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Application News

No. V26

High-Speed Video Camera

Observation of Fracture Behavior of Resin Material from an Impact Compression Test by the Hopkinson Bar Method

Understanding the properties of materials is important in designing products. For this reason, there are various testing standards such as tensile testing, compression testing, and bend testing. Regarding transport aircraft, the possibility of sustaining impact loads must be taken into account, meaning that in order to accurately understand the properties of a material, impact properties must be grasped in addition to static properties. In particular, impact testing is necessary since the stress-strain characteristics of a material may differ between when it is subjected to a static load and when it is subjected to an impact load. The Hopkinson bar method is one method for impact testing. Proposed by Bertram Hopkinson, this method deforms a specimen by impact. A striker bar is fired against an input bar by a bar launcher, transmitting a compressive elastic wave through the input bar to apply a sudden force to the specimen which is contacting the input bar.[1)] A schematic of the Hopkinson bar method is illustrated in Fig. 1.

In this study, an impact compression test by the Hopkinson bar method was conducted using a specimen made of acrylic resin and the fracture behavior of the specimen was observed.

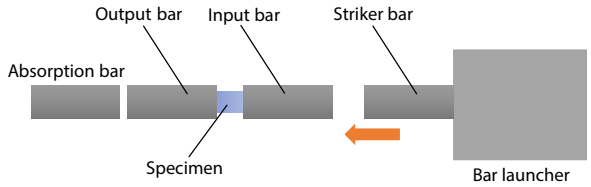

Fig. 1 Schematic Diagram of the Hopkinson Bar Method

Measurement System

Fracture behavior was observed using the HPV™-X2 high-speed video camera (hereinafter referred to as HPV-X2). The equipment used for recording in this study is shown in Table 1. Figs. 2 and 3 show the observation and test setup. Cavilux was employed for illumination. Cavilux is a laser light which can emit short pulses down to 20 ns in accordance with the shutter signals of the HPV-X2, making it optimal for high-speed recording.

Table 1 Recording Equipment

High-Speed Video Camera	: HPV-X2
Lens	: One 105 mm macro lens, two teleconverters
Illumination	: Cavilux

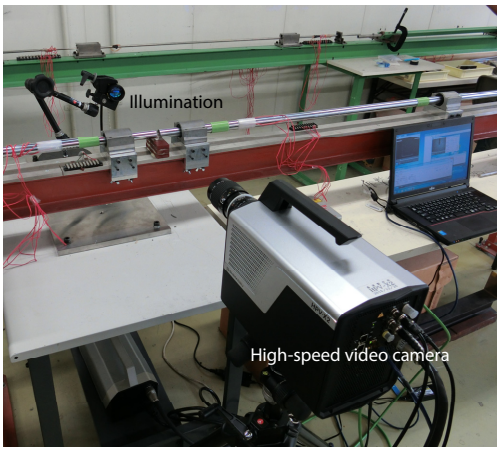

Fig. 2 Setup of Recording Equipment

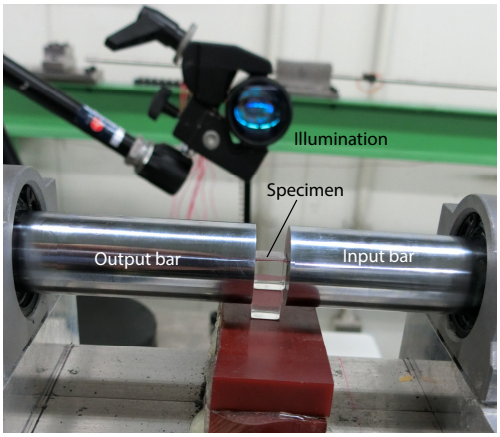

Fig. 3 Test Setup with Specimen Inserted

Measurement Results

The test was recorded at 500,000 frames per second. Examples of the captured images (frames) are shown in Fig. 4. The time interval between the images in Fig. 4 is 140 µs. These images show that deformation was concentrated at the four corners of the acrylic resin specimen. Fig. 5 shows the crack propagation during the breakage of the specimen. Fig. 4-(4) and Fig. 5-(1) are the same image. The images show that a crack first occurred in Fig. 5-(2) at the surface of the specimen contacting the output bar, and the crack reached the surface contacting the input bar in Fig. 5-(7). The white arrows in Fig. 5 indicate the length of the crack inside the acrylic resin specimen.

Conclusion

A compression test by the Hopkinson bar method was conducted and fracture behavior was observed using the HPV-X2 high-speed video camera. Although crack propagation in impact tests cannot be observed visually due to their extreme speed, in this study, the use of the HPV-X2 enabled a successful observation of the crack propagation. This study demonstrates that the HPV-X2 is a useful tool for evaluating the impact properties of materials.

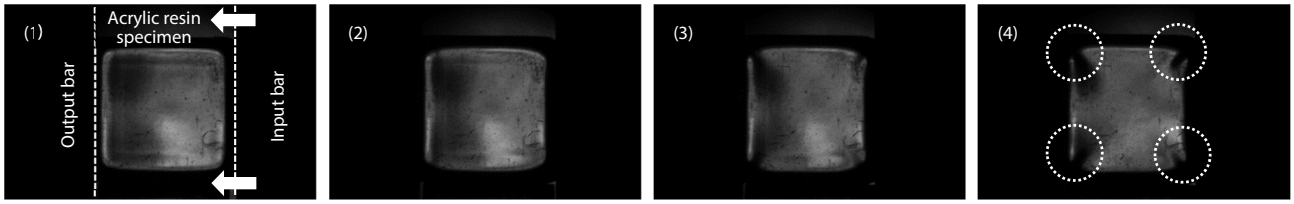

Fig. 4 Captured Images (Time interval between images: 140 µs)

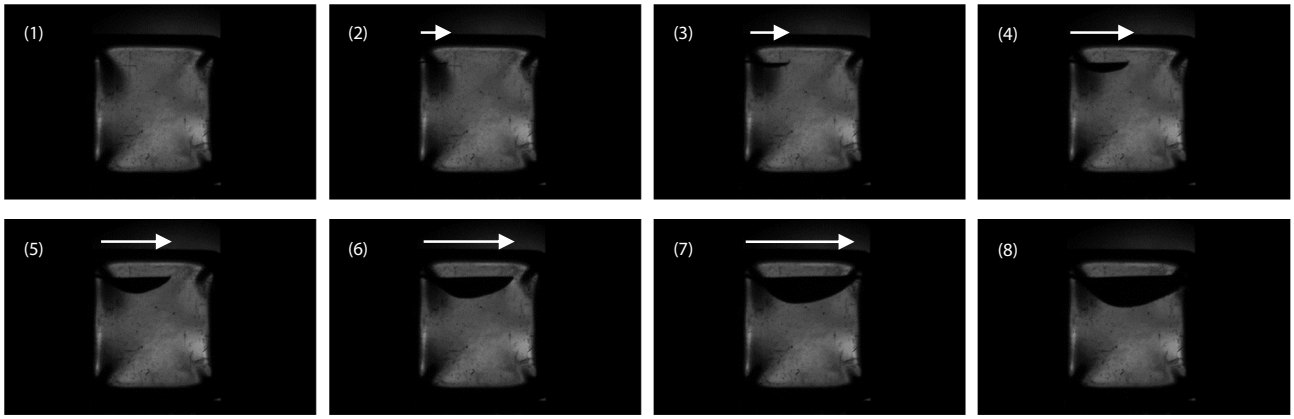

Fig. 5 Crack Propagation (Time interval between images: 2 µs; Fig. 5-(1) is same image as Fig. 4-(4))

The test was recorded in collaboration with the Structural Mechanics Laboratory in the Department of Mechanical Engineering, Faculty of Science and Engineering at Ritsumeikan University.

Reference

1) Kichinosuke Tanaka and Yoji Adachi, Aeronautical and Space Sciences Japan, Volume 21, Issue 230 (1973)

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