# Instron® TechNotes **Getting the most up-to-date information on materials testing**

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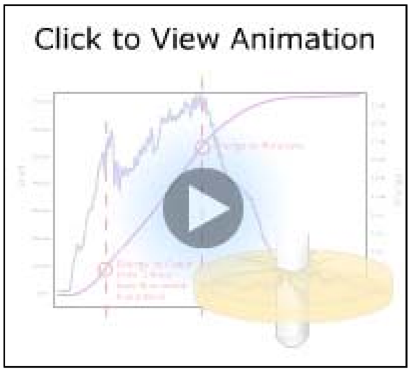
**ISSUE 22**

## Application Note

### Why Instrumented Impact Testing is Becoming More Popular




Traditional impact testing provides basic information about how a material or finished product may behave when it is intentionally or accidently impacted. Instrumented impact testing not only reveals this information, but also gives you a complete record of the test event, which can be captured and recorded in terms of:

1. Energy absorbed by the specimen over time
2. Force applied to the specimen over time
3. Displacement of the impactor (from the point it contacts the specimen) versus time
4. Velocity of the impactor versus time

When you capture and graph this data, many details of the impact become visible. A tabulation of the test results can be easily obtained, which removes the need for tedious, manual calculations.

Test standards, such as ASTM D3763 and ISO 6603-2, are commonly used as a way to create a comparison database and are fairly straightforward. For most homogeneous materials, four values are critical: 1) maximum or peak load, 2) energy to maximum load, 3) total absorbed energy, and 4) deflection to maximum load.

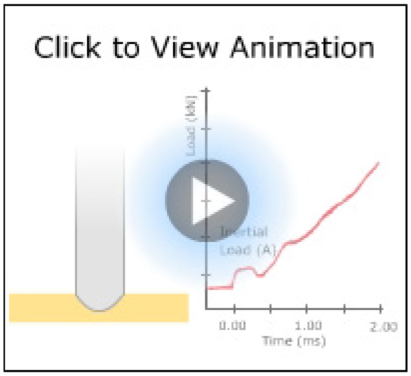
The relationship between the material and its final application is important. For example, the primary function of a windshield is energy absorption – keeping foreign objects from penetrating into the interior of the vehicle. In an automotive windshield, the total energy absorbed at peak load is the most useful data. Similarly, a windshield in a fighter-jet must not only prevent a foreign object from entering, but must do so while minimizing deflection during the impact event. In this application, energy to failure and deflection at maximum load are the critical data.

The composite panels used on aerospace applications are often subjected to impacts. These impacts do not necessarily penetrate or even cause visible damage to the end product; however they may weaken the part with internal cracks. These cracks can only be seen through the graphical data by looking for the incipient load (point A), which is often much lower than the maximum load needed to puncture the panel. With composite materials such as this, incipient loads are often more important than the maximum load, since the internal cracks will propagate (due to fatigue), and lead to failure of the part.

Click here to view an animation of fracture initiation.

## You Asked - We Answered

### Q:  What Causes the First Peak in the Load Curve of My Impact Test Data?




A:  The first peak in your test data is the initial contact between the tup and the specimen. Then, for a quick instant, the specimen moves away from the tup (rebounding from the initial impact). This quick separation is revealed as the first drop in your test data. Then the tup catches up with the specimen (re-establishing contact) and continues to penetrate through the material.

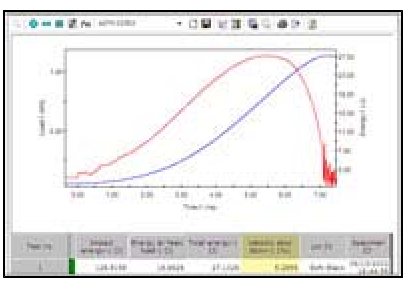
This initial contact is known as the inertial loading event. The size of the inertial spike can be explained by Newton's Second Law of Motion, F=ma, the sudden acceleration (a) of the specimen mass (m) produces a force (F) on the tup. The greater the mass of the specimen relative to the force generated during failure, the greater the size of the inertial "spike".

Inertial loads are a normal part of impact test data. The only time a problem occurs is when the inertial load is higher than the maximum load or when specimen failure occurs during the inertial loading event. When using a standard impact test method, the inertial load is rarely a problem and can be ignored. At times, problems occur in non-standard impact test applications where the tup first strikes a fixture that in response delivers the impact force. Fortunately, modern impact software contains various features that can be used to eliminate the inertial load event from the data calculations.

Click here to view an animation of an inertial loading event.

## You Asked - We Answered

### Q:  How Much Energy Should I Use for My Impact Test?



A:  When your test calls for the specimen to be completely penetrated by the tup or broken into multiple pieces, the general rule is to use at least three times the amount of energy absorbed by the test specimen. The reason behind the equation is that the energy delivered from the drop weight must be significantly greater than the energy absorbed, so that there is no appreciable slowdown of the tup during the impact event.

Some standard test methods mandate that the velocity slowdown at the point of maximum load should not exceed 10% (GM 9904P) or 20% (ASTM D3763). The slowdown velocity can be calculated using modern impact software.

The only time the energy ratio rule does not apply is when the test specimen is expected to absorb all of the impact energy so that the post test analysis can be carried out using other instruments. Examples of these types of applications are single impact rebound tests or component crush tests.

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