Bainitic Steel as an Alternative to 41Cr4 in Towing Hook Forging: Process Design and Application

Oğuzhan Akyol

Birinci Automotive R&D Center, Türkiye

Abstract:

In this study, the feasibility of using Bainitic Steel instead of the currently used 41Cr4 steel in the production of the Towing Hook part manufactured by hot forging was investigated. The Towing Hook under examination is a critical component produced for OEM customers, present in every vehicle, and rendered non-functional when it loses its intended functionality.

The currently used 41Cr4 steel is heated to a temperature range of 1150°–1250°C prior to forging, then subjected to hot forming, followed by cold flash trimming and other machining operations. Finally, a heat treatment process is applied. As a result of this process, the parts are expected to achieve a tensile strength of 1050–1200 N/mm² and a hardness of 34–39 HRC.

The Bainitic Steel evaluated in this study was specially developed by one of Turkey's leading steel manufacturers, considering the working conditions of the part. While designing the forging process for the Bainitic Steel, the preheating temperature was kept the same as the current process (1150°–1250°C), hot flash trimming was applied after forging, and the parts were cooled in a controlled manner using a fan-assisted closed conveyor system. The cooling process was planned according to the material specific Continuous Cooling Transformation (CCT) diagrams to establish the ideal cooling regime.

To obtain the desired bainitic microstructure, the starting temperature for controlled cooling must be between 800°–900°C, and the bainite start (Bs) temperature is 525°C. Therefore, in order to achieve the target microstructure, several production trials were conducted with varying conveyor speeds and fan blowing powers. After each trial, selected samples were subjected to hardness testing, tensile testing, and microstructural analysis.

As a result of the production trials, suitable process parameters were determined, and it was confirmed that the mechanical and microstructural properties obtained met customer requirements. After ensuring the reliability of the process, a Design Validation (DV) test was conducted in accordance with customer demands, and the parts successfully passed the validation tests.