MODE II FRACTURE TOUGHNESS TESTING WITH APPLICATION TO PMMA

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ABSTRACT

The authors' studies of a newly proposed Mode II fracture specimen containing a region of nearly uniform pure shear stress in which all of the isostatics pass through at an angle of approximately 45°, before crack introduction, are first reviewed. This region has been examined by means of photoelasticity and finite elements and the main results are concisely described. A calibration formula for $K_{II}$ determined by a finite element analysis, is also presented.

The testing of PMMA specimens for Mode II fracture toughness, yields a $K_{IC}/K_{IIC}$ ratio of approximately 0.91 and an average fracture initiation angle of 74°. The new Mode II fracture specimen proved to be well-suited to the measurement of Mode II crack propagation characteristics.

THE SPECIMEN

A newly developed Mode II fracture specimen was presented in [1-4], see Figure 1a. The main aim in those studies was to demonstrate by means of photoelasticity and finite elements the potential of this specimen for $K_{IIC}$ measurement. A description of other specimens for Mode II fracture toughness testing may be found in those papers. The seeming advantage of this specimen lies in the fact that the crack is placed in a uniform pure shear field (called subsequently the "significant region") and in which all of the isostatics pass through at an angle of approximately $\pm 45^\circ$; thus, the crack faces will move parallel to one another maintaining a Mode II deformation along their entire length.

The uncracked specimen is shown in Figure 1b. A nearly uniform pure shear zone is achieved in its significant region. In [2] and [4], both a photoelastic and a finite element analysis of the specimen without a crack were presented showing the extent of the nearly uniform pure shear zone. As an example, Figures 2a and 2b illustrate the region of constant $\tau_{max}$ and the 45° isoclinic, respectively, demonstrating photoelastically that a nearly uniform pure shear region exists in the significant region of the specimen. The extent of this region is affected by the choice of dimensions. With all dimensions held fixed, the effect of several values of b/c was examined. Finite element results which were
Fig. (1) - Test specimen with inner part made of sensitive photoelastic material PSM-L; \( r_1 = 190 \text{ mm}, r_2 = 40 \text{ mm}, d = 36 \text{ mm}, c = 30 \text{ mm}, \) (a) with a crack; (b) without a crack.

Fig. (2) - Uncracked test specimen (\( b/c = 0.2 \)); (a) isochromatic pattern; (b) the 45° isoclinic.

determined in [2] are presented here for completeness. Table 1 shows that as \( b/c \) increases, the width of the pure shear zone increases while its length decreases. In addition, for each value of \( b/c \) studied, the stresses \( \sigma_{xx} \) and \( \sigma_{xy} \)