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Microstructure-property relationship in a high strength-high toughness combination  
ultra-heavy gauge offshore plate steel: the significance of multiphase microstructure

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#### Abstract

We elucidate here the microstructure-property relationship in a high strength and high toughness 60 mm thick ultra-heavy gauge plate steels characterized by ferrite-bainite multi-phase microstructure and compare with the conventional bainitic microstructure. Pilot-scale results indicated that high yield strength of ~486-508 MPa with high ductility of ~10% in uniform elongation, low yield to tensile (Y/T) ratio of ~0.74-0.77, excellent low temperature toughness of ~186-228 J at -60°C and good weldability are obtained in a multi-phase steel through combination of controlled rolling and accelerated cooling. The multi-phase microstructure steel consisted of quasi-polygonal ferrite and lath bainite with the corresponding phase proportion of 3:2 and 2:3 at 1/4 thickness (1/4t) and 1/2 thickness (1/2t) locations, respectively. The positive impact of multi-phase microstructure on ductility, Y/T ratio, toughness and weldability were attributed to the following aspects: (a) results from Crussard-Jaoul (C-J) analysis indicated that the soft ferrite phase in the multi-phase microstructure favorably modifies the work hardening behavior and results in high ductility

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