Extreme Cold Weather Effects on High Strength Steels for Cranes

Overview

To determine a material’s ability to perform in cold temperatures, the ductile to brittle transition temperature (DBTT) is one of the most important material properties to review. The DBTT specifies the range in which a material performs to its established specifications under mechanical stress. This study seeks to determine the impact energy changes and the DBTT, by producing ductile to brittle transition curves for three high-strength materials using Charpy impact testing in accordance with ASTM standard A370. The grain orientation within the samples in reference to the Charpy v-notch is also being studied by comparing the DBTT for longitudinally and transverse oriented samples.

Objectives

Our objects were to pin point the ductile to brittle transition temperature for the three different strength steels provided to us by Manitowoc. Additionally, we made inferences as to the application of these steels in extreme cold weather crane application based upon their performance at the low temperatures.

Approach

- An understanding of the different steels and how they were employed in Manitowoc’s cranes was gathered via a visit to Manitowoc’s Shady Grove facility.
- Charpy impact testing was used to perform strength testing of the samples.
- Samples were broken at temperatures encompassing what Manitowoc and our team felt were appropriate “extreme” cold weather temperatures.
- Sample performance was plotted and inferences as to performance across the temperatures were drawn based upon knowledge of materials.
- Appropriate conclusions were reached in accord with sample performance and only one steel alloy was recommended for use in cranes exposed to “extreme” cold weather, being the 100 ksi steel alloy (shown below).

Outcomes

- The primary outcome from this project is that the steel samples Manitowoc wants to use for extreme cold weather applications are not currently ready for such use.
- Additional alloys will need to be produced and tested that meet strength requirements at low temperatures.
- This testing was extremely useful as the results were not anticipated.