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Utilization of Artificial Neural Networks for Prediction of the Slab Surface Crack Formation

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Designing the continuous casting process of advanced high strength steels(AHSS) requires precise simulation of fracture formation based on high-temperature properties of steel grades and casting conditions in order to minimize surface defects of the slab. Reduction of area(RA) as an indicator of ductility was utilized to correlate with the cracking performance of the continuous caster of Pohang Steel Works. The RA curve of each steel grade was predicted using a Gaussian fitting-based ANN model that learned accumulated measurement data of over 3,000 data points from high temperature tensile tests. Uneven solid-shell index(USI) as another indicator of crack sensitivity of a steel grade was also introduced by thermal analysis using differential scanning calorimetry(DSC) and by calculating volumetric shrinkage of the slab surface during initial solidification based on the thermodynamic database of JMatPro. Each type of surface crack seemed to be influenced by different mechanisms, where longitudinal face cracks increased with USI while transverse cracks showed a relatively high correlation with predicted RA. However, it was difficult to assure that either USI or RA independently determined the frequency of a certain type of cracking with absolute Pearson's correlation values of less than 0.6. Classification of cast slabs based on USI and RA indicated that the combined effect of initial solidification and ductility behavior in the strand bow determines crack frequency for diverse types of cracking such as corner cracks, transverse cracks, and longitudinal face cracks. The ANN-based surface crack prediction model in which simulated RA and USI were introduced as derived variables resulted in higher precision of 0.84 compared to the model with a precision of 0.80 only including steel composition and casting parameters excluding the simulated physical propreties.

Author: JUNG, Sung-Suk (Posco)

Co-authors: HONG, Dae Geun (POSCO); CHO, Kyung Chul (POSCO); KWON, Sang Hum (POSCO)

Presenter: JUNG, Sung-Suk (Posco)

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