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Study of Damage to ABS Specimens Submitted To Uniaxial Loading

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--ABSTRACT--
Polymers have experienced a remarkable historical development and their use has greatly taxed in our civilization in a matter of decades gradually overtaking the most ancient materials. These polymer materials have always distinguished themselves by their simple formatting and inexpensive, their versatility lightness chemical stability but despite their widespread use both in everyday life and in advanced technologies, these materials are generally still very misunderstood which requires a thorough knowledge of their chemical, physical, rheological and mechanical. In this work we focus on the characterization of an ABS plate under uni axial loading using the unified theory of damage.

KEYWORDS : *polymer, breakdown, damage, traction, ABS*

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I. INTRODUCTION

Polymers offer many features that make it appealing, one can distinguish their corrosion features, their lightness, their low cost, their insulating character their ductility, the many available methods to implement and shape simultaneously. Or, if one seeks only to their mechanical properties, their behavior is complex and is a major obstacle [1], as potential users have difficulties to take account in the steps of design and optimization. However because of the presence of voids in the material, or even damage, cracks can start and propagate to a size causing the collapse of the structure [2]. To assess the level of damage to a structure subjected to any solicitation, two models exist: the mechanics of mechanical damage to the rupture [3] and this work is a contribution to the study of the failure mechanism an ABS plate under urging by the uniaxial tensile test.

II. THEORY

The damage of a material leads to a lowering of the limit of endurance and resistance to static strength [4]. Gatts's hypothesis [5] to stress above the endurance limit, fatigue damage is a power function of the form:

$$\gamma_D=(\gamma_{ur}/\gamma_u)^m$$

with $\gamma_D=(\sigma_D/\sigma_{D0})$, $\gamma_{ur}=(\sigma_{ur}/\sigma_{D0})$, $\gamma_u=(\sigma_u/\sigma_{D0})$

or σD0 is the endurance limit of the virgin material, σD is instantaneous endurance limit of the material (after n cycles of loading) σur is the instantaneous value of the tensile strength of the material monotonous, σu is the maximum resistance monotonic tensile virgin material, m is an empirical constant [6]. Bui Quoc model [7] provides a correlation between the tensile strength and the monotonous cyclic loading, the resistance of a material to a static effect diminishes if previous efforts undergoes cyclical nature of the application the static force [8]. We are talking about the reduction of the residual strength of the material [9]. σur (equal to σer for polymers) is the residual stress of the final damage after n cycles of loading, σu (σe equal to polymers) the material is virgin material of the ultimate stress, β is the fraction of life and σm = γ / σD0 is the level of loading (σm average cyclic stress) [10]. for polymers, the ultimate stress σu and the stress at the limit of elasticity σe are identical [11]. Thus, the parameter m is a parameter material with m = 1 for amorphous [12] polymers. The formulation proposed by Bui Quoc damage is different from that previously presented by Miner [13]:

$$D=(1-\gamma_D)/(1-\gamma_D^*)$$

$\gamma_D=\sigma_D/\sigma_{D0}$, $\gamma_D^*=\sigma_m/\sigma_{D0}$
σ_D : the endurance limit

σ_D^* : Critical endurance limit
the damage model resulting fraction is a function of the load and the life of the mechanical properties of the virgin material [14]:

$$D = \frac{\beta}{\beta + (1-\beta)\left[\frac{\gamma - (\frac{\gamma}{\gamma_u})^m}{\gamma - 1}\right]}$$

or $\gamma_u = \sigma_u / \sigma_{D0}$ is a parameter characterizing the virgin material

III. EXPERIMENTAL

To highlight the influence of the notch on the behavior of specimens ABS, a series of tests was carried out on the characterization of damage on two rectangular sample groups of SBS using the database of ASTM 882 -02 [15] and 766m ASTM D [16]. the first test is smooth on rectangular specimens (without defects) for the mechanical characterization and the second is on rectangular test specimens with notches of 1mm to 7mm length. All the experimental tests were carried out under a controlled displacement and the following figure shows the implementation of the tensile test

Figure 1 Experimental set-up: A test specimen held by the sample holder of the tensile testing machine (left), and dimensions of the test specimen (right).

IV. RESULTS

It should be noted that the phenomenon of stress concentration is created in notched specimens is observed and also the notch effect of the reaction which reflects the structure of the force applied depending on the length of cut.

Figure 2 shows the evolution of the stress versus strain

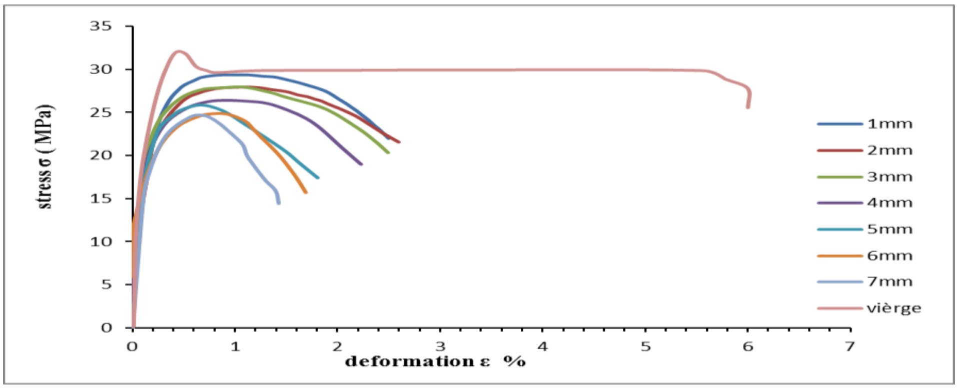

Figure 2 . Evolution of the stress-strain curves for uniaxial tensile tests on rectangular test specimens according to ASTM D 882-02 two and ASTM D5766M

In the curves of the figure, we notice a decrease in the resistance threshold of elasticity as the cut increases in length. After this threshold we observe a short softening stage called "draw hook" that is assigned to the multiplication of microstructural defects, and a long curing step. These curves also show a remarkable degradation of the mechanical properties of the material comprising the elastic stress, ultimate tensile stress and elongation.

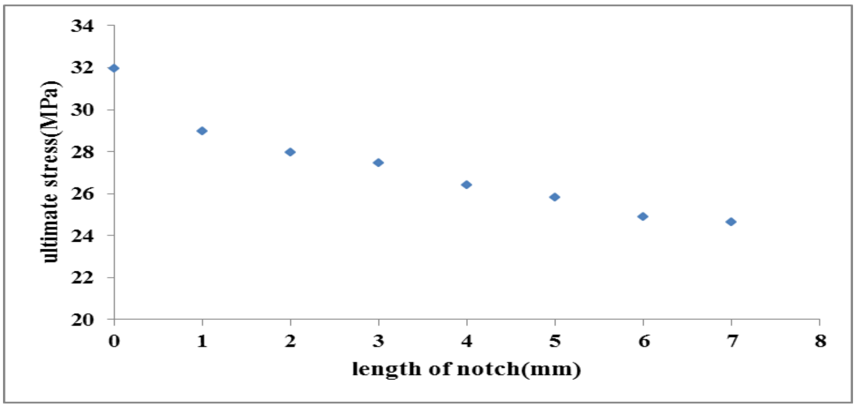

Figure 3 : evolution of the maximum stress as a function of the length of notch

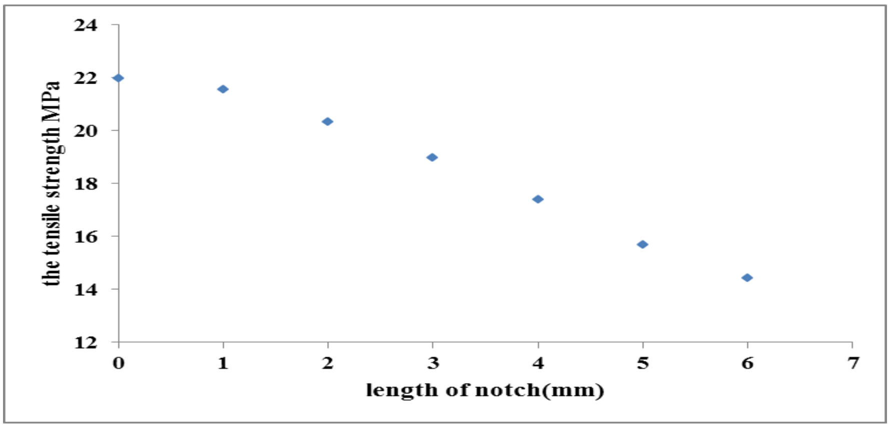

Figure 4 : evolution of tensile strength depending on the length of notch

As already mentioned in the curves of the right branch shows the stress-strain response of the sample elastic, this allows the calculation of the branch Young's modulus. However, with the existence of the cut we'll talk more stiffness for samples that notched Module young for smooth specimens, stiffness determines the limits of intervention for elastic structures notched.

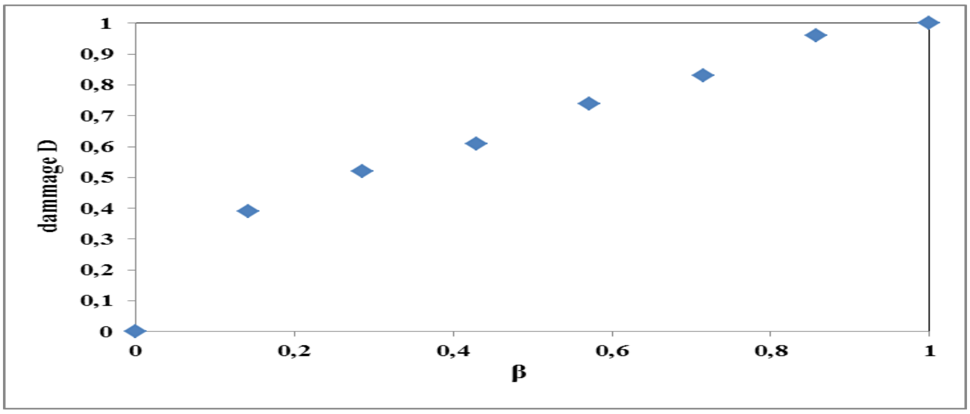

Figure 5. Evolution of the damage versus the fraction of life

The figure shows the evolution of damage in notched specimens with a length of cut ranging from 1mm to 7mm which is a linear variation. At the beginning of the curve we see negligible levels of damage and as the crack length increases the damage accelerates to a maximum value of 0.98. Or the first installment of the curve that represents the initiation zone characterizes the highest mechanical properties of the material until the last break point represents degradation. This approach is proposed by analogy with the cumulative damage theory proposed by Gatts [17] Bui Quoc- by [9] to show the evolution of damage in a structure ABS.

V. CONCLUSION

The aim of our study was to assess the level of damage ABS thermoplastic plates subjected to uniaxial stress. We have found that the tensile test is the most effective approach to approximate the actual deformation of the structure during the loading technique. This Require to agree on the use of the unified theory of damage in the interest of present closer to the actual state of damage model. With the aim to provide a formulation of the damage depends only loading conditions of the mechanical properties of virgin material, we looked at the model Bui Quoc, and the results showed the use of this approach is therefore to describe strictly the state of matter. This preliminary work is a necessary step to achieve our goals completely and develop other tools to simulate the microstructural degradation phenomenon structures ABS.

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