EFFECTS OF THICKNESS AND LOADING RATE ON MIXED MODE FRACTURE BEHAVIOR OF POLYCARBONATE

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ABSTRACT

In daily life polycarbonate materials are using in many applications like construction of building, Medical instrument, automotive vehicle, safety device etc. In engineering the fracture fatigue failures are subjected, so calculating in-plane tearing energy of a ductile thin plate [4]. Whenever largest tensile stress following straight line connecting the crack tips and perpendicular to cracks propagate were discussed in universal shapes formed by two interacting cracks [8]. There are many experimental studies which related to mechanical behavior of polycarbonate, such as Experimental Investigation on the EWF of mixed mode fracture of PC/ABS alloy [5]. Ductile fatigue crack propagation in polycarbonate,[14] and behavior of universal shapes repulsion and attraction between a pair of cracks in a plastic sheet[9].

The Goal of present studies is effects of thickness and loading rate on mixed mode behavior of polycarbonate We have used UTM machine for finding tearing energy and then after used scanning machine for Universal shape.

II. TEARING ENERGY

The energy is require for small change in area of surface during the crack propagation is called tearing energy. In fracture mechanics energy dissipating is important in the reduce the damage cause during a collision. In many cause kinematic energy is dissipates by stretching, bending and tearing. in the energy dissipation there are two component are plastic deformation energy and tearing energy. The tearing energy is nothing but specific essential fracture work which in denoted by wt [5]

\[ W_{total} = W_p + W_t \]
\[ l_{\text{wp}} + l_{\text{wt}} = \beta l_{\text{wp}} + w_t \]  \hspace{1cm} (1)

Where \( l \) is ligament length, \( t \) is thickness of sheet, \( w_{\text{total}} \) is total fracture work, \( w_{\text{p}} = \) plastic deformation work, \( w_t = \) tearing energy, \( \beta = \) plastic shape factor

III. EXPERIMENT

DENT specimen have used in the test. The Design of specimen is shown in Fig.1 and the dimensions are 150 mm \( \times \) 50 mm and thickness is 0.8 mm. Laser device was used to produce artificial crack tips with various ligament lengths. Different loading angles were introduced with different values of \( \theta \) are 0° to 90° increase with 10° .

There is DENT specimen of polycarbonate material. Dent specimen shown in fig.1 where \( l \) = ligament length and \( \theta \) = loading angle.

Figure 1 DENT specimen

All experiments were performed on the Universal testing machine. The loading rate was constant and failure specimen used to observe the crack tip deformation. The loads and displacements applied to the specimens were recorded automatically during the test. Then we have create load vs. displacement graph. Show in the figure2

We can shows self similarity in load vs. displacement graph means ligament increasing with respect to load vs. displacement curve also increasing. Evaluated area under the curves for different ligament and various loading angle. We have finding good linearity of specific fracture work between ligament length show in fig 3.
In fig. 2 shows load vs. displacement graph for $\theta = 20^\circ$ for different ligament lengths $l = 10\text{mm}, 12.5\text{mm}, 15\text{mm}, 17.5\text{mm}, 20\text{mm}$

IV. RESULT AND DISCUSSION

Shown in fig 3, whenever the ligament lengths is extrapolated that time we can easily find the tearing energy from the above graph. In fig 3, shows when $l = 0$ for $\theta = 20^\circ$, tearing energy $W_e = 36.047 \text{kJ/mm}$ and $\beta_{wp} = 0.7824$. Shown in table 1 when loading angle $\theta = 0^\circ$ to $40^\circ$ tearing energy continuously increasing then after $\theta = 60^\circ$ suddenly decreasing and after that its highly increasing.

$t=0.8\text{mm}$

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$w_f$</th>
<th>$w_f$</th>
<th>$w_f$</th>
<th>$w_f$</th>
<th>$we_{kJ/m^2}$</th>
<th>$\beta_{wp}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L=10\text{mm}$</td>
<td>$L=12.5\text{mm}$</td>
<td>$L=15\text{mm}$</td>
<td>$L=17.5\text{mm}$</td>
<td>$L=20\text{mm}$</td>
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Figure 2 Load vs. displacement

Figure 3. $W_f$ vs Ligament
from the result of table we can say that whenever $\theta$ increasing the value of tearing energy also increasing shown in table1.tearing energy and loading angle $\theta$ which indicated convex value which say that the value of tearing energy is not constant

V. UNIVERSAL SHAPES
Now we have used failure specimen for the finding the universal shape. we have used scanning machine and specimen put on the desk board of machine near the auxiliary camera then after zooming for the scanning the cracks propagation and finally capture the photo. During the propagation of cracks we show that where two cracks pass each other square root shape begins shown in fig 5. Two cracks propagate approximately straight way until they pass to each other and then after they curve and square root shape generate. figure 5. also indicate that the $l/d$ ratio is constant for loading angle $\theta = 0^\circ$ to $40^\circ$ and various ligament lengths so we can say that universal shapes formed by two interacting cracks in polycarbonate material.

CONCLUSION
After the study presented here, we can conclude that the tearing energy $w_e$ is not a material constant and which is not depended geometry of specimen for polycarbonate material
Universal shapes formed by two interacting cracks in mixed mode for polycarbonate material which suggests that a geometric model into the dynamics..
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