Cyclic Stability and Strain Localization during Fatigue of Advanced High Strength Steels

Cycle dependent changes in deformation resistance have been challenges in both engineering design of structures and new steel grade development for almost 200 years. Newer Advanced High Strength Steel (AHSS) grades with higher Tensile strength and ductility are being developed at an ever increasing pace utilizing a combination of metallurgical strengthening mechanisms. Many of these alloy designs often result in challenges to meet the implementation requirements from “end-use” and “in-use” perspectives, including component durability. This seminar will highlight two related aspects in developing fatigue resistant steel grades. First, cycle dependent changes in deformation resistance of several commercial steel grades will be illustrated with special emphasis on the role of the second phase in a ferrite matrix. The second aspect refers to how a slip line develops into a crack from cyclic deformation over many thousands of cycles. It is well known that strain localization leads to the formation of Persistent Slip Bands (PSBs) which eventually become fatigue cracks. The role of the second phase particles that impart static strengthening, especially martensite/bainite, in strain localization and the evolution of PSBs will be illustrated through quantitative stereological observations. These semi-empirical models indicate that reducing strain localization is beneficial for improved fatigue resistance. Utilization of these concepts in commercial steel grade development will also be highlighted.

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