High Speed Impact Characteristics of Plastic Material Based on Finite Element Simulation

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Keywords: Impact Simulation; High Speed Puncture Test; Finite Element Method

Abstract. Testing material specimen on impact using high speed puncture machine can be used to observe the ability of material to withstand under a certain impact speed by looking at the energy required to tear the material. Other detail parameters such as stress, strain and tearing development on impact cannot be seen or measured. This paper presents a finite element method approach to see the strain history and the tearing sequence that cannot be obtained during impact puncture testing of plastic material (Polyethylene Terephthalate / PET). Simulations in different speed; 10 m/s (36 km/h) and 20 m/s (72 km/h) are performed employing a dynamic-explicit Impact finite element program suite. The simulations are able to capture the tearing process, to see the strain histories of tearing region and to predict the tearing pattern. The tearing pattern simulation results are verified by comparing with that from experiment.

Introduction

Plastics have been widely used for several decades. The plastic materials have been used for various applications which require the high strength, high stiffness and low weight. In many cases, plastic materials have superiority over metals. This is due to the moldability plastic materials and production low cost.

Plastics are all around us, in a form of plastic wrap for our foods and drinks, home appliances to automotive structures. In other applications, plastics can be used in clothing, eyeglasses, teeth, toothbrush, electronic components like board circuit, computers, phones, dishes, utensils, also toys.

There is growing need in an automotive, an aircraft and military applications for plastic materials that have not only good structural characteristic but also good penetration resistance and structural integrity after impact [1]. Among various types of plastics, one is Polyethylene Terephthalate (PET) used for carbonated drinks bottles, jars, plastic film, microwavable packaging and many other applications in engineering.

Literature Review

For any complex engineering problem including nonlinear material such as plastics, Finite Element Method (FEM) approach can be used to simulate nonlinearity. This numerical method divides the structure into smaller, more manageable elements, i.e. finite elements.

The behavior of structures can also be reduced to a set of linear equations that can easily be solved using the standard techniques of matrix algebra [2]. For example, FEM can be used to analyze impact problems and high speed metal-forming processes [3]. Another application for nonlinear problem in impact is also perform in dynamic-explicit finite element method [4].

In penetration mechanics, meshless method can also be implemented [5]. The geometrical structure is described mesh-less functions that concludes a solution to predict the penetration process. The target structures is modeled in a mesh-less way by finite layers of the target materials, which