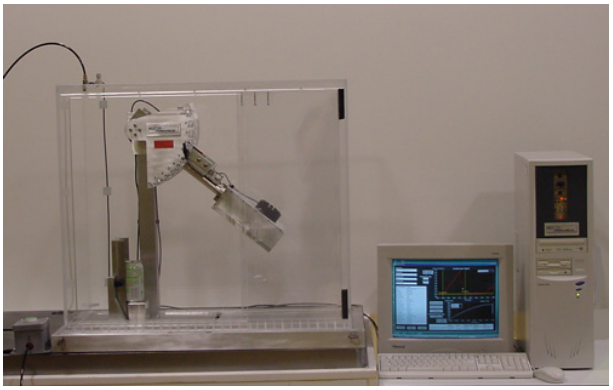
MPM Technologies, Inc.

Charpy/Impact Testing



MPM Instrumented Beverage Can Impact Tester

INTRODUCTION

Impact tests are performed to measure the response of a material to dynamic loading. The most common laboratory test configurations are the pendulum machine and the drop tower. However, other test geometries and loading configurations have been used in the past.

TYPES OF TEST MACHINES

MPM manufactures several impact test systems including:

- Charpy pendulum and drop tower impact testing (ASTM E23)
- Drop tower nil-ductility transition temperature (NDTT) impact testing (ASTM E208)
- Drop weight tear (DWT) impact testing (ASTM E 436)
- Dynamic tear (DT) impact testing (ASTM E604)
- Plastic Charpy impact testing (ASTM D256)
- Miniature Charpy pendulum impact testing
- Beverage can impact testing

OPTIONS

The impact test equipment can be provided with several options:

- Optical encoder for velocity and energy measurement (pendulum machines only)
- Instrumented striker system
- Automatic hammer return system
- In-situ heating & cooling system
- Automatic specimen transfer system
- Image analysis system for percent shear determination

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ENERGY AND IMPACT VELOCITY

Drop tower test machines measure energy using an instrumented striker system (see the Instrumented Impact Testing brochure). MPM pendulum impact test machines measure the energy absorbed in fracturing a test specimen using an optical encoder with 20,000 divisions per revolution. This is the finest division encoder ever used in Charpy testing and is capable of resolving energy to a much finer resolution than can be achieved with a dial. For example, the MPM encoder resolves energy to within 0.04 ft-lbs on pendulum machines in the 300 ft-lb to 700 ft-lb range. Experience at MPM has shown that it is not possible to resolve a dial indicator to within better than about 0.2 ft-lbs. The encoder data is acquired by the Impact™ v 3.0 software and used to determine the absorbed energy by calculating the height of the striker contact point before release and the maximum height attained after impact. In addition, the velocity of the striker is recorded from release up to termination of the impact event. Therefore, the exact velocity at impact is recorded in the test record for each test. The software provides a printed test record which includes key information such as the test specimen ID, the date of the test, name of the operator, test temperature, impact velocity, measured energy, etc.

MPM PENDULUM 9000 TEST MACHINES

The MPM Charpy/Izod 9000 Series impact test machines can be used with pendulums in the 100 ft-lb to 700 ft-lb energy capacity range. The various energy capacities are achieved by changing the pendulum. Since the machine frame has been designed for up to 700 ft-lbs, any lower capacity can be accommodated. Therefore, you can upgrade your machine capacity later by purchasing a higher capacity pendulum without the need to buy an entire test machine.

Research at MPM over the past decade has shown that there are differences between the optical encoder energy and the instrumented striker determined energy. MPM has published journal articles on this subject and the research findings will not be reviewed here other than to note two key elements in test machine design that must be addressed to ensure accurate energy determination. The first is reduction of pendulum arm vibration and the second is test specimen interaction with the striker. Vibration in the arm is undesirable because it is incorrectly recorded by the

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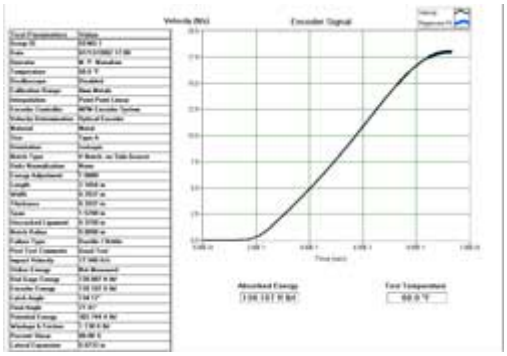
dial/encoder as energy absorbed by the test piece. MPM has performed extensive finite element design calculations to develop a design that has natural frequencies which are substantially different from those generated during the impact event. This design ensures that modes are not excited in the pendulum which would affect the energy measurement.

Specimen contact with the striker or hammer after fracture of the test piece is highly undesirable because it removes energy from the pendulum which is incorrectly recorded by the dial/encoder as absorbed energy. In U-hammer test machines, this presents a problem for tests conducted in the transition region. High speed photography has confirmed that the specimen halves rebound off the U-hammer exit channel and can impact the striker several times after the fracture event has been completed. This is the reason MPM manufactures C-hammer test machines. The C-hammer has the advantage that there is no pendulum material on either side of the swing plane and therefore the broken specimen halves move away from the striker after the fracture event.

SAMPLE CHARPY IMPACT DATA

Sample Charpy impact data for a Charpy pendulum impact test conducted on a steel specimen is given below. The encoder is used to measure the velocity from release to impact. The report summarizes the key test parameters and energy measurement. Additional data can be obtained by instrumenting the striker. Please refer to the Instrumented Impact Testing brochure for an example of instrumented test results.



Sample Charpy impact data

WINDAGE AND FRICTION CORRECTION

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Another important benefit associated with the encoder technology is that the windage and friction correction is much more accurate than can be achieved using a dial. The MPM system automatically corrects for windage and friction on every test. A free swing is performed to determine the windage and friction correction without a test specimen. During an actual test, the software applies the correction only to the height of the swing after specimen impact. The program contains a geometric function which precisely scales the correction.

CONTINUOUS VELOCITY ADJUSTMENT

MPM pendulum and drop weight test machines are also equipped with a continuous hammer release height adjustment. Some pendulum manufacturers refer to this as a "low-blow" fixture. Adjusting the hammer release height enables testing at velocities from 0 to $v = (2gh)^{0.5}$, where v is the impact velocity, g is the gravitational constant, and h is the release height. The software has an equation to determine the local gravitational constant based on elevation above sea level and latitude.

DETERMINATION OF RADIUS TO COP

An important element in pendulum machine design is to ensure that the test specimen is impacted with the center-of-strike (COS) coincident with the center-of-percussion (COP). This results in very little (theoretically none) shock and absorbed energy being transmitted into the test machine frame. The MPM Impact™ v 3.0 software has an automatic algorithm for measuring the radius to COP. The radius to COP measurement is extremely accurate with a standard deviation on the order of 0.001 inches. The program uses this exact radius in the energy measurements to determine the peak height of the strike point before and after impact. This algorithm has been shown to significantly improve the accuracy of the encoder energy measurement.

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SYSTEM UPGRADES

MPM In-Situ Heating & Cooling

Existing test machines can be upgraded by addition of the MPM instrumented striker system, encoder energy/velocity system, in-situ heating and cooling system, and automatic hammer return system. MPM will assemble the system and provide a field installation and calibration if desired. Shown here is an example of an upgraded test machine (Tinius Olsen Model 84) which includes the MPM encoder system, instrumented striker system, and in-situ heating and cooling system.

FOR MORE INFORMATION

If you would like a price quotation or additional information concerning MPM's services or products, please contact us at the below listed address:

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