High-stress abrasive wear characteristics of ultra-high strength press-hardening steel

O. Haiko[1]*, K. Valtonen[2], A. Kaijalainen[1], J. Kömi[1]

[1]Centre for Advanced Steels research, Materials and Mechanical Engineering, University of Oulu, FI-90014, Oulu, Finland
[2]Tampere Wear Center, Materials Science and Environmental Engineering, Tampere University, FI-33720, Tampere, Finland

Ultra-high strength steels are widely utilized in many applications operating in harsh abrasive wear conditions. For instance, the machinery used in mining and mineral handling or in agricultural sector require robust, but cost-effective wear-resistant materials. Steels provide excellent combination of mechanical properties and usability. In addition, alloying and processing routes can be varied to adjust the final properties of the product.

Press-hardening is an example of a modern processing method, which combines forming and heat treatment to produce complex shape steel parts. This study encompasses mechanical and wear testing of an experimental medium-carbon (0.5C) press-hardening steel. The as-received material was austenitized at two different temperatures and quenched in water. Additionally, low-temperature tempering was applied for one variant. In total, three variants of the press-hardening steel were produced. Microstructural characterization and mechanical testing were conducted for the steel samples. The wear testing was done with high-stress abrasive method, in which the samples were rotated inside a crushed granite bed. For comparison, a commercial 400 HB grade wear-resistant was included in the wear testing.

The experimental steel showed very high mechanical properties reaching tensile strength up to 2600 MPa with hardness of 750 HV10 (700 HB). Wear testing resulted in only minimal differences between the three variants indicating that the improved impact toughness by tempering did not significantly affect the wear resistance. The commercial 400 HB wear-resistant steel had nearly two times greater mass loss compared to the higher hardness press-hardening steels. Microhardness measurements done on the worn surface showed drastic increase of hardness for the deformed structure for all samples. It was concluded that even the high-hardness martensitic steels exhibit notable wear surface work-hardening. Therefore, hardness had the most significant effect on the wear performance.

Keywords: steel, abrasion, wear testing, tempering, press-hardening

*Corresponding author: oskari.haiko@oulu.fi