Descriptor Extraction on Inherent Creep Strength of Carbon Steels by Exhaustive Search

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Abstract: According to the inherent creep strength concept proposed by Kimura et al., microstructural strengthening effect is expiring after a long-term creep deformation at high temperature. In the region, the solid solution hardening effect becomes dominant so that the rupture time is expected to be a simple function of chemical composition and test conditions. In fact, they found that there was a linear relationship between logarithm rupture time and the amount of Mo for the carbon steel JIS STB410. They also found the positive correlations of Cr and Mn to the logarithmic rupture time. However, it is difficult to specify the descriptors that intrinsically control the creep strength from their findings since not only the target element but also the other elements concurrently varied their amounts in the plot of the logarithmic rupture time. This is due to the limitation of available data that were obtained from the creep tests using commercial steels and thus their compositions were not designed for the purpose to systematically examine the effect of elements. Considering high cost and long time for additional creep tests, a method is significantly important to specify the descriptors from such available data.

In this study, we applied a Bayesian-inference based method to properly compare the necessity of descriptors even from the limited data for the inherent creep strength region of JIS STB410 carbon steel. In the method, the posterior probabilities for linear regression models for all combinations of elements were calculated and dominant descriptors were extracted from the results of high probability models. The analysis showed that the Larson-Miller parameter is described with the terms of the decimal logarithm of stress, the Mo concentration, and the constant. That is, it turned out that the positive correlations of Cr and Mn appeared not intrinsically but extrinsically due to concurrent changes in the amount of Mo.

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