INTERIM REPORT

Accession No. ________

Contract Program or Project Title: Crack Arrest Technology

Subject of this Document: Monthly Progress

Type of Document: Letter Report

Author(s): A. R. Rosenfield

Date of Document: May 3, 1979

Responsible NRC Individual and NRC Office of Division:

M. Vagins, RES Headquarters

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Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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Under Contract No. AT(49-24)-0293

INTERIM REPORT

7908020239

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May 3, 1979

Mr. Milton Vagins
U. S. Nuclear Regulatory
Commission
Mail Station 1130 SS
Washington, D. C. 20555

Dear Mr. Vagins:

This is the monthly progress letter for April, 1979 on the subject contract.

During the past month we have been examining the relation between load-line displacement and clip gage displacement for the compact crack arrest test specimen. This relation needs to be determined because the clip-gage measurement point for the proposed specimen is at a distance removed from the load line and its reading needs to be corrected in order to calculate arrest toughness. This information is a byproduct of compliance calculations.

Before 1973, the compliance of the compact-tension (CT, Figure 1) and the crack-line wedge-loaded (CLWL, Figure 2) specimens was obtained from a boundary collocation analysis, which did not include the loading holes. Note that these drawings indicate symbols corresponding to the various locations of displacement measurements. The load was assumed to be externally applied and since both types have the same external shape the results of the calculations were identical[1,2]. In 1973, J. C. Newman, Jr. presented an improved method of boundary collocation for the CT specimen including the effects of pin-loading[3]. This method requires the specification of the resultant forces on the boundaries in constrast to the boundary stresses of former methods. He calculated the crack-opening displacements for various crack-length to specimen-width ratios and the difference from Roberts' values was insignificant (Figure 3). However, additional calculations with this improved method showed that the compliance of a specimen with pin-loaded holes is greater than without holes (about 8% for V_o when $a/w = 0.5$).

The theoretical displacement data for the CLWL specimens resulted from the continuation of these calculations by J. C. Newman, Jr.[4] which were verified experimentally in part by D. E. McCabe and G. T. Sha[5]. Newman found a significant difference in the compliance behavior of these two similar-shaped specimens (Figure 3). Experimental verification of theoretical values for both types of specimens did not employ V_{LL}/V_o but showed good agreement for the V_1/V_2 ratio. Accordingly, we plan to measure V_{LL}/V_o to determine whether the ratio is also in good accord with Newman's analysis.

References

(1) Roberts, E., Jr., "Elastic Crack-Edge Displacements for the Compact Tension Specimen", ASTM Methods Development, February 1969.

(2) Tada, H., Paris, P. C., and Irwin, G. R., "The Stress Analysis of Cracks Handbook".

(3) Newman, F. C., Jr., "Stress Analysis of the Compact Specimen Including the Effects of Pin Loading", Fracture Analysis, ASTM STP 560, ASTM, 1974, pp. 105-121.

(4) Newman, F. C., Jr., "Crack-Opening Displacements in Center-Crack, Compact, and Crack-Line Wedge-Loaded Specimens", NASA TN D-8268, National Aeronautics and Space Administration, Washington, D.C., July 1976.

(5) McCabe, D. E., and Sha, G. T., "Compliance Calibration of Specimens Used in the R-Curve Practice", "Developments in Fracture Mechanics Test Methods Standardization", ASTM STP 632, W. F. Brown, Jr., and J. G. Kaufman, Eds., ASTM, 1977, pp. 82-89.

Sincerely,

A. R. Rosenfield
Metal Science Section

ARR:lw

xc: U. S. Nuclear Regulatory Commission
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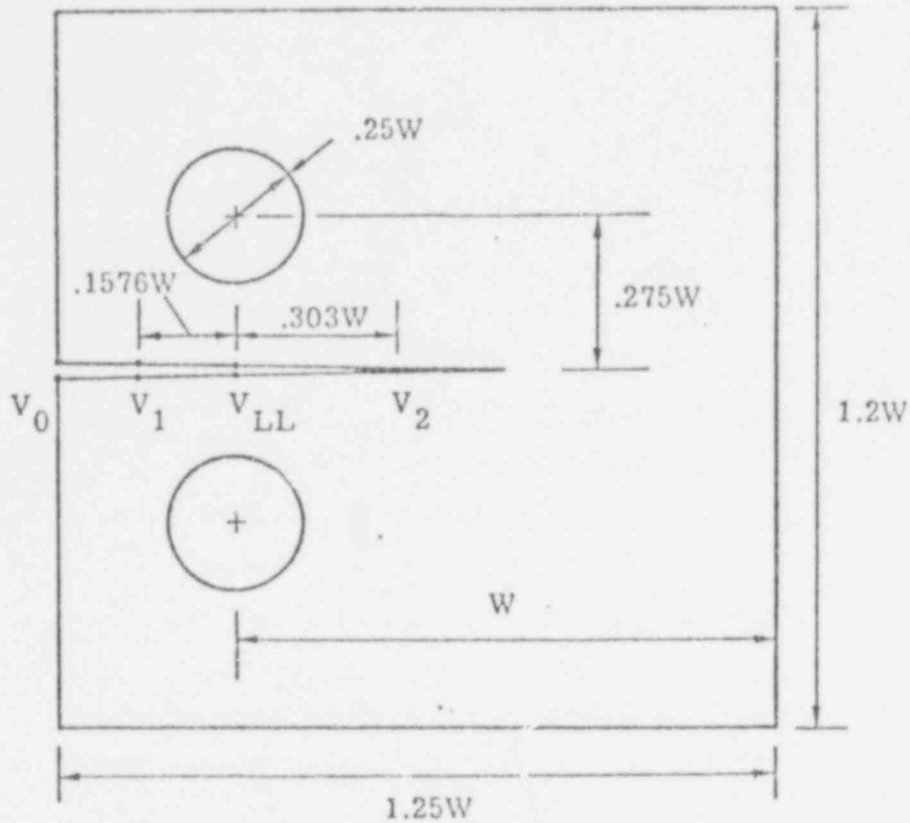

FIGURE 1. LOCATIONS WHERE CRACK-LINE DISPLACFMENTS WERE CALCULATED FOR COMPACT SPECIMEN

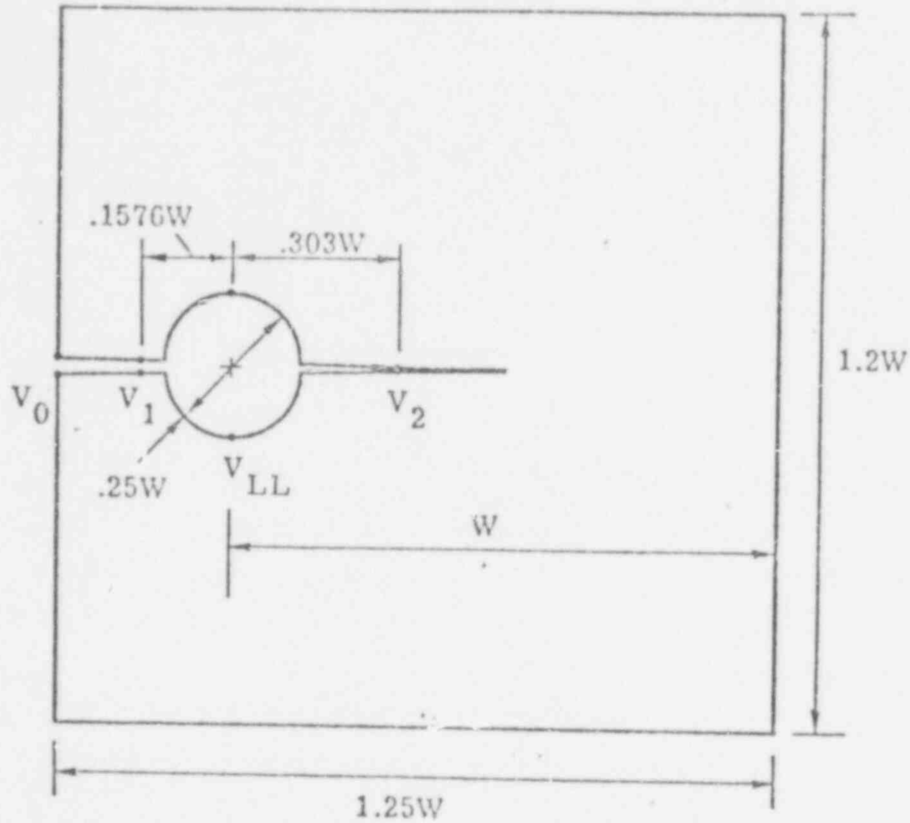

FIGURE 2. LOCATIONS WHERE CRACK-LINE DISPLACEMENTS WERE CALCULATED FOR CLWL SPECIMEN

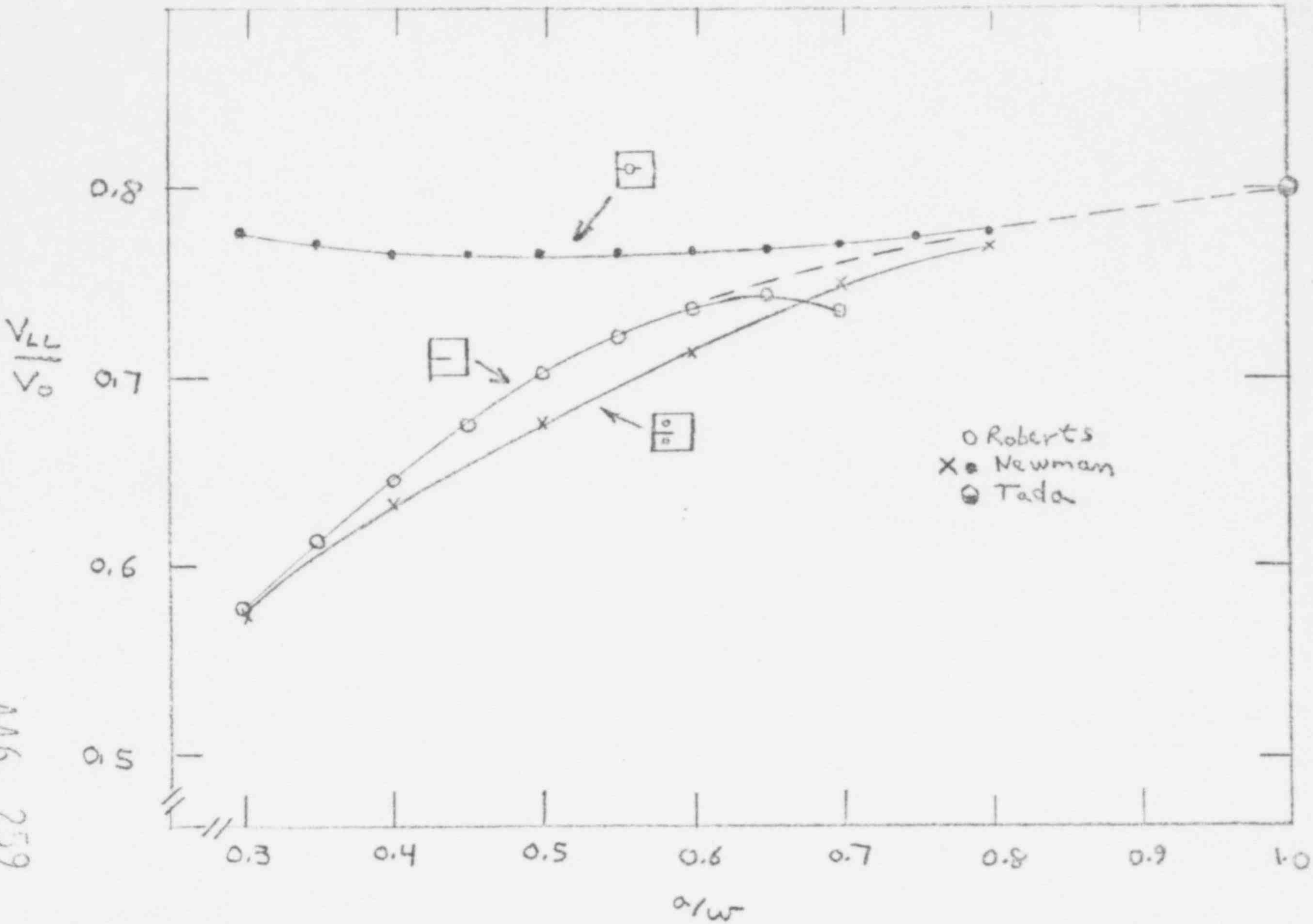

FIGURE 3. THEORETICAL DISPLACEMENT RATIO FOR COMPACT SPECIMEN GEOMETRY AS A FUNCTION OF LOAD-HOLE ARRANGEMENT

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