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Evolution of the heterogeneous structure of 1999 Mw 7.6 Chi-Chi earthquake thrust in Chushan excavation site, central Taiwan, based on distinct element models

Chia-Hsiang Hsu (1), Wen-Jeng Huang (1,2), Yu-Yi Chang (3), Wei-Tung Nien (4), and Wen-Chao Huang (3)

(1) Institute of Applied Geology, National Central University, Taoyuan, Taiwan (eric267213@hotmail.com), (2) Department of Earth Sciences, National Central University, Taoyuan, Taiwan, (3) Department of Civil Engineering, National Central University, Taoyuan, Taiwan, (4) Department of Civil Engineering, National Taiwan University, Taipei, Taiwan

Exposures in the Chushan trench, 40 m long and 10 m deep, excavated across a 1999 earthquake-induced escarpment of 2 m high, show a steep, monocline-like fold with significantly different limb-truncated structures on either side of the 14 m wide trench. On southern exposure the fold is truncated through along the axial trace of its anticline by a fault branch with a dip angle of 32˚ and a maximum separation of ∼4.2 m while on the northern exposure the steep limb of the fold is displaced up to ∼3.0 m along the axial trace of its syncline by another fault branch with a dip angle of 24˚. This study intends to explore how this heterogeneous structure might form using distinct element simulation of blind reverse faulting.

All our models in this study consist of two mechanical layers, including an upper clayey layer of 7 meters thickness and a lower gravelly layer of 8 meters thickness at maximum, as revealed by the excavation, a borehole nearby and soil tests. Our results show that the steep, monocline-like fold can be simulated by a low-angle reverse faulting similar to a subsurface dominant fault with a dip angle of 24˚ derived from the trench site at the ground surface and in a borehole in the hanging wall. Furthermore, the different structures on the two exposures were mainly controlled by the dip-angle variation of the upper part of the subsurface dominant fault. The simulation of reverse faulting with a dip angle of 24◦shows a monocline forms in the clayey layer, and then a gravelly wedge starts to protrude into the clayey layer and displace it along the axial trace of the anticline similar to the structure on the southern exposure, and the simulation of reverse faulting with a dip angle of 32◦shows a monocline forms in the clayey layer, and then this monoclonal clayey layer starts to be displaced along the axial trace of the synclinal by a newly fault similar to the structure on the northern exposure. We also find the strength of clayey layer and the thickness of the gravelly layer likely played an insignificant role in the formation of this heterogeneous structure under the reasonable ranges of these two parameters for our geological consideration.