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Tempering Response of Martensitic and Bainitic Microstructures

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High strength heavy gauge plate steels for structural applications are subjected to quenching and tempering treatments. Due to the material thickness, different cooling rates are obtained throughout the thickness of the material and several grades do not fully harden to martensite, resulting in a material containing a mixture of martensite and bainite. Therefore, it is desirable to model the tempering response of martensitic and bainitic microstructures in order to allow tempering optimization for mixed microstructures. The early stages of tempering as well as the high temperature tempering were studied with respect to martensite and bainite with a focus on the influence on the tempering response associated with the presence of the alloying elements molybdenum (Mo), vanadium (V), chromium (Cr), and silicon (Si). Microstructural characterization prior to tempering was performed using light optical microscopy, scanning electron microscopy, and electron backscatter diffraction. Tempering response was assessed through dilatometry, Vickers micro-hardness, and Mössbauer spectroscopy. Finally, tensile and impact properties were studied using tensile and Charpy V-notch testing.