

Application News

High-Speed Video Camera

DIC Analysis of Impact Compression Test Using the Hopkinson Bar Method with HPV™-X3

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User Benefits

- ◆ With a maximum frame rate of 20 Mfps, the HPV-X3 is well suited for observing high-speed phenomena such as impact tests.
- ◆ The HPV-X3 offers three times the resolution of conventional models, enabling DIC analysis at much higher resolution.

Introduction

Understanding material properties is extremely important in product design. In particular, for applications such as transportation equipment, where materials may be subjected to impact loads, it is necessary to evaluate not only static properties but also impact properties. When subjected to impact, materials may exhibit stress-strain characteristics different from those under static loading, making it essential to clarify these characteristics through impact testing.

Among available methods, the Hopkinson bar method is widely used for impact compression testing. This method, proposed by B. Hopkinson, enables detailed analysis of a material's impact response and fracture behavior by applying a sudden force to the specimen using a bar-launching device.

This paper presents an example in which the impact compression test of an aluminum specimen using the Hopkinson bar method was recorded with an HPV-X3 high-speed video camera (Fig. 2), and DIC (Digital Image Correlation) analysis was performed.

Imaging System

The specimen is shown in Fig. 3. A random speckle pattern was attached to the specimen surface on the camera side using a transfer sticker. The imaging setup is shown in Fig. 4, and the imaging devices are listed in Table 1. Imaging was performed with the HPV-X3 using a close-up ring, bellows, and a macro lens. LED illumination was directed from the camera side, and the resulting specimen deformation was recorded.

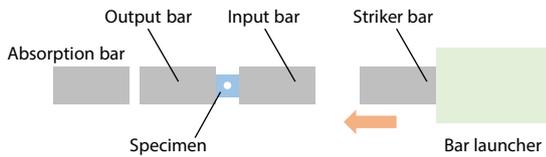


Fig. 1 Schematic Diagram of the Hopkinson Bar Method



Fig. 2 HyperVision™ HPV-X3 High-Speed Video Camera

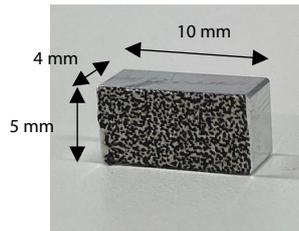


Fig. 3 Aluminum Specimen

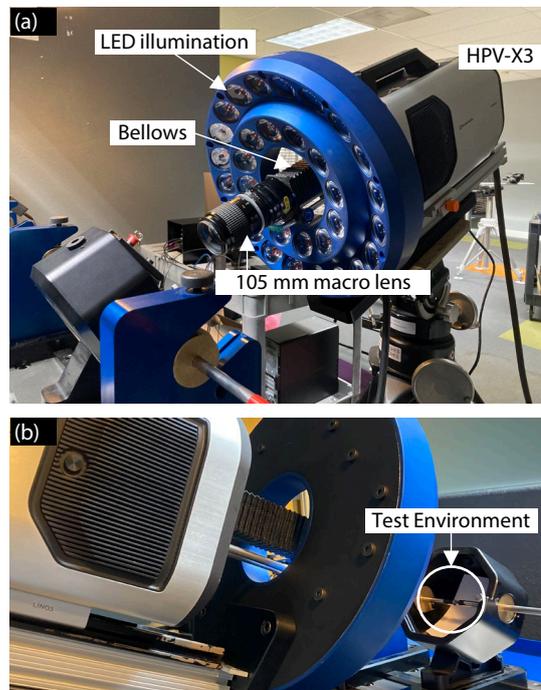


Fig. 4 Imaging Setup

Table 1 Imaging System

High-Speed Video Camera:	HPV-X3
Lens:	Close-up ring Bellows 105 mm macro lens
Light:	LED illumination
DIC Software:	VIC-2D (Correlated Solutions, Inc.)

■ Imaging Results

The imaging was performed at 500 kfps. Fig. 5 shows representative frames from the DIC-analysis video produced by the VIC-2D software. The analysis results show strain in the loading direction produced by the incident and transmission bars. Using the VIC-2D software, it is possible to output synchronized strain-vs-time graphs and strain-distribution movies, as in Fig. 5. As the graph in Fig. 5 shows, the strain increases approximately linearly after load initiation. Fig. 6 shows a sequence of strain-distribution images. From around 120 μ s after load initiation, between Fig. 6 (8) and (9), the maximum strain is reached. Afterward, residual strain remains even after the input/transmission bars separate from the specimen, indicating that the specimen underwent plastic deformation.

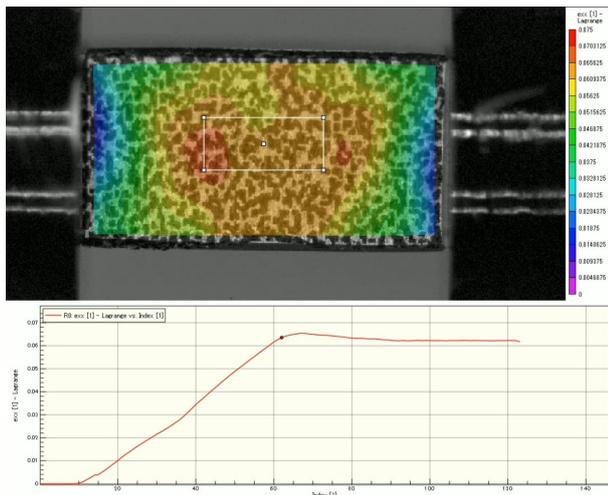


Fig. 5 Example of an Analysis Screen in VIC-2D

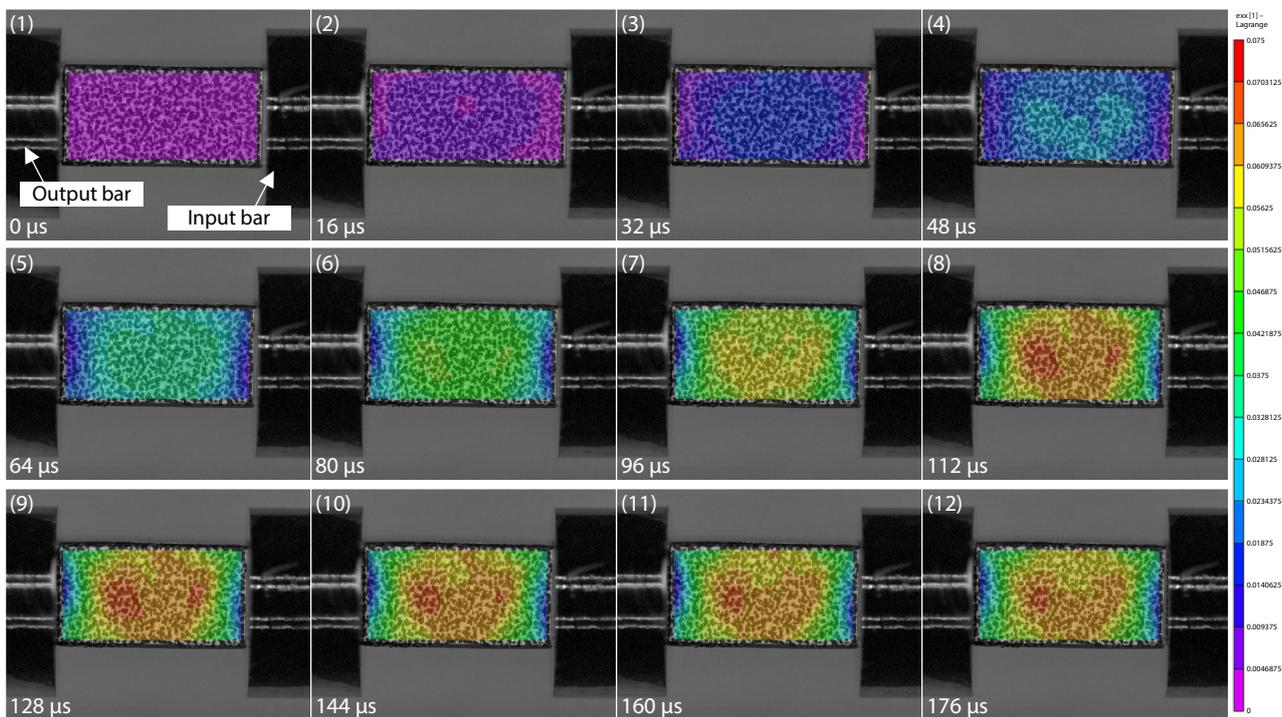


Fig. 6 DIC Analysis Results of the Aluminum Specimen (Imaging Speed: 500 kfps)

■ Conclusion

The HPV-X3 high-speed video camera was used to image an aluminum specimen undergoing impact-compression testing by the Hopkinson bar method, and DIC analysis was performed. High frame rate and high spatial resolution are both essential for imaging and DIC analysis of impact tests such as those using the Hopkinson bar method. Compared with previous models, the HPV-X3 offers improvements in both frame rate and resolution, making the camera well suited for DIC analysis in impact testing.

References

- 1) Hopkinson, B.: A Method of Measuring the Pressure Produced in the Detonation of High Explosives or by the Impact of Bullets, Phil. Trans. Roy. Soc. Lond., A. 213, pp. 437-456, (1914).

Related Applications

1. Observation of Fracture Behavior of Resin Material from an Impact Compression Test by the Hopkinson Bar Method, [Application News No. V26](#)
2. 3D-DIC Analysis of a Metal Specimen Following an Impact Compression Test by the Hopkinson Bar Method, [Application News No. V27](#)
3. Fracture Observation and Observation of Strain Distribution of Plastic Material with Hole in Impact Compression Test, [Application News No. V29](#)

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