I-7 Three Dimensional Photoelastic Method using Laser-Light-Sheet

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1. Introduction

A new photoelastic method to detect three-dimensional stress distribution in a massive structure model has been presented by the authors[1]. Using this technique, it is possible to obtain the same information of stress conditions as that by the conventional freezing-stress method without destroying the model. Included here are some examples of application of the method.

2. Proposed Method

Since it is absolutely necessary to let polarized light pass through a specimen, a massive model is cut into slices in conventional methods for three-dimensional stress analysis. The authors got an idea to use scattered light as a source of plane-polarized light, and in our method, a model of interest is sliced not by a knife but by a laser-light-sheet. Thus, it is possible to put a polarized-light source in any arbitrary cross-section of the model. And the obtained fringe patterns can be analyzed by using the technique for the conventional freezing-stress method.

3. Application

(a) Foundation Models: Five different shapes of footing were considered. They are put on a homogeneous ground model made of gelatin. Photo.1 shows observed fringe patterns through an analyzer when a rectangular footing is mounted on the ground model. The positions of laser-light-sheet are different in those three pictures. Fig. 1 shows the observed fringe order along the vertical line z*. Since the sheet was moved in parallel by 1cm, the difference of fringe order between them shows the principal strain difference in the slice between the laser-light-sheets. Dense isochromatic fringe pattern near the edge of the footing shows that stress is not uniformly distributed over the contact surface and is concentrated at its edges. Dark isoclinic lines are superimposed on the isochromatic fringes.

(b) Embankment Models: An embankment model was deformed by its own weight. The model is a symmetric wedge of gelatin, 15cm in height, with slopes of 1:1 and crest width of 2 cm. Photo. 2 shows the fringe patterns for two different sections of the model. Fig. 2 shows variations of fringe orders along the vertical line z*. Though the variation of fringe order is not monotonously downward to the right, maximum strain difference in this slice decreases gradually with increase of z*.

References

1) ORTIZ, J. D., "Study on Photoelastic Method for Analysis of Stress and Strain in Massive Structures", Dr. of Engrg. Thesis, Univ. of Tokyo, 1991.

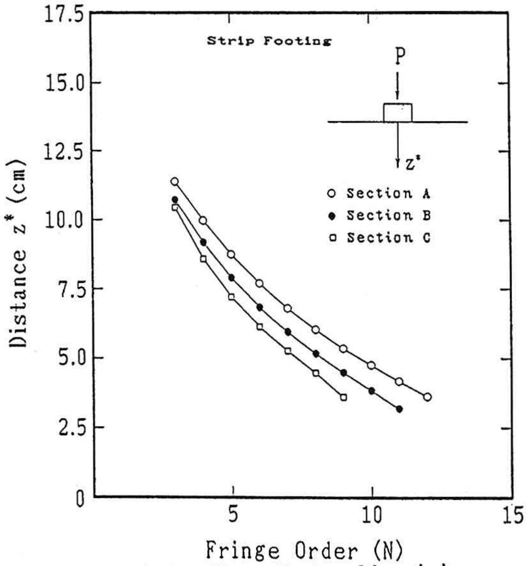


Fig.1 Fringe Order Along Center Line A-A for Two Different Sections due to Strip-Footing

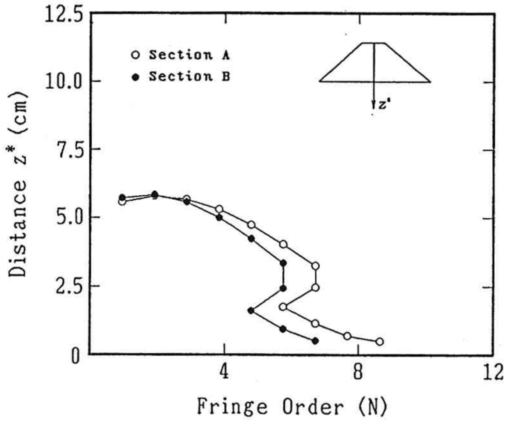
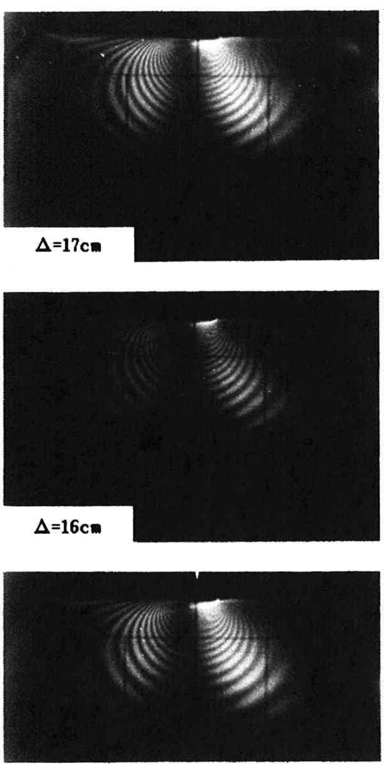


Fig.2 Fringe Order Along Center Line for Two Different Sections for Embankment Model



Δ=15cm

Photo.1 Typical Fringe Patterns for Foundation Model(Strip-footing)

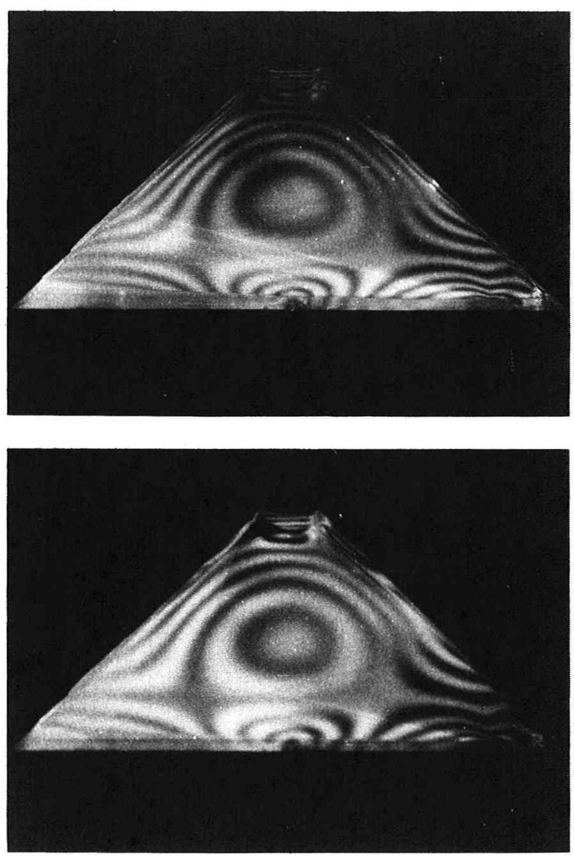


Photo.2 Typical Fringe Patterns for Embankment Model