Projected fringes method to identification of the mechanical discontinuities in metallic materials

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**Abstract:** The present work shows results of fracture measuring by projected fringes method. Square-shaped aluminum sheet sample was clamped along three corners while mechanically point loaded at fourth one. The mechanical stress leads to out-of-plane displacements. The mechanical fracture can be observed from displacements field measured.

1. Introduction

The identification of the discontinuities represents an essential part for a complete analysis of quality in a metallic structure, in such a way that from these deformations it is possible to determine a correct valuation and continuity of operation of the same. Discontinuities can appear on the surface in the form of fractures or cracks. Non-destructive tests have been used to detect and quantify the quality of a piece. Some non-destructive techniques [1] have been based on recent technological developments such as electronic speckle pattern interferometry (ESPI), projected fringes technique, shearography, digital holography, etc. Many others have done so in traditional methods such as fluorescent penetrating liquids, magnetic inspection, ultrasound and x-rays [2,3]. In this work we analyzed the technique of projected fringes to locate mechanical fractures.

2. Experimental details

We used the optical setup shown in Fig. 1a. A projector (DELL model *1609WX*, resolution *WXGA 1280 × 800*) was utilized for projecting gray-code fringes onto the surface of the specimen. was equal to . The illumination distance was selected adequately large, such that the CCD camera (Pixelink model *PL-B776*, QXGA resolution *2048 × 1536*, Pixel Pitch 3.2 × 3.2 ) in Fig. 1b captured, at the beginning of the test, nearly straight equally spaced fringes of period . The out-of-plane deformation induced by the mechanical load application led to the departure of the viewed fringes from straight lines. The pulling direction was *z* and the stress of . As the test progressed, we retrieved the whole-field phase map obtained from state 1 and 2, Fig. 1c.

If the in-plane displacement is adequately small, encodes information only on the out-of-plane displacement *W* (the departure of the surface from the initially surface) induced on the illuminated surface by the application of load. According to [4], the phase modulation is related to the corresponding out-of-plane displacement *W* by

(1)

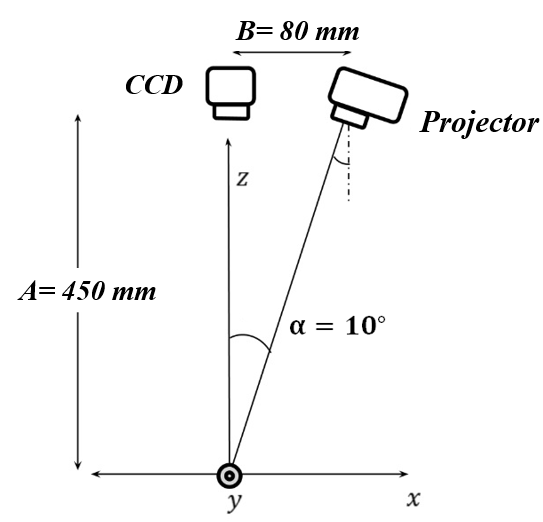
where is the angle between the observation direction and the illumination direction.

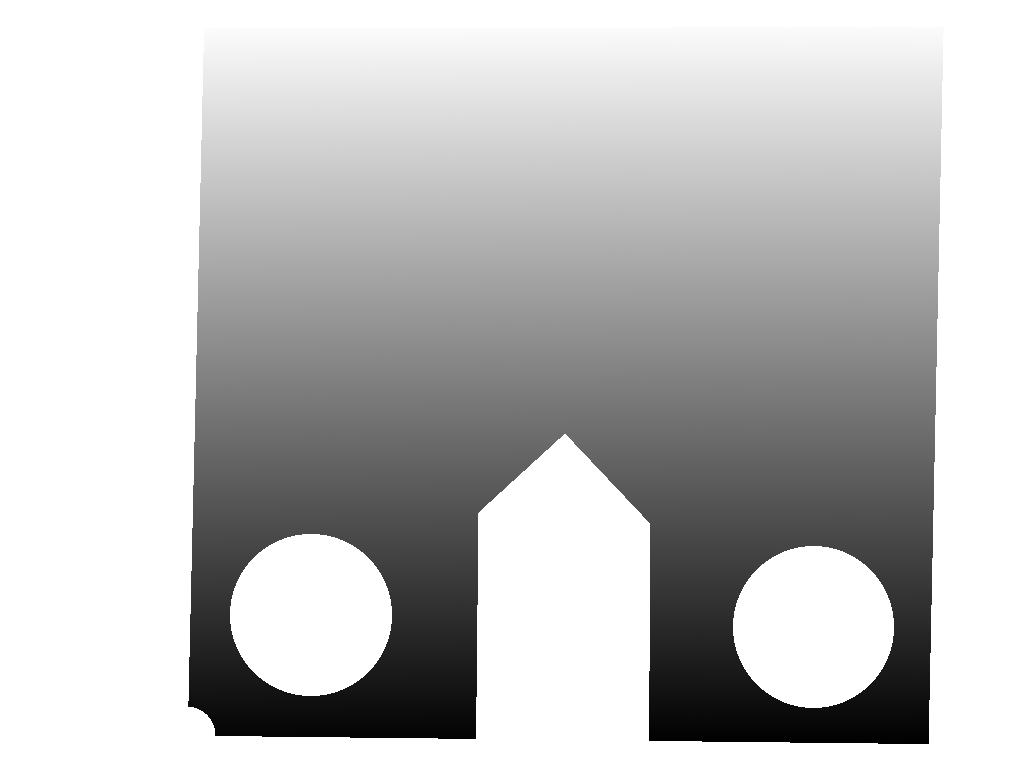
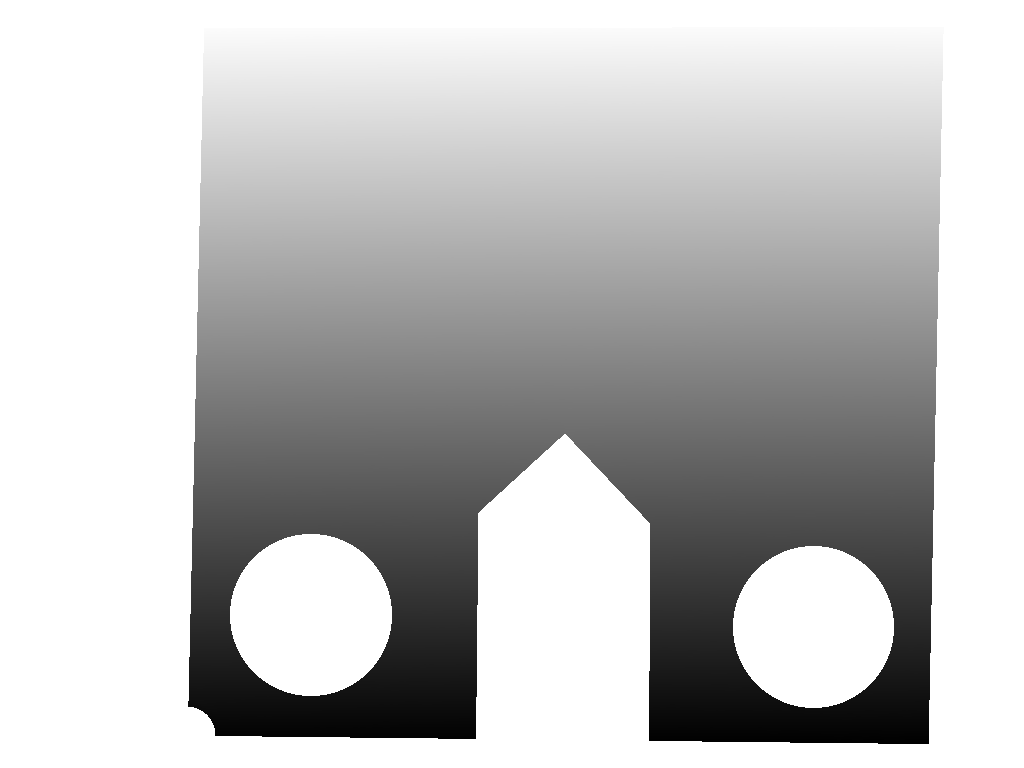
Note that in general, stands for the phase modulation induced between any pair of load stages. When the phase stepping technique [5] is used to retrieve the phases at two load stages (Fig. 1c), the corresponding phase difference can be computed and then used (by applying Eq. 1) to evaluate the out-of-plane relative displacement *W* between these two load stages (Fig. 2a). The fringe projection technique has been successfully applied to monitor changes in the shape that involved out-of-plane deformations greater than *.*

Fig. 3 exhibits some profiles from the graphic shown in Fig. 2a.

3. Conclusions

The present work shows results of fracture measuring by the technique of projected fringes to metallic plate. One of advantage of this technique is that is a quantitative method in comparison with traditional non-destructive tests.



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*c)*

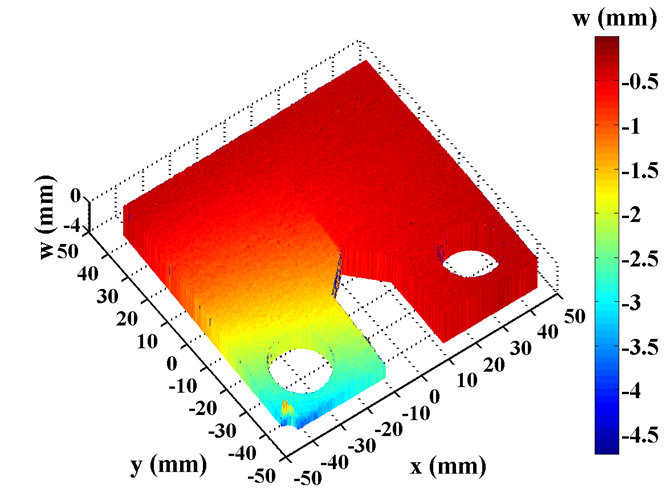
*a)*

*b)*

*a)*

*a)*

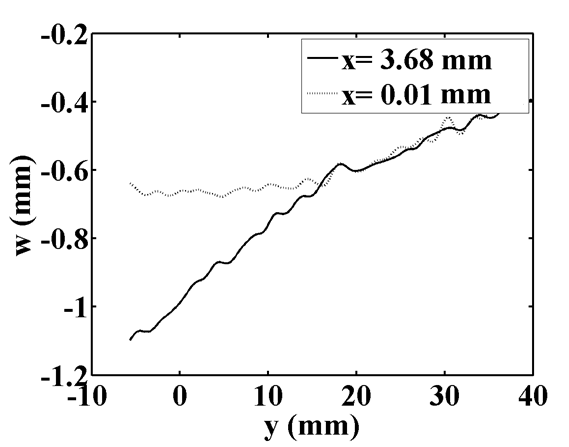
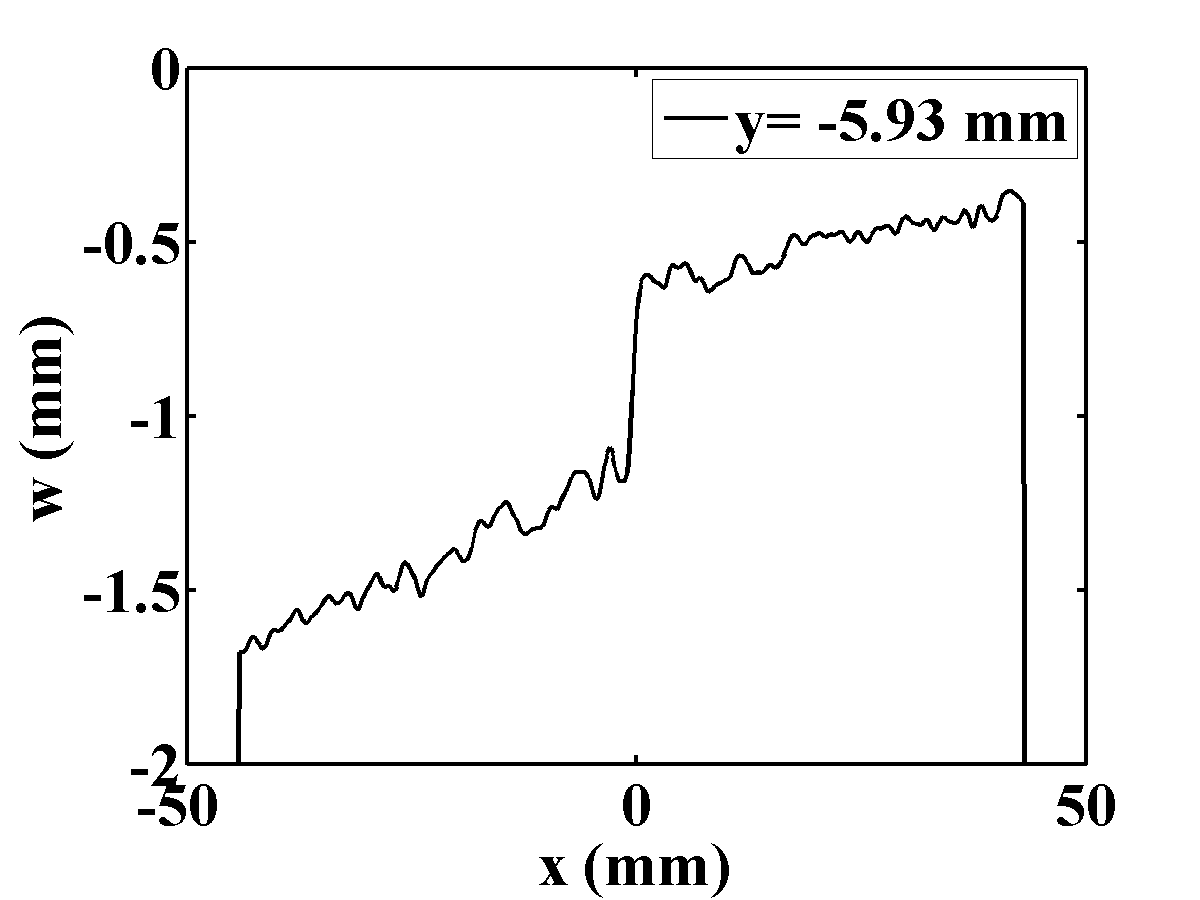
Fig. a) Scheme of the fringe projection system, b) Projected fringes onto the sample, c) Unwrapped phase for the states 1 and 2.



*a)*

**14.8N**

Fig. 2 a) Relative displacement *W* induced on the sample during the mechanical load applied.



*b)*

*a)*

Fig. 3. a) One-dimensional plot of some columns from the graphic shown in Fig. 2a; b) plot to one row.

4. References

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