AN EXPERIMENTAL STUDY OF THE STRENGTH OF ORGANIC GLASS UNDER DYNAMIC LOADS

M. F. Drukovanyi, V. G. Zhurba, and V. M. Komir

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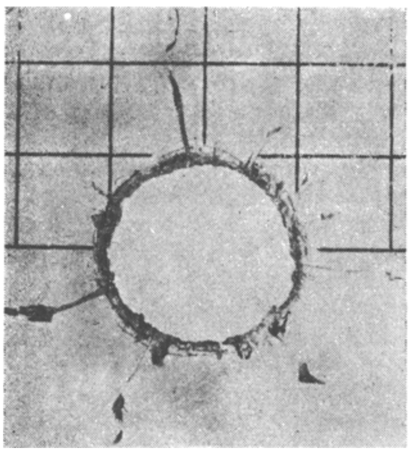
The experiments reported in this article were carried out on organic glass (plexiglas) plate specimens which were dynamically loaded by explosive charges, placed in cylindrical holes drilled through the specimen thickness.

An optical polarization method of stress measurement was used to record certain parameters of cylindrical stress waves produced in the plates by explosive charges [1, 2].

The isochromatic field produced in an explosively loaded plate placed in the field of a circular polariscope was recorded with a superhigh-speed instrument SFV, using the time magnifier variant.



It was found that an explosive load produces a narrow, cylindrical, sharply defined zone of intense destruction of the material (see figure) in the region adjacent to the explosive charge, with isolated cracks of various length radiating from this zone.

The aim of these tests was to determine the difference between the principal stresses at the boundary between the localized fracture zone and the undamaged part of the plate, i.e., to determine the critical stress difference. This difference was determined for plates of various thickness subjected to explosive pulses of various strengths and durations.

The strength of explosive loads was varied by using two explosives: PETN and lead azide. The maximum pressure and heat of explosive decomposition of PETN are several times larger than the corresponding values for lead azide [3]. The diameter of the explosive charges and the specimen thickness were identical in these comparative experiments.

The duration of the explosive pulse was varied by varying the explosive charge diameter at a constant specimen thickness.

The dependence of the critical difference between the principal stresses on the specimen thickness was determined using PETN charges of a constant diameter.

It should be pointed out that, in contrast to statically loaded specimens, it is not always possible to determine the order of isochromatics from a black-white photograph obtained for a dynamically loaded specimen. In the present case, it was assumed that the maximum radial stress in the unaffected part of a plate at any stage of the propagation of the local destruction zone is at the boundary of this zone. With this assumption, the order of isochromatics during a given time interval will increase from the boundary of the stress field to the boundary of the local destruction zone.

Analysis of the photographic records showed that in the case of identical charges exploded in plates of the same thickness, PETN charges produce local destruction zones of a larger radius. In the case of plates explosively loaded by PETN charges of various diameters, the radius of the local destruction zone is proportional to the charge diameter. Test results showed that, within the limits of experimental error, the difference between the principal stresses does not depend on the loading conditions or plate thickness, and is equal to

$$(\sigma_1 - \sigma_2)^* = 508\text{–}594 \text{ kg/cm}^2.$$

(The optical constant of the material studied was determined by a moiré bands and color cinephotography method; this work was carried out by V. V. Mishin and V. G. Zhurba.) It should be noted that the short-time strength of organic glass is 470–550 kg/cm^2 according to our own data, and 550–600 kg/cm^2 according to data in [4]; these figures are approximately equal to the value of $(\sigma_1 - \sigma_2)^*$ found.

Summary

1. The strength of impulsively loaded organic glass plate in the region of localized destruction is determined by the critical difference between the principal stresses, which is independent of the intensity and duration of the explosive pulse.

2. The critical difference between the principal stresses in dynamically loaded organic glass plate is approximately equal to the short-time strength of the material under static load.

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Dnetropetrovsk Branch of the Institute of Mechanics, AS UkrSSR