

Background

The knowledge of dynamic mechanical properties is useful in all cases where the strain rate sensitivity of metallic materials is an issue, and whenever the actual loading conditions for a structure (either in normal operation or under accidental circumstances) are different from static. Furthermore, in some investigations increasing the loading rate in a mechanical test is used to simulate other embrittling mechanisms such as thermal aging or neutron exposure.

Precracked Charpy-type (PCVN) specimens, tested under impact loading rates using an instrumented pendulum, have been used for more than 30 years to measure dynamic fracture toughness; the experimental procedure and the analysis methodology are fairly well established, despite the lack of an ASTM or ISO official test standard.

Objectives

Qualifying sub-size precracked Charpy (PKLST) specimens for dynamic toughness measurements in the ductile-to-brittle transition region and in the upper shelf regime.

Principal results

In the transition region, tests have been analyzed using the Master Curve approach; the multiple-specimen (low-blow) method has been applied in the upper shelf regime. A well-known and fully characterized RPV steel of the A533B Cl.1 type (JRQ) has been used; the results obtained have been compared with data previously obtained from standard-size precracked Charpy specimens.

The results obtained (Figure 1 and Figure 2 for transition and upper shelf regime respectively) show that PKLST samples suffer from significant loss of constraint and provide higher toughness values than PCCv, particularly in fully ductile conditions.

For measurements in the ductile-to-brittle transition region, this observation (which however requires further experimental confirmation) contradicts published results obtained under quasi-static conditions, showing substantial equivalence between PKLST and PCCv specimens. On the other hand, KLST samples are known to show a significantly more ductile behaviour than standard Charpy when tested as conventional (notched) impact specimens.

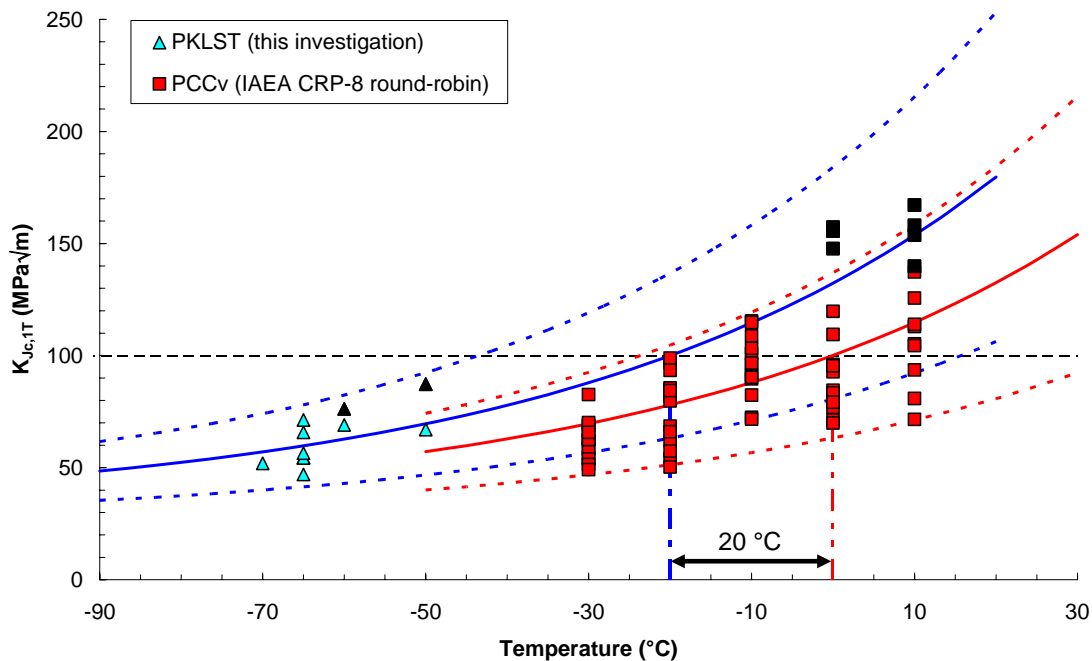


Figure 1 - Comparison between impact fracture toughness data measured from PKLST and PCCv specimens of JRQ material.

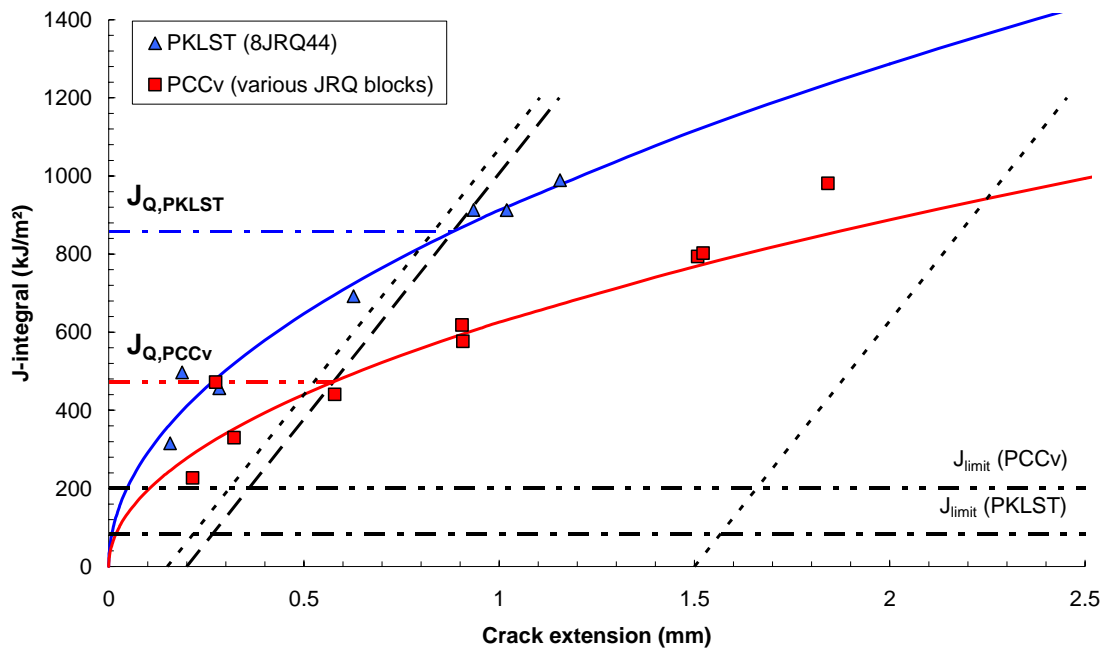


Figure 2 - Comparison between PKLST and PCCv specimens of JRQ material tested in the upper shelf regime under impact loading conditions.

Future work

In 2007, tests in the ductile-to-brittle transition region will be repeated using two other RPV steels, 20MnMoNi55 and JSPS.

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Main references

E. Lucon and M. Scibetta, *Use of KLST-type Miniature Charpy Specimens for Measuring Dynamic Fracture Toughness under Impact Loading Rates*, presented at the 5th ASTM Symposium on Small Specimen Test Techniques, Anaheim, CA (USA), Jan 31-Feb 1, 2007; to be published in Journal of ASTM International (JAI) and in an ASTM STP (Special Technical Publication).

E. Lucon and M. Scibetta, *Use of KLST-type Miniature Charpy Specimens for Measuring Dynamic Fracture Toughness under Impact Loading Rates*, External Report ER-21, November 2006.