

Charpy Impact Verification

Objective

We evaluate the performance of pendulum impact test machines used worldwide to qualify structural steels for construction. We offer standard reference materials (SRMs) to our customers, support their certification with a traceable measurement system consisting of three master impact machines, and provide post-test analysis to certify machine compliance. This indirect verification of machine performance increases the accuracy of impact data used to predict infrastructure reliability.



Impact and Customers

- Infrastructure reliability remains a key issue for the U.S.: 25 % of our bridges are considered structurally deficient or obsolete; 27 % of our highways need upgrading or rebuilding; 21 % of our rail track is rated "less than good"; 30 % of our airport runways need major repair.
- A healthy steel industry is essential for improving the steel-intensive infrastructure in the U.S. Contractors require an uninterrupted supply of quality steel that they trust to meet performance targets. Impact testing remains the best measure of steel quality.



- >2000 pendulum impact test machines are currently used worldwide to certify construction steel, as described in ASTM E23. NIST has provided SRMs to customers globally for nearly 20 years, with annual sales of approximately 10,000 impact specimens.

Approach

Charpy impact is a standardized high strain rate test to measure energy absorption during fracture. The absorbed energy provides an indirect measure of fracture toughness. Despite its relative ease of use, complex energy loss mechanisms are involved, making it impossible to verify test machine performance directly. Periodic testing of impact machines with certified test specimens is necessary to indirectly verify machine performance. To achieve the required accuracy, a well-defined target (master machine) for absorbed energy is required. NIST maintains three master impact machines, which are the designated reference machines for the U.S. (per ASTM E23). The average value for these three machines is considered the correct value for certification.

NIST provides a complete certification service for our customers. A set of five SRMs are sold to each customer, and the customer then destructively tests the specimens and returns them for assessment. By evaluating the test results and the fractured specimens, NIST can indirectly assess the machine tolerance and issue either a certificate of compliance or provide suggestions for correction. A customer database is maintained for SRM quality control, tracking of individual machine performance, and for trend analysis for ISO and ASTM.



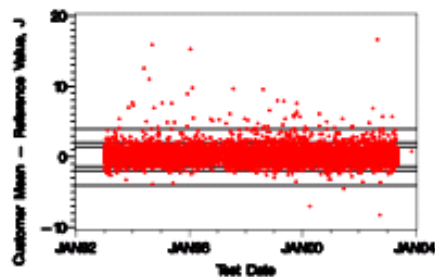
Accomplishments

Customer Service

For many years, NIST has offered Charpy-V-Notch SRMs for verifying the performance of impact machines to meet ASTM E23 "Standard Test Methods for Notched Bar Impact Testing of Metallic Materials." This standard is widely used to assess a material's resistance to sudden fracture, allowing designers of load-bearing structures (e.g., buildings, bridges, railroads, pressure vessels, etc.) to predict how the material will behave in use. We provide 3 SRMs addressing different energy levels: 2092 (low-energy, 14-20 J); 2096 (high-energy, 88-136 J); and 2098 (super-high-energy, 176-244 J). An ultra-high energy SRM is in development. A new 900 J impact machine has been purchased for this development program, with delivery expected in spring 2008. This new machine will provide impact energies at nearly twice our largest capacity machine.

Over the past five years, the Charpy program has supplied an average of 2000 reference material sets per year to customers worldwide (5 SRMs per set), bringing in revenues of nearly \$1M per year. In FY07, we evaluated nearly 800 verification tests and reported results to customers. We also interfaced with well over 1500 customers by email, fax, or phone. In FY06, we redesigned our customer website and database to make it easier for these interactions to occur. The results have been overwhelmingly positive, and NIST's Charpy team was recognized with the Judson C. French award for customer service for these improvements.

Customer service does not stop with the certificate of compliance. NIST maintains an extensive database of customer data in attempts to further improve measurement accuracy through ISO and ASTM activities. In 2006, NIST and ASTM co-sponsored a workshop on uncertainty analysis, and NIST prepared a new user guide for Charpy testing that better explains the role of statistics.



Example scatter in customer data

New Izod SRM (2115)

In FY07 NIST added another SRM to its product portfolio. SRM 2115 Izod verification specimens are now being provided for machines set up for the Izod test configuration also listed in ASTM E23. The principal difference between the Charpy and Izod tests is the manner in which the specimen is supported. By providing an SRM appropriate for Izod configurations, NIST will be able to serve an even broader customer base.

SRM 2115 is made from the same 4340 steel used for the Charpy SRMs; however,

its physical dimensions are tuned to the cantilever-beam configuration for Izod testing. Similar to Charpy SRMs, Izod specimens are sold in sets of five and cover an energy range of 15 to 18 J, a target useful in assessing the performance of the machine near the ductile-to-brittle transition of many metals.



Charpy 2092 (left); Izod 2115 (right)

International Collaboration

Representatives from INMETRO (the Brazilian National Institute of Metrology) visited MSEL for several weeks in FY07 to learn the details of NIST's Charpy impact verification project. Brazil recently decided to develop a national program in impact test machine verification and has chosen to pattern their program after the NIST/ASTM system. The US, Europe, and Japan currently provide specimens for Charpy machine verification, with Brazil and China developing new programs to serve local customers. Collaborating with Brazil early in their development process allows NIST to transfer best practices while working toward international harmonization and better linkage to primary SI units (force and time).

Learn More

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Publications

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