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Site Effects Estimation by a Transfer-Station Generalized Inversion Method

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Site effect is one of the essential factors in characterizing strong ground motion as well as in earthquake engineering design. In this study, the generalized inversion technique (GIT) is applied to estimate site effects. Moreover, the GIT is modified to improve its analytical ability.GIT needs a reference station as a standard. Ideally the reference station is located at a rock site, and its site effect is considered to be a constant. For the same earthquake, the record spectrum of an interested station is divided by that of the reference station, and the source term is eliminated. Thus site effects and the attenuation can be acquired. In the GIT process, the amount of earthquake data available in analysis is limited to that recorded by the reference station, and the stations of which site effects can be estimated are also restricted to those stations which recorded common events with the reference station. In order to improve the limitation of the GIT, a modified GIT is put forward in this study, namely, the transfer-station generalized inversion method (TSGI). Comparing with the GIT, this modified GIT can be used to enlarge data set and increase the number of stations whose site effects can be analyzed. And this makes solution much more stable. To verify the results of GIT, a non-reference method, the genetic algorithms (GA), is applied to estimate absolute site effects. On April 20, 2013, an earthquake with magnitude of MS 7.0 occurred in the Lushan region, China. After this event, more than several hundred aftershocks with ML<3.0 occurred in this region. The purpose of this paper is to investigate the site effects and Q factor for this area based on the aftershock strong motion records from the China National Strong Motion Observation Network System.
Our results show that when the TSGI is applied instead of the GIT, the total number of events used in the inversion increases from 31 to 54 and the total number of stations whose site effect can be estimated increases from 29 to 37. By adding another transfer station in the TSGI, the number of events and stations analyzed rise to 64 and 40 respectively. Most stations exhibit site amplifications from the results obtained by the GIT or TSGI. The results of GA demonstrate that the site response of the reference station is not a constant, which is the main reason for the difference between the results of GIT and GA. When the results of GIT are corrected with the site effect of the reference station obtained from GA, these two results agree very well for most of the stations. This indicates that the site effects obtained by GA can represent the absolute site effects, and the results of GIT or TSGI are reliable if the reference site is void of amplification, for instance, the reference station is located at a real rock site.