

REPORT
ON
CREEP TESTS AT 900°F ON TYPE 418 STEEL

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Project 2330

June 9, 1955

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CREEP TESTS AT 900°F ON TYPE 418 STEEL

Duplicate creep tests were conducted at 900°F and 30,000 psi on Heats 01350 and 81445 of Type 418 steel for the purpose of establishing the time for 0.1 percent plastic deformation to occur. All tests were continued until the time for 0.1 percent total plastic deformation had been determined or until the test data indicated that excessively long times would be required to establish this value.

Summary

The creep data show that the time required to attain 0.10-percent deformation was considerably greater for Heat 81445 than for Heat 01350. Duplicate samples gave values of 370 to 520 hours for Heat 01350 as compared to 1250 to approximately 2000 hours for Heat 81445.

The variations in time for 0.10-percent deformation between duplicate specimens and between heats were primarily the result of differences in the amount of primary creep. The difference was most pronounced for the duplicate tests on Heat 81445.

Test Material

Two samples, approximately 1-inch square by 6-inches long, identified as "34T" from the top of an ingot and as "1B" from the bottom of an ingot were submitted for Heat No. 01350. For Heat No. 81445, two bars, 6" x 2-3/8" x 1-3/16", were submitted for testing. Inasmuch as no differentiation was made regarding the two bars, both bars were split longitudinally and one-half of each bar was machined into a test specimen. For identification, the specimens from one of the original bars were designated A1 and A2 and

those from the other bar as Z1 and Z2. The creep tests were conducted on bars A1 and Z1. The test specimens employed for both heats were standard 0.505-inch diameter tensile specimens with a 2-inch gage length.

The heat treatment was reported to be as follows for both heats of material:

- 1) Heat at 1840°F for 25-minutes and oil quench.
- 2) Draw 2-1/4 hours at 1075°F and air cool.

The reported hardnesses after tempering were Rc 36 for Heat No. 01350 and Rc 36/38 for Heat No. 81445.

The chemical analysis report for Heat No. 81445 was as follows:

C	0.160	W	2.96
Mn	0.31	S	0.012
Si	0.41	P	0.020
Cr	13.08	Cu	0.24
Ni	2.01	Al	0.005
Mo	0.09	Sn	0.018

The chemical analysis of Heat No. 01350 was not supplied.

Procedure

It was requested that time-elongation data be obtained to establish the time for 0.1 percent creep deformation under a stress of 30,000 psi at 900°F. It was stated that the creep test was to originate at the point where the elongation on loading changed from elastic to plastic deformation. Thus, the creep curve would represent the total plastic deformation.

To achieve the desired deformation data, the stress was applied in increments of about 1200 to 2400 psi and a stress-strain curve was obtained during loading. Since the stress-strain data revealed that the elastic limit was not exceeded during loading, the time-elongation curves obtained start at zero deformation and the time was measured from the instant the 30,000 psi stress

was attained.

Results

The time-elongation curves obtained for Heat No. 01350 are shown in Figure 1, and those for Heat No. 81445 are graphed in Figure 2. Since no plastic deformation occurred during loading, these curves start at zero deformation and consist entirely of creep deformation. Table I summarizes the creep data and time required to obtain various total creep deformations for the two heats.

These data show that times between 370 and 520 were required to obtain 0.10-percent creep deformation for Heat No. 01350, whereas a similar deformation for Heat 81445 required 1250 to approximately 2000 hours.

Discussion

The data of Figures 1 and 2 and Table I show that not only was there considerable variation between heats insofar as time for 0.1-percent deformation was concerned, but that there was pronounced variation between duplicate tests from the same heat.

Study of the data given in Table I shows quite clearly that the major difference between duplicate test bars from a given heat was in the primary creep behavior. For Heat 01350, the data show that at 300 hours the creep rate of Specimen 1B was somewhat greater than that of Specimen 34T, but that the primary creep of Specimen 1B was sufficiently less to result in a longer time to 0.10-percent creep deformation for Specimen 1B. A similar situation was encountered for Heat 81445 in that beyond about 300 hours both Specimen A1 and Z1 exhibited similar creep rates, but the primary creep behavior varied sufficiently to result in a wide variation in time for 0.10-percent creep deformation. In this connection, it was noted that not only did Specimens A1 and Z1 exhibit similar creep rates beyond about 300 hours, but both tests indicated the

the beginning of 3rd-stage creep at about 1200 hours.

Comparison of the creep behavior of the two heats reveals that the heat-to-heat variation was also primarily the result of considerable difference in primary creep characteristics. Although the creep tests on Heat 01350 were discontinued after 0.10-percent creep deformation was obtained at from about 370 to 520 hours, the creep data suggest that the creep behavior of the two heats may have been similar at longer time periods. However, the primary creep of Heat 01350 was so much greater that a total creep deformation of 0.10-percent occurred at much shorter times.

It is difficult to offer any explanation for the variations observed in primary creep behavior. For Heat 01350, the relatively small difference in primary creep may have been due to variations between the top and bottom of the ingot. However, insufficient information is available to account for the differences between specimens of Heat 81445 or between heats without undue speculation.

TABLE I

Summary of Creep Deformation Data for Type 418 Steel at 900°F and 30,000 Psi Stress

Heat No.	Spec. No.	Elastic Deformation on Loading (%)	Time to Reach Specified Plastic Deformation (hours)		Creep Rate at Specified Time (%/1000 hrs)	
			0.05%	0.075%	300-hrs	1000 hrs
01350	34T	0.120	22	90	0.040	--
01350	1B	0.114	33	150	0.050	--
81445	A1	0.117	250	~1450	0.034	0.014
81445	Z1	0.121	24	190	0.038	0.012

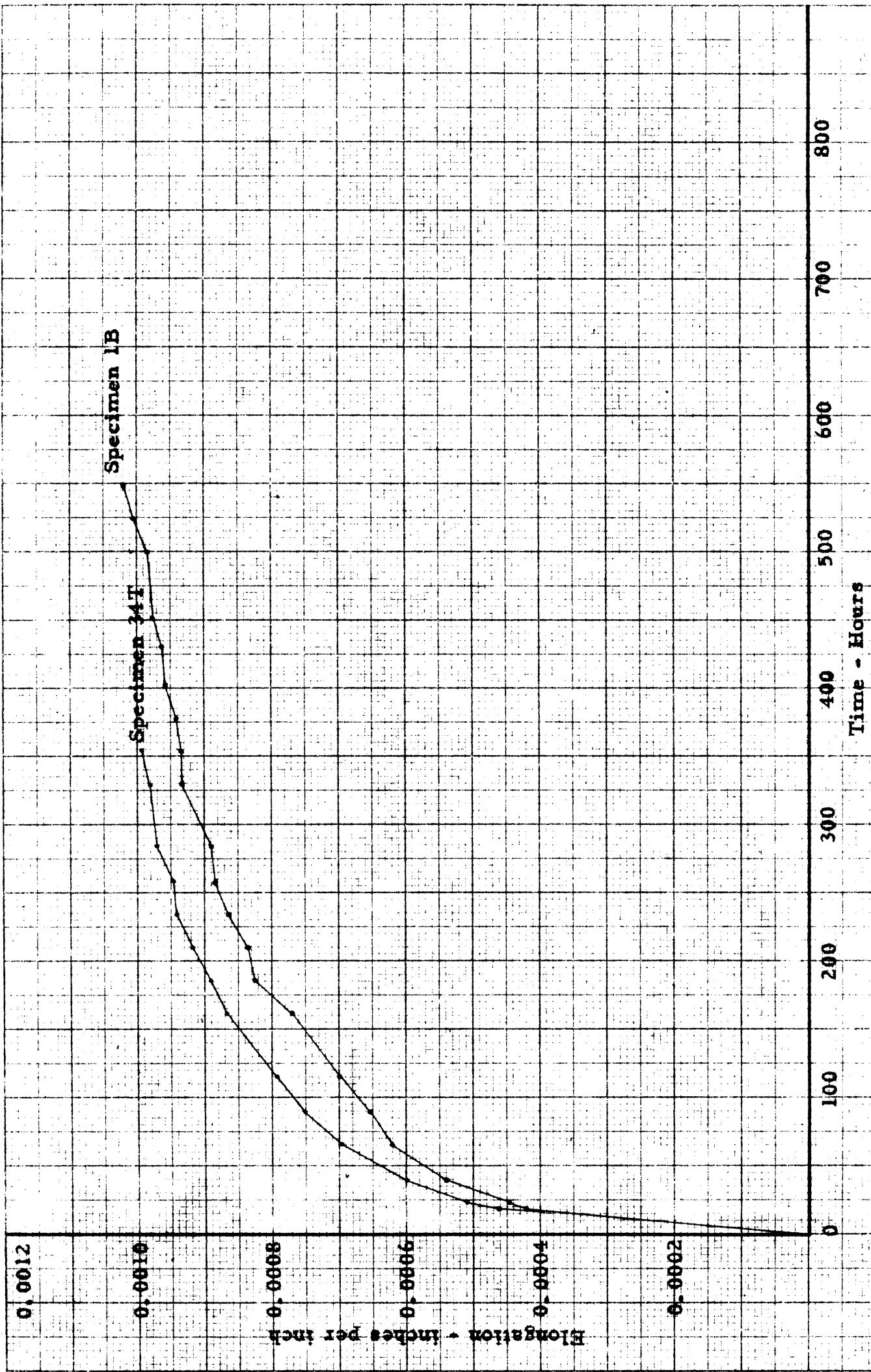


Figure 1. - Time-Elongation Data Obtained from Creep Tests at 900°F and 30,000 psi Stress on Type 418 Steel (Heat No. 01350). Deformation Shown is that Occurring during Creep and Does Not Include Deformation during Loading to the Test Stress.

