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Charpy Impact Test on Polymeric Molded Parts

The paper presents the Charpy impact tests on the Acrylonitrile-Butadiene-Styrene (ABS) polymeric material parts. The Charpy impact test, also known as the Charpy V-notch test, is a standardized strain rate test which determines the amount of energy absorbed by a material during fracture. This is a typical method described in ASTM Standard D 6110. We use for testing an Instron - Dynatup equipment which have a fully integrated hardware and software package that let us capture load information at very high speed from the impact tests.

Keywords: *Charpy test, polymeric material, ABS samples, injection molding*

1. Introduction

Impact performance can be one of the most important properties for a component designer and also the most difficult to quantify. Charpy test on polymeric material is an impact tests which measure the resistance to failure of a material to a suddenly applied force. The Charpy test measures the impact energy or the energy absorbed prior to fracture. In this paper we measure the impact energy for a test specimen made by molded polymeric material, called Acrylonitrile-Butadiene-Styrene (ABS).

We used the method described in ASTM Standard D 6110 to study the impact behaviour on samples made by ABS molded polymeric material. When the striker impacts the samples, the sample absorbed the energy until it yields. At that point, the sample began to undergo plastic deformation. The test specimen continued to absorb energy and worked hardens at the plastic zone. At the moment when the ABS sample couldn't absorb more energy, fracture occurred [1].

We observe that polymeric material behave very differently at high rates of loading and for that we cannot use static strength tests to predict impact behaviour. Regarding the author's further research is to measure the impact on different polymeric material and to make a comparative study between them.

2. Materials samples and testing equipment

Tests were done on polymeric material made from ABS and the samples measure 80±0,2, 10±0,2, 4,9±0,1 (mm), with respect to ASTM D 6110 or SR EN ISO 179 Charpy plastics testing [2].

The testing machine that we used is an Instron Dynatup Impact System with Data Acquisition and Control, model 8200. The Dynatup Model 8200 Impact Test Instrument meets the need for a small mass drop weight impact test instrument with a wide range of adjustable energies and velocities. The method is applicable to sample without notch. The sample is placed horizontally on two supports, and it is the subject to disruption by a striker one-shot, applied at a distance equal supports [3].

Designed for use with Dynatup tups and data acquisition systems, the model 8200 can be equipped with the appropriate options to perform dart-penetration ASTM D 6110 Charpy plastics testing. A support table is included for testing large or odd-sized specimens. The impact testing system have: maximum gravity mode velocity up to 5,0 m/s, maximum spring assisted high velocity up to 20 m/s, maximum physical drop height of 1,25 metres, self-id load cell for measuring drop mass, figure 1 [4].

Figure 1. The Dynatup Model 8200 Impact Test

The 8200 is ideal for low energy testing of thin section or brittle plastics, composites, ceramics, and metals.

The injected samples made from the ABS material were without notch. We placed horizontally a sample, on two supports, and we applied at a distance equal supports a striker one-shot.

3. Experimental study for the ABS molded samples

The figure 2 presents the picture taken with the ABS samples with thickness 4,9±0,1 [mm] used to determine the resistance to impact, at the time of the Charpy tests. The impact mass used was m=3,94 [kg].

The table 1 presents the experimental results collected for ten samples from molded ABS material, measure 80±0,2, 10±0,2, 4,9±0,1 [mm], with respect to ASTM D 6110 or SR EN ISO 179 Charpy plastics testing [2].

In the table 1, H in [mm] is the sample drop height, v the impact velocity in [m/s], E the total energy in [Kgm] and W is the total energy in [J]. In the total energy E is included and gravitational acceleration.

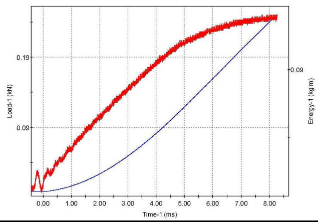
Figure 2. ABS sample tested

Table 1. Experimental results

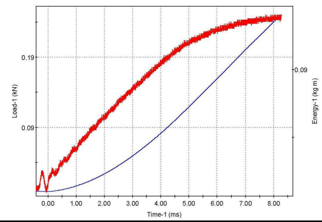
Sample	Characteristics					Results
	m [kg]	*H* [mm]	*v* [m/s]	*E* [Kg m]	*W* [J]	Type of the impact
1	3,94	35	0,8911	0,1302	1,2764	Without break
2		40	0,9272	0,1516	1,4862	Total break
3		45	0,9661	0,0740	0,7254	Total break
4		50	1,0250	0,1903	1,8656	Total break
5		55	1,0994	0,1883	1,8460	Total break
6		60	1,1295	0,2054	2,0137	Total break
7		65	1,1993	0,1382	1,3549	Total break
8		70	1,1838	0,1585	1,5539	Total break
9		75	1,2372	0,1656	1,6235	Total break
10		80	1,3127	0,3247	3,1833	Total break

Table 2. ABS charts

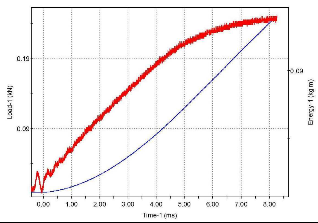
Sample 1, H =35mm



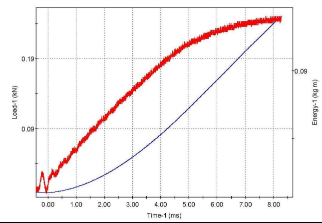
Sample 2, H =40 mm



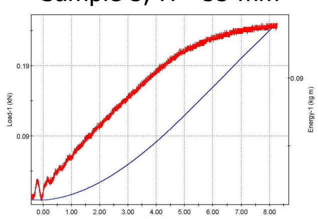
Sample 3, H =45 mm



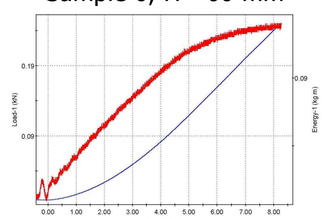
Sample 4, H =50 mm



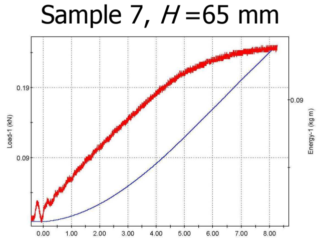
Sample 5, H =55 mm



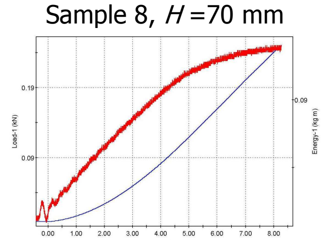
Sample 6, H =60 mm



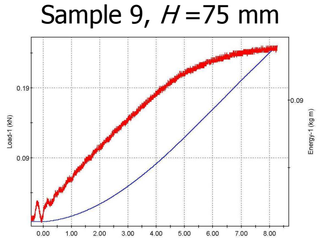
Sample 7, H =65 mm



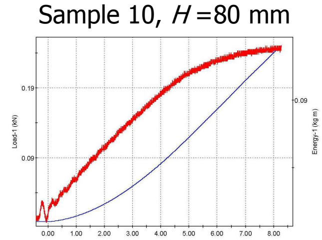
Sample 8, H =70 mm



Sample 9, H =75 mm



Sample 10, H =80 mm



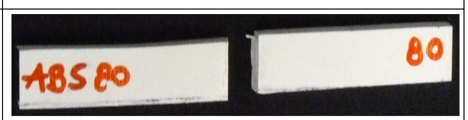
Data collected by the Impulse system was organized, analysed and displayed both graphically and numerically based on PC software. Analysis options include automatic yield and failure point calculations, as well as digital filtering to screen out load cell resonances and noise.

Test data could be exported to spread sheets and charts, as you can see in table 2 for the ABS material.

In the charts the blue variation is the energy, E in [Kgm] and the red variation is the load, F in [kN]. The break type is evident for the height of impact, which in our case is from H=35mm on sample 1 to H=80mm on sample 10.

Table 3 present the photograph taken with the Acrylonitrile-Butadiene-Styrene samples with thickness 4,9±0,1 [mm] used to determine the resistance to impact, after we made the Charpy tests. As you can see from the picture, the materials behave very differently at high rates of loading.

Table 3. ABS samples

Sample 1	Sample 10
H =35mm	*H* =80 mm
Without break	Total break
	

Toughness is the most important characteristics for structural component materials and has been evaluated widely by Charpy impact test. Various polymeric, such as acrylonitrile-butadiene-styrene were used to estimate quantitative fracture toughness values under dynamic loading condition have been presented.

The test measures the impact energy, or the energy absorbed prior to fracture. When the striker impacts the samples, the samples will absorb energy until it yields. The test sample continues to absorb energy and when the sample can absorb no more energy, fracture occurs. Fracture toughness decreases with increasing the strength.

4. Conclusion

The materials behave very differently at high rates of loading and for that we cannot use static strength tests to predict impact behaviour. Break type of evidence is amended according to the drop height as to H = 35 mm no breakage, and for H = 40 mm up to H = 80 mm total breaking.

Standard test method such as Charpy is an important tool for raw material research and quality control. The total energy, W [J] accumulates over time and increased to achieve a level of constancy, then it is absorbed in the polymeric material.

References

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[4] ***** http://www.instron.com - *Dynatup Drop Weight Impact Test Machine*, Impact Testing Solutions Brochure, pod_8200_rev5_0606, 2006.

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