Rate-dependent hardening behavior and TRIP effect in Quenching and Partitioning steels for application in crash energy-absorbing structures

This manuscript (permalink) was automatically generated from mamaxb/ictp2023@20aa2e1 on February 21, 2023.

Authors

- **Max-Maria Bisch** ✉
  0000-0002-7591-6019 · mamaxb
  Institute of Automotive Lightweight Design, University of Siegen, Siegen, Germany
- **Chongyang Zeng**
  Institute of Automotive Lightweight Design, University of Siegen, Siegen, Germany
- **Rongfei Juan**
  Department of Mechanical Engineering, Aalto University, Espoo, Finland
- **Junhe Lian**
  Department of Mechanical Engineering, Aalto University, Espoo, Finland
- **Xiangfan Fang**
  Institute of Automotive Lightweight Design, University of Siegen, Siegen, Germany

✉ — Correspondence possible via GitHub Issues or email to Max-Maria Bisch <max.bisch@uni-siegen.de>.

Abstract

Belonging to the 3rd generation advanced high strength steels (AHSS), Quenching and Partitioning (Q&P)-steels exhibit an excellent combination of high strength and good ductility while having a similar alloying concept as the already existing 1^{st} and 2^{nd} generation AHSS, such as DP- and TRIP-steels. While the mechanical properties are generally well understood, Q&P-steels are still subject to current research and can not be widely found in industrial applications. Driven by the need to decrease vehicles' weight while maintaining high safety standards, the predictability of material behavior under dynamic load cases in simulations is a deciding factor for successful industrial usage. To widen the understanding of mechanical response to high-speed loading, a wide range of strain rates from 0.001^{-1} up to 1000^{-1} are conducted on two grades of Q&P-steels, namely QP980 and QP1180. Special attention is given to the hardening behavior, which is influenced by a rate-dependent TRIP effect. The effect of strain rate on the microstructure evolution is also investigated to enable the theoretical connection of the rate-dependent TRIP effect with the respective mechanical response. The influence of increased strength and ductility compared to classical AHSS, such as dual-phase steel DP1000, is finally validated on a generic axial crash structure commonly found in vehicle crash management systems [1].

References

1. **Prediction of crack formation in the progressive folding of square tubes during dynamic axial crushing**
   Wenqi Liu, Junhe Lian, Sebastian Münstermann, Chongyang Zeng, Xiangfan Fang
   International Journal of Mechanical Sciences (2020-06) https://doi.org/gpxvjm
   DOI: 10.1016/j.ijmecsci.2020.105534