EXPERIMENTAL INVESTIGATIONS OF FRACTURE MECHANISMS IN BRITTLE PHOTOELASTIC MATERIAL

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Samples which are made of new brittle photoelastic material and have various slendernesses are tested in uniaxial compresson at average strain rates of ~ 10^{-4}/s and up to 10^{3}/s. The material characteristics, cracking mechanisms and failure modes are compared.

INTRODUCTION

Brittle photoelastic materials are often used to investigate the stress and strain fields in monolithic engineering structures, or in their elements at the stage of failure particularly the phenomenon of crack initiation and its grawth in structures (or their model) made of real materials.

In experiments a new britte photoelastic material, which consists mainly of the epoxy resin and colophony, was used. Its behaviour in static and dynamic loading conditions was examined. This is of importance not only for a better recognition of the material properties,but it also furnishes information needed to appropriately model the process of fracture.

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EXPERIMENTAL DETAILS

Tests were performed at a quasi-static rate of about 10^{-4}/s in standard testing machine and at impact rates up to 10^3/s using a split Hopkinson's pressure bar (SHPB). The cylindrical specimens with four slendernesses s = 0.5, 1, 1.5 and 2 were determined by the requirements of the SHPB technique.

EXPERIMENTAL RESULTS

Static and dynamic stress-strain curves for the samples are presented in Figure 1.

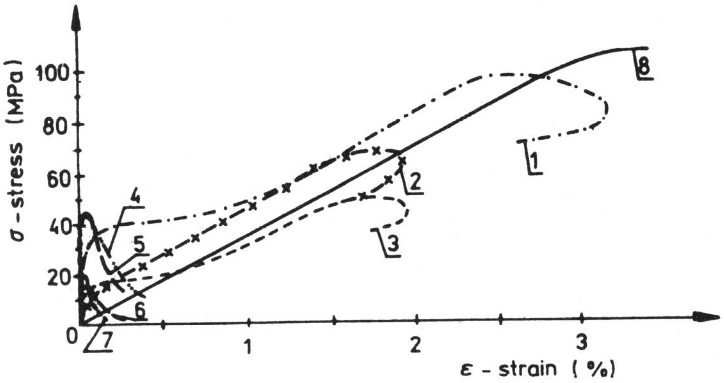
The following types of failure were observed in static tests: axial (longitudinal) splitting, faulting (shear), slabbing (peeling) and shear (two 45° cones) with axial splitting, see Figure 2. Dynamic fractured specimens are shown in Figure 3.

DISCUSSION

The examination showed that longitudinal splitting was present in specimens deformed both statically and under impact. The shear mode was the more dominant at the quasi-static rate (particularly in samples for which $s \geqq 1$) and longitudinal splitting - under impact loading (associated with secondary transversal cracks) and at the quasi-static rate in the lowest specimens (s = = 0.5). The cracking is more extensive in the quasi-static tests (where the time is long for the propagation of cracks). The impact damage is characterised by delaminated regions at a sample end on the side where the impact loading was applied. The overall specimen dimensions remain unaltered after the impact. Those regions enlarge with increasing load up to completely fragmentation of specimens. The slabbing failure was quite rare and occurs due only to static loading.

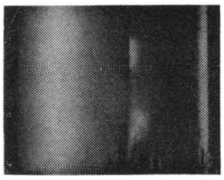
CONCLUSION

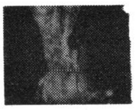
The experimental method furnished information which makes it possible to describe the fracture mechanisms of the specimens. For the static and dynamic loading conditions the material characteristic, cracking mechanisms and failure modes were compared with account for the effect of varying slenderness of specimens. More detailed information about the experimental results will be given by authors on their poster considering limited length of the paper.

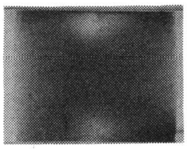


1 - s=0.5, $\dot{\varepsilon}$=680/s; 2 - s=0.5, $\dot{\varepsilon}$=390/s;
3 - s=1, $\dot{\varepsilon}$=215/s; 4 - s=1.5, $\dot{\varepsilon}$=270/s;
5 - s=2, $\dot{\varepsilon}$=200/s; 6 - s=1.5, $\dot{\varepsilon}$=180/s;
7 - s=2, $\dot{\varepsilon}$=130/s; 8 - s=0.5, $\dot{\varepsilon}$=$1.4 \cdot 10^{-6}$/s.

Figure 1 Stress-strain curves for britte photoelastic material specimens


axial (longitudinal) splitting


slabbing (peeling)


shear (two 45° cones) with axial splitting

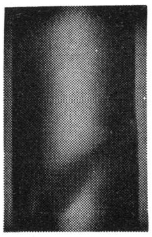
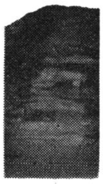

faulting (shear)

Figure 2 Quasi-static failure modes in specimens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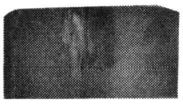
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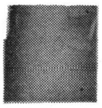
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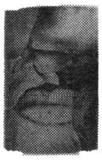
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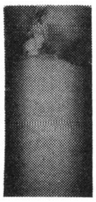
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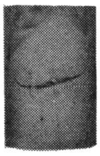
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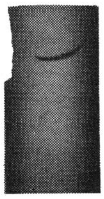
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Figure 3 Impact damage (for curves 1-7, see Figure 1)