CRUSHING FOR EFFECT

Figure 1:
Brookfield's CT3 Texture Analyzer
with Compression Top Plate

The mechanical strength of food containers can be quantified by performing a crush test using an instrument that applies a compressive force to the package. The same instrument can also perform a puncture test to evaluate the toughness or durability of the packaging material. And a stretching action on packaging components, like tapes and seals, can determine how much force it takes to pull these materials apart.

Texture Analyzers are a type of instrument used by the food industry to measure both the physical properties of food (mouth feel for example) as well as the mechanical properties of the packaging material. (See Figure 1.) The following explains how a crush test could be performed on a packaging container shown in Figure 2.

Figure 2: Packaging Container

In the compression test, the sample is placed between the compression plate and the base table. As the compression plate moves down, the sample is compressed and deformed. The resulting data is automatically calculated to give hardness (force required to crush container) and work done (energy required to crush sample).

Typical test specifications for the instrument might look like the following:

Test Type:	Compression
Test Speed:	2.0 mm/s
Target Distance:	40 mm (Depends on container height)
Trigger Force:	30 g

Test equipment includes the choice of a probe, in this case the Compression Top Plate Fixture. The instrument must also have the capability to provide a maximum compressive force that exceeds the crush strength of the package; in this case we elected to use a Texture Analyzer with 50kg force capability.

The target distance is chosen so that the probe does not touch the base table; otherwise the instrument will become overloaded. A compression distance not exceeding 60% of the packaging container height is recommended.

Hardness values will increase relative to the increased penetration depths. Consequently, for comparison purposes, penetration distances must always be reported.

For best results in analyzing data from multiple tests, containers of equal length and size must be used along with a fixed target distance.

RESULTS

The following graphs show the crushing strength of the container in Figure 2.

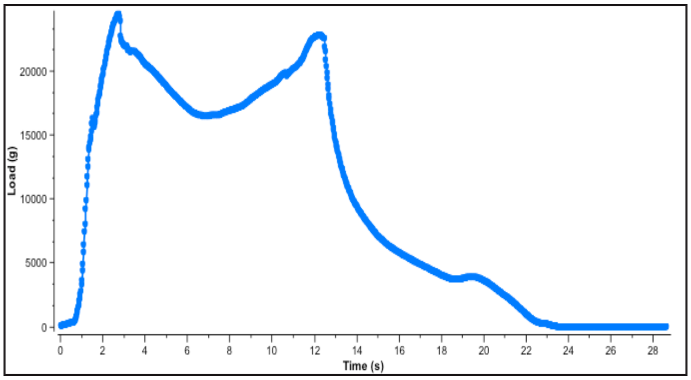

Figure 3: Force vs. time to deform a food container over a specified distance of 40 mm.

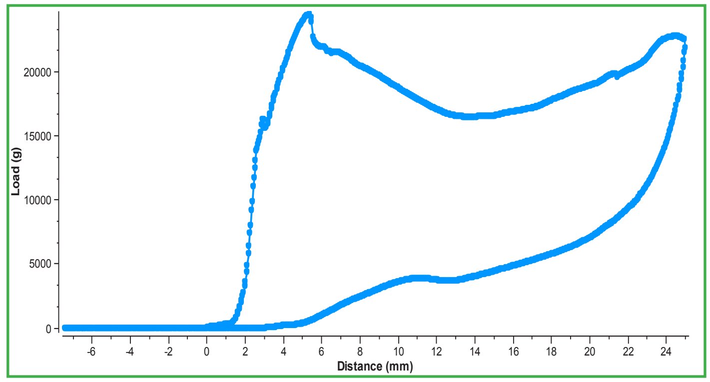

Figure 4: Force vs. distance for the deformation of the same food container.

OBSERVATIONS

When a trigger force of 30 g has been detected on the container surface, the compression plate proceeds to compress the sample package container over the specified distance, deforming it in the process. The force is seen to increase rapidly to a maximum point (peak load) before dropping after the collapse of the container. The initial peak is a measure of the maximum force required to crush the container and is a measure of hardness over the specified distance. The hardness work done is calculated as the area under the graph and is a measure of the energy required to crush the container.

Other than hardness work done values, the test can also provide information on the packaging container's recoverable deformation, defined as the height recovered by the container on removal of the compression force. The recoverable work done is also calculated, which is the spring-back behavior of the container against the compression force as the load is removed. This is a measure of the recoverable property of the container after the crush test.

The table below summarizes the results:

Hardness (g)	Work Done (mj)	Recoverable Deformation (mm)	Recoverable Work Done (mj)
40525	8168.5	27.21	1086.1

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