

Evolution of microstructure and its influence on stretch-flange-formability in thermo-mechanically controlled processed (TMCP) quenched and partitioned (Q&P) steel

Chintada Umasankar^a, Uday Chakkingal^a, S. Sankaran^a

^a*Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai-600036, India.*

e-mail: mm18d002@smail.iitm.ac.in

Forming of Advanced High Strength Steels (AHSS) into complex shapes is challenging due to lower formability and many of their grades have poor stretch flangeability, which is the ability to resist through-thickness edge crack formation during a stretch flanging operation. Hole Expansion Ratio (HER) is the standard formability index to quantify stretch flangeability. The current study investigates the influence of thermomechanical controlled process (TMCP) prior to Quenching and Partitioning (Q&P) treatment on the stretch flangeability of CMnSiAl steel. Two different levels of reductions viz. 30% and 60% were accomplished in the TMCP by controlled hot rolling prior to the Q&P treatment. Uniaxial tensile tests were conducted on the controlled hot rolled Q&P treated CMnSiAl steel, the results showed improved product of strength and percent elongation (PSE, MPa%) for the TMCP-Q&P method over conventional Q&P due to grain refinement and the formation of high fractions of high-angle grain boundaries. The microstructural studies were also performed on the CMnSiAl steel processed through QP and TMCP-QP methods, which showed primarily small lath packets with fine martensite laths and thin films of inter-lath austenite. Hole expansion tests were also performed with conical punch geometry to understand the effects of processing conditions on performance, and these results are discussed in terms of mechanical properties and microstructures.

Keywords: Formability; Stretch Flangeability; Hole Expansion Test; Quenched and Partitioned Steel, Hole Expansion Ratio