we also derive the covariances between the velocities and displacements.