Implications of Low Strain Hardening of Modern Steels on the Design, Construction, and Maintenance of Pipes and Fittings

MATH-5-3

Contract Number: PR-350-154502

Center for Reliable Energy Systems
5858 Innovation Dr.
Dublin, OH 43016
614-376-0834

PRCI 2018 TC Meeting
October 24, 2018
San Diego, CA
Outline

- Background
- Objectives and deliverables
- Project status to date
- Major findings from this work
- Comments and questions
Characteristics of modern linepipe steels

- Manufactured by thermo-mechanical controlled processing (TMCP)
- Low carbon content and low hardenability
- Increased use of microalloying elements
- Increased yield strength and toughness
- Reduced propensity of HAZ hydrogen cracking
- Reduced strain hardening capacities
- Propensity of HAZ softening in seam/girth welds

Background – Evolution of Tensile Properties

- The change in UTS for early low grade to modern day high grade can be quite small in some cases.
- Yield strength increased with pipe grade over time, leading to lower strain hardening.
- Some of the new pipes can have yield strength well exceeds the SMYS and very low strain hardening capacity, leading to unintentional girth weld strength undermatching.
Objective and Deliverable

Objective

❖ To understand the risks and benefits associated with the widespread use of linepipes made from modern microalloyed steels with low strain hardening capacities as compared to linepipes made from traditional hot-rolled and normalized steels

Deliverable

❖ A final report to cover
   ► Impact of low strain hardening of modern TMCP steels
   ► Implications of modern microalloyed linepipes
Project Status to Date

- All work has been completed except for the final report.
- Draft final report was submitted on 9/10/2018.
- The first round voting process was completed during 9/26 – 10/12. Only two members voted as “Accept with Exceptions”.
- The second round voting process will be open.
- CRES is working on the revision of the report based on the comments from the team.
- The submission time for the revised final report will depend on the team’s voting process.
Major Findings from this Work

- The pipe burst pressure is mainly controlled by pipe’s UTS, while the pipe’s yield strength has minimal impact on the burst pressure.

- Pipelines are generally designed using YS, not UTS. The higher grade modern pipes would be operated at a higher pressure, which effectively means a reduced safety margin.

- Under the same bending loads, the pipe with a low strain hardening capacity shows a lower resistance to wrinkle formation than the pipe with a high strain hardening capacity.

- The modern low strain hardening pipelines may not fail due to the reduced safety margin. However, the reduced safety margin needs to be considered when applying new practices in pipeline design, construction, and maintenance in order to keep the risk levels to historical norms.
Comments and Questions

☐ Thank you