

A basic analysis of stress and strain of elastic plate with cracks

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In the earthquake generation mechanism of low-angle reverse faults near the trench, the region of island arcs faced to the trench is pushed to the land side and continues to subside (Mogi, 1982). The continental plate is assumed to deform elastically in this stage. On the other hand, the faults, which exist in the plate boundary or the inside of the earth, are great mechanical defect surface, which exist in the interior of the earth (Ohnaka and Matsu'ura, 2002). The present paper simplifies the above stress field of the oceanic and continental plates in terms of 2D plane stress problem of the thin elastic plate of mild steels with cracks. The problem is solved by the use of the finite element method. The Young's modulus of the material (domain 1) is 21000 kg/mm² and the poisson ratio 0.3. The size of the plate is 625 and 325 mm in the x- and y-directions. The right and left edges of the plate are fixed and free, respectively. A small crack is located at the upper surface of the central part of the plate and a series of discontinuities (domain 3) is, from the edge of the crack, diagonally to the lower right of the plate. The upper (domain 1) and lower (domain 2) sides of the plate are constituted of different kinds of mild steels. Domain 2 occupies the lower left part of the plate. The elastic plate is framed as follows; the left and right sides of domain 3 correspond to the oceanic and continental plate, domain 2 corresponds the mantle under the oceanic plate and domain 3 forms the boundary between the oceanic and continental plates. The external force is horizontally exerted at the left edge of domain 1. The characteristics of the stress and strain fields in the elastic plate are obtained as follows: (C1) The horizontal component of strain exceeds the vertical one in the right side of domain 3, while the situation is reverse in the left side of the boundary. (C2) The elastic plate, except the lowermost part of the plate, contracts towards the right and sinks downwards. The lowermost part of the plate extends towards the left. (C3) Mises stress (Kikuchi and Wada, 2004) in domain 3 is locally and closely increased and decreased. (C4) The shear stress is concentrated near the location of a crack on the upper side in domain 1. The characteristic (C2) shows that there is a change of stress flow inside the plate. The abnormal distribution of stress in (C3) shows the situation that fracture is likely to occur there. This characteristic seems to be related with a factor of seismogenesis of subducting plate.

References: Mogi, K., 1982, Earthquake prediction in Japan, Science K. K., pp. 11. Ohnaka, M. and M. Matsu'ura, 2002, The physics of earthquake generation, Univesity of Tokyo Press, pp. 24-25. Kikuchi, M. and Y. Wada, 2004, Fundamentals of material mechanics (Strength of materials), Shuwa system K. K., pp. 136-138.