Development of inference methods for rotational motions on ground surface

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In this study, we develop two methods for the inference of rotation vector on ground surface, two rocking rotations and a single torsional rotation. The first, termed nth-order elastic method, is based on the elasticity of the ground surface, and the rotation vector is constructed from the first derivative of ground motions which are approximated by nth-order Taylor expansion. Meanwhile, the second, termed rigid method, is based on the rigidity of ground surface and the rotation vectors are directly obtained by the least square method which minimize the sum of the squared difference between recorded differential motions and the equation of the rigid motions. Furthermore, the second is divided into two methods. The one, multi-site rigid method, uses the differential motions at multi sites, while the other, single-site rigid method, uses the differential motions at a single site. Also, we show that the 1st-order elastic method is the same as the rigid method. Appling the nth-order elastic method to microtremor recordings acquired with a small-size dense array, we successfully infer the rotation vector and find the rigid zone with a radius of 5m for the torsional motions. We furthermore obtain the two findings. The first is that the rotation vector can be inferred with a simpler array of a small size and a fewer observation sites. The second is that the root mean squared (RMS) amplitudes of the torsional rotation inferred by the single site rigid method are approximately the same as the RMS amplitudes obtained by the 1st-order elastic method in a zone close to the reference site.

Keywords: Inference methods of rotational motions, Ground surface, Microtremors, Small-size dense array

