Elber [1] has proposed the concept of crack closure in an attempt to explain various phenomena observed when studying fatigue crack propagation. In his work Elber obtained records of crack surface displacement versus applied load. A typical record for a fatigue test where \( R = \frac{\sigma_{\min}}{\sigma_{\max}} = 0 \) is shown in Figure 1. Elber found for 2024-T3 aluminum tested with \( R = 0 \) that the crack was not fully open until 50% of the maximum stress was reached. This is shown schematically in Figure 1 where the load displacement record becomes linear at 50% of the maximum load.

The type of instrumentation employed by Elber [1] can prove to be very difficult to handle when measuring crack closure. To overcome this, R. Schmidt [2] developed a simple strain gage technique to measure crack closure. Schmidt's technique consists of bonding the ends of a narrow strain gage across the crack surface as shown in Figure 2. Since only the ends are glued down the strain gage acts as a very sensitive displacement gage. It should be noted that it is not necessary to calibrate the displacement gage since all that is of interest in a given load displacement record is the load at which the record becomes linear.

To better understand crack closure a series of tests on 2024-T3 and 7075-T6 aluminum alloys were run at Lehigh using the techniques proposed by Schmidt. A compact tension specimen with \( h/W = 0.6 \) and \( W = 2.5 \) inches was used for the testing. The 2024-T3 alloy tested was 0.126 inches thick while the 7075-T6 alloy was 0.25 inches thick. In all tests \( R = 0 \). The stress-intensity range \( \Delta K \) varied between 8 and 15 ksi\( \cdot \)in. Typical load-displacement records are shown in Figure 3.

The results of all tests on the 2024-T3 and 7075-T6 aluminum alloys conducted to date at Lehigh indicate that for both alloys the load at which the crack is fully open is approximately 20% of the maximum cyclic load for \( R = 0 \). These observations are in disagreement with Elber's findings of a 50% opening level. At the present time, we cannot explain the difference between Elber's data and the Lehigh data. Perhaps the difference is due to the fact that Elber's data were obtained at very high \( \Delta K \) levels and for center cracked panels. In any event it is the purpose of this note to acquaint the reader with the very simple crack closure measurement techniques developed by Schmidt. It is hoped that others will employ Schmidt's technique to study closure and thus shed more light on the subject of crack closure. More crack closure tests using Schmidt's technique are being conducted at Lehigh. Anyone interested in this data or in discussing their own data should contact R. Roberts at Lehigh University.
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REFERENCES


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Crack Configuration and Applied Stress-Displacement Relationship

Figure 1