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**EVALUATION OF WELD JOINT DESIGNS
BETWEEN WIRE WRAP AND END CAP**

R. L. Myers

April 1970

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DEVELOPMENT REPORT**

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EVALUATION OF WELD JOINT DESIGNS BETWEEN
WIRE WRAP AND END CAP

by

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April, 1970

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EVALUATION OF WELD JOINT DESIGNS BETWEEN
WIRE WRAP AND END CAP

R. L. **Myers**

ABSTRACT

A preliminary study of potential problems associated with five different wire to end cap joint designs was conducted. The designs included a 45° hole, 90° hole, 45° groove, small and large tangent welds.

Tensile tests indicated sufficient strength can be attained by using any of the five joint designs. Fabrication techniques pose various problems that are minimal with the [REDACTED] 90° hole and small tangent weld designs.

TABLE OF CONTENTS

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LIST OF FIGURES

1	Tensile Test Specimen	7
2	Load Versus Elongation	8
3	45° Hole	9
4	90° Hole	9
5	45° Groove	10
6	Large and Small Welds	10

EVALUATION OF WELD JOINT DESIGNS BETWEEN WIRE WRAP AND END CAP

R. L. Myers

INTRODUCTION

This report contains a description of the examination and tests that were made on various potential designs of the weld joint where the wire wrap is attached to the end cap. Tensile tests were conducted, using five different joint designs. Fabrication tests were also conducted, using typical wire wrapping and welding techniques. The results of these tests and observations are discussed as are the different designs.

SUMMARY

Tensile tests were performed on five end cap designs, and the results, in order of strength, are as follows: 45° hole, 45° groove, 90° hole, large (1/4 in.) tangent weld, and small tangent weld. The weakest of these, the small tangent weld alongside the end cap, still had more than twice the yield strength of fully annealed wire. Thus, from a strength standpoint all designs tested are satisfactory.

Dummy pins were wrapped and the wire welded to the end cap in a typical manner by using the different end cap designs. There are problems associated with each design, but these are minimal with the 90° hole or tangent weld designs. The problems associated with the 45° hole and 45° groove are most significant on the second end where the tension in the wire must be maintained. Thus, the order of wrapping the pin is also a significant factor in the design choice.

DISCUSSION

TENSILE TESTS

Fourteen test specimens representing five different wire to end-cap weld designs were tested in a 306 facility tensile test machine.⁽¹⁾ The purpose of these tests was to obtain information for use as a comparison of these designs. The test specimens were made to simulate the joint between the end cap and wire wrap. The results of the tests are included along with photographs of the specimens before and after testing.

Test Description

The test specimens consisted of a 3 in. length of wire (316 SS, 0.056 diam, 20% CW) welded to a 4 in. length of 316 SS rod. The five different weld designs were: 45° hole, 90° hole, 45" groove, small (at end of wire) tangent weld along the side of the end cap, and large (1/4 in. long) tangent weld along the side of the end cap. The rod was the same diameter and material as the reference end cap design. The specimens are shown in Figure 1.

The specimens were tested in the 306 Bldg. Lab. in a tensile testing machine. The rate of loading was set at 0.050 in./min. Each specimen was tested to fracture and the load and elongation were recorded.

Test Results

The fracture load, corresponding tensile strength, and location of fracture are given for each sample in Table 1. In all cases, the fractures occurred either in the wire or at the wire-weld joint. No welds were pulled from the rods. With one exception, the wire broke at the bend where it entered a hole or a groove.

A graph showing elongation as a function of load was obtained from the testing machine for each specimen. Figure 2

TABLE 1. 20% CW, 0.056 Wire Test Results

Specimen No.	Fracture Load	Strength	Break Location
1 - 45°	296	120,500	Inside hole next to weld
2 - 45°	296	120,500	At Bend
3 - 45°	304	123,500
1 - 90°	282	114,500	
2 - 90°	283	115,000	
3 - 90°	275	112,000	
1 - 45° groove	282	114,500	
2 - 45° groove	288	117,000	
3 - 45° groove	280	114,000
1 - small weld	185	75,300	
2 - small weld	237	96,400	
3 - small weld	233	94,700	
1 - large weld	242	98,400	
2 - large weld	242	98,400	

shows four of these graphs for different specimens. Photographs showing the fractured samples are reproduced in Figures 3, 4, 5, and 6.

The results of previous tests as reported by R. M. Crawford⁽²⁾ are given in Table 2. The specimens used in these tests were made up of 0.062 diam, annealed 304 SS wire welded alongside a 1/4 in. rod in one spot. These wires also broke either in the wire or at the weld joint. The welds did not pull off the rod.

FABRICATION TESTS⁽³⁾

Six pins were wire wrapped using the end cap designs described above in an attempt to discover what fabrication problems exist with each design. The pins were 6 ft long,

TABLE 2. Wire Wrap Tensile Tests

<u>Specimen No.</u>	<u>Tensile Strength</u>		<u>Wire Diam After Test, in.</u>	<u>Location of Failure</u>
	<u>lb</u>	<u>psi</u>		
1	200	64,500	0.054	Weld
2	250	80,500	0.054	Weld
3	255	82,000	0.050	Wire
4	240	77,500	0.055	Weld
5	235	75,500	0.050	Weld
6	235	75,500	0.055	Weld
7	260	84,000	0.050	Wire
8	255	82,000	0.053	Weld
9	260	84,000	0.050	Wire
10	260	84,000	0.050	Wire

0.250 diam, and empty. The wire was 0.056 diam, 20% CW, 316 SS. The end cap configurations and wrapping tension for each pin are listed in Reference 3.

The problems observed with each end cap design are listed below. It should be noted that these observations are made strictly from the standpoint of ease of fabrication only.

45° Hole End Cap

On the first end, where the wire was welded in place prior to wrapping, it was difficult to keep the wire tight against the pin near the end cap. The reason for this difficulty was that the wire could not be pushed up into the hole and held during welding, as can be done with a 90° hole. To overcome this problem, it will be necessary to prebend the end of the wire prior to inserting it into the 45° hole.

On the second end, where the wire is welded to the end cap after wrapping, the 45° hole presents a bigger problem. On this end the wire must be pulled back along the pin, as well as away from the pin, to be inserted into the hole. To bend

the wire this way almost necessitates kinking, and when this happens it is difficult to get the wire to lay tight against the pin.

45° Groove End Cap

The 45° groove also presents some fabrication problems. It is very difficult to get the wire to lay in the groove. There is also a possibility that two welds will be necessary to keep the wire from slipping out of the groove.

90° Hole End Cap

Inserting the wire into the 90° hole on the second end requires pulling the wire back away from the pin. This condition can be tolerated because the distance is insufficient to cause kinking of the wire.

Tangent Weld to End Cap

When the wire was welded alongside the end cap, it has a tendency to curl away from the pin. Consequently, it had to be held against the pin during welding. This problem could be reduced by keeping the wire in straight sections rather than rolls, as has been done.

Order of Wrapping

The order of wrapping the fuel pin should be considered in the end cap design. At the first end the welding of the wire to the end cap is considerably easier than at the second end. The reason for this is that at the second end the wire is in tension and must be clamped to the pin while the end is cut, inserted into the hole, and welded. Some flexibility can be incorporated into the design since the first end can be either the top or bottom of the pin.

RECOMMENDATIONS

The tensile tests show that any of the considered designs has sufficient strength. The fabrication steps, however, are

more difficult and time consuming with the 45" hole and 45° groove. Therefore, from a production standpoint, either a tangent weld or a 90" hole is preferred to the 45° hole or the 45° groove.

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Neg 0692485-7

FIGURE 1. Tensile Test Specimen

FIGURE 2. Load Versus Elongation

Neg 0692595-7

FIGURE 3. 45° Hole

Neg 0692595-8

FIGURE 4. 90° Hole

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FIGURE 5. 45° Groove

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FIGURE 6. Large and Small Welds

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