LETTERS TO THE EDITOR

HOLOGRAPHIC INTERFEROMETRY; MEASUREMENT OF IN-PLANE DEFORMATION

Holographic Interferometry, now-a-days, has become a powerful tool to study distortion of structure under load, effects of creep, fatigue, buckling or thermal distortion. This method added extra capability to the existing conventional interferometry by relaxing some of the exacting requirements.

To investigate the in-plane deformation an annular ring is selected in view of its special nature involving discontinuities within. With a specially made apparatus, the ring is subjected to known diametrically compressive force. Double-exposure hologram is recorded for three different loads with the usual off-axis arrangement. With equal duration of exposures before and after the specimen is loaded the 'frozen' fringes are produced on the reconstruction of the hologram. These fringes are photographed for the purpose of measurement. One such pattern for the load of 1.5 Kg is shown in Fig. 1.

Fig. 1. ‘Frozen’ fringe pattern with 1.5 kg load.

Fringe order is assigned assuming the fringe formed at the bottom resting point of the ring as the zeroeth one for at this point the deformation is considered zero. If P is a representative point before loading, on the vertical diameter of the specimen and P' is the position it assumes a distance d away on compression, the path difference, \( \Delta \), produced is

\[
\Delta = d (\cos \theta_i - \cos \theta_s)
\]

(1)

where \( \theta_i \) is the illuminating angle and \( \theta_s \) is the scattering angle both made with the plane of the member. The order of the fringe N can be given by

\[
d (\cos \theta_i - \cos \theta_s) = N \lambda
\]

where \( \lambda \) is the wavelength used. If \( d' \) is the maximum linear displacement occurred at the point of loading and \( N_{\text{max}} \) is the order number at the point, we have

\[
d' = \frac{N_{\text{max}} \lambda}{(\cos \theta_i - \cos \theta_s)}
\]

(2)

Employing this formula the in-plane deformations at this point are calculated and the results are given in Table I.

<table>
<thead>
<tr>
<th>Load applied (Kg)</th>
<th>Order of the fringe at the topmost point</th>
<th>Deformation ( d' ) (Cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>6</td>
<td>( 4.15 \times 10^{-4} )</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>( 8.29 \times 10^{-1} )</td>
</tr>
<tr>
<td>2.5</td>
<td>18</td>
<td>( 12.45 \times 10^{-1} )</td>
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</tbody>
</table>

The possible errors that may creep into the results are due to (1) diverging nature of the illuminating laser beam, (2) difficulty in estimating the fraction of the fringe and (3) inaccuracy in the measurement of the angles \( \theta_i \) and \( \theta_s \). After minimizing the effects produced on these accounts the total error estimated is about 12%.

The correlation of these results with those of theoretical values which are being calculated, and the experimental details will be published elsewhere.

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