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Evaluation method for ductile fracture property of thin steel sheet and weld metal

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In collision accidents, ductile fracture may occur in base metal or weld metal without evident defects. We propose a test method for evaluating the initiation and growth behavior of internal ductile cracks in metals, particularly in high-strength steel materials. In previous studies, the internal ductile crack initiation behaviors in steel were evaluated considering the effect of stress triaxiality on the critical equivalent plastic strain using some round bar specimens, where each specimen had a different circumferential notch in size. However, it is difficult to observe a transition process from crack initiation to growth and measure crack driving force parameters in high-strength steels, because ductile cracks grow abruptly soon after their initiation. Accordingly, to investigate the ductile crack initiation and growth behavior, we developed two stress triaxiality controlled specimens with a mechanism to decelerate the propagation rate of ductile cracks. The applicability of these specimens to the evaluation of ductile crack initiation condition was discussed based on the results of tensile fracture tests used on steel and weld metal and finite element analyses. The ductile crack initiation limits of the weld metal widely varied compared to the base metal, and were comparable to or significantly lower than those of the base metals in this study.Thin steel sheet is cold-rolled steel with a tensile stress 590MPa class.Weld metal was made by Metal Active Gas (MAG) welding on two overlapping plates of the steel. As a result of the tensile test, it was found that the crack occured from the center of the thickness and width of the evaluation region at the 1st slope change seen in the load-displacement curve (Fig. 2) (Fig. 3), and that the evaluation region was ruptured at the 2nd slope change. It can be observed that the developed specimen exhibits ductile crack initiation and growth behavior. It should be note that evaluating the ductile crack initiation condition of weld metal of structures, because the ductile crack initiation conditions and strength of the weld metal varied widely compared to base metal (Fig.4).

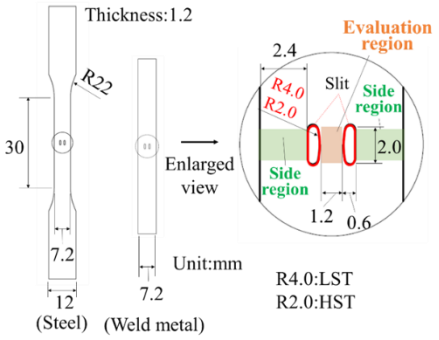

Figure.1 specimens

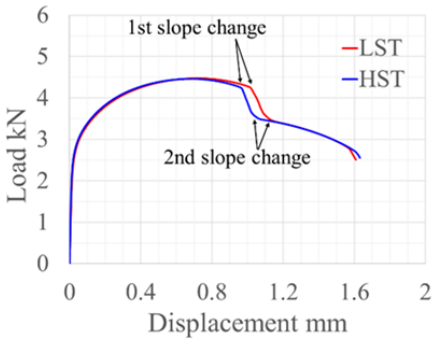

Figure.2 Load-Displacement curves

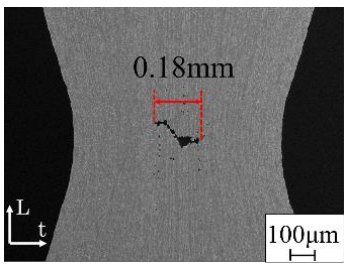

Figure.3 Internal ductile crack_1st slope change

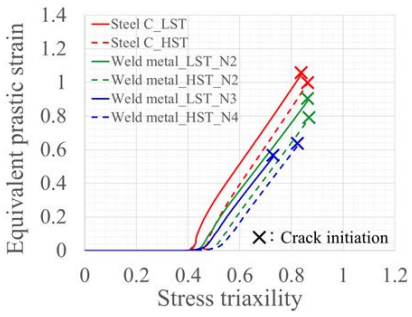

Figure.4 Ductile crack initiation conditions