G460
RT 1653

Discussion of the Paper by Professor Westergaard:
"Stresses at a Crack, Size of the Crack, and the Bending of Reinforced Concrete." by Inge Lyse* and D.M. Stewart**.

Professor Westergaard has in this excellent treatise on stresses at a crack raised a question of fundamental interest to the engineering profession. This question is on the stress condition at the root of a crack in the case of a reinforced concrete beam with a crack extending to the neutral axis. In order to study experimentally this particular problem, the specimen shown in Fig. 1 was cut from a sheet of bakelite, 0.264" thick, and subjected to photoelastic analysis by means of the Winkler-Zeiss Apparatus which was recently added to the equipment of the Fritz Engineering Laboratory. A slot which was intended to simulate a crack was extended up to the computed neutral axis of the specimen, leaving a section of the material to act as the reinforcement to resist the tensile force. This beam was subjected to direct bending, and the photoelastic pattern shown in Fig. 2 was obtained. This figure shows that no stress exists at the root of the crack. Furthermore the first fringe shows a dip next to the cracked section, indicating some readjustment of the stress distribution above the neutral axis at the crack. This is better illustrated in Fig. 3 which shows the evaluation of the stresses. The crack has disturbed the straight line stress distribution at the vicinity of the crack, and a stress diagram similar to that presented in Fig. 3 of Professor Westergaard's paper is obtained.

This simple photoelastic study of a bakelite specimen il-

* and **, Associate Professor and Research Fellow, respectively, at Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

lustrates how rather difficult theoretical problems may readily be subjected to direct observations. In the particular case analyzed, since the shear across the central section was zero, the photoelastic fringes gave a direct measure of the normal stresses at this section. Although the evaluation of the principal stresses P and Q for a more complicated type of test conditions is not as yet a very simple matter, the partial analytical and partial graphical method of solution serves well for their evaluation and with some practical experience gives the solution with a reasonable amount of work. Further simplification is obtained when soap film experiments are used for observing the P + Q values.

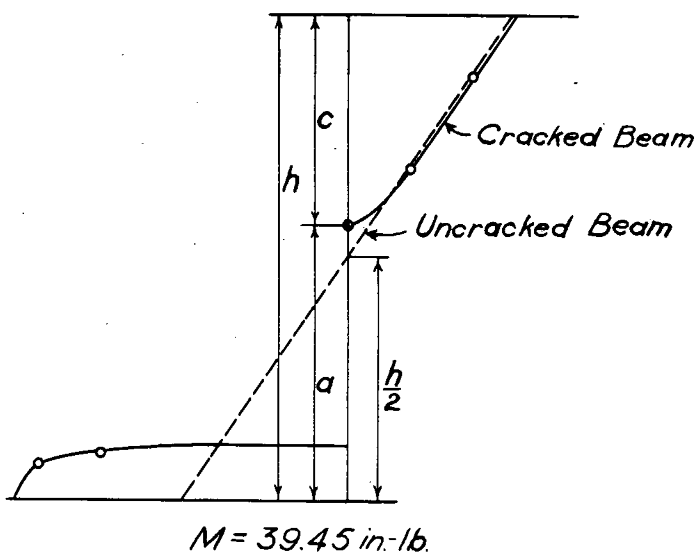

Fig. 3 Stress Distribution in a Cracked Beam Under Uniform Bending Moment

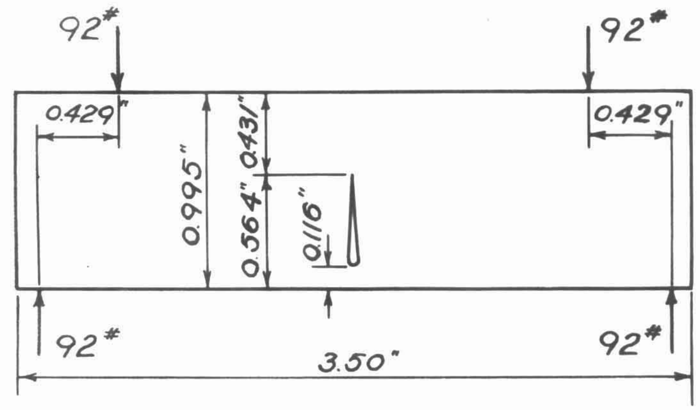

Fig. 1 Bakelite Model of a Cracked Beam with Tensile Reinforcement

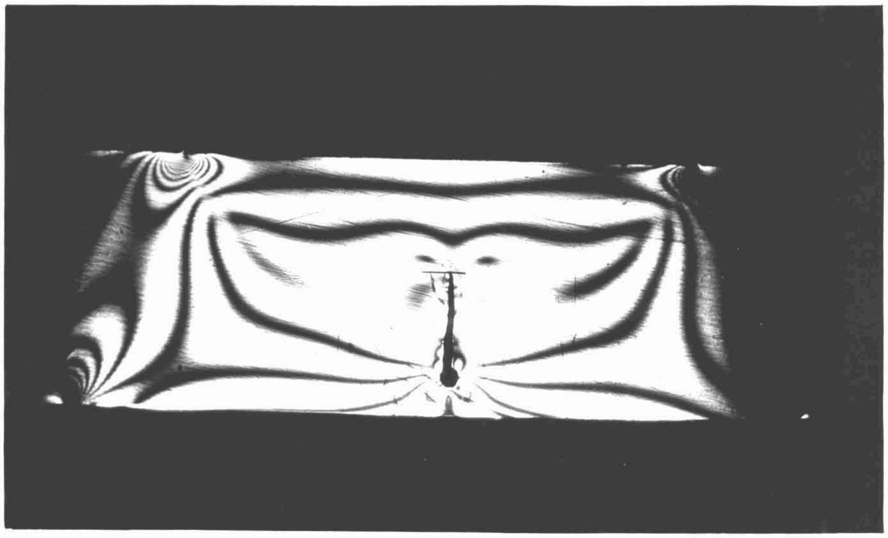

Fig. 2 Photoelastic Fringe Pattern of Model Under Uniform Bending Moment of 39.45 in.-lb.