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Stress Corrosion Behavior of K01-T7 Aluminum Alloy Castings

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STRESS CORROSION BEHAVIOR OF KO1-T7 ALUMINUM ALLOY CASTINGS

B.T. Sanderson and W.F. Gerhold

Reference: (a) Naval Air Systems Command, Department of the Navy, request by AIR-5203-01.

Introduction

A new high strength aluminum casting alloy designated as KO1-T7 has become available. Reference[(a)] requested that NBS conduct tests to determine the stress-corrosion behavior of this alloy in a marine atmosphere environment.

Material

Three KO1-T7 aluminum alloy castings were obtained from Electronic Specialty Company in Pomona, California. Two of these castings appeared to be brackets and were identified as part number C740301-50. The third casting was a flange marked C5T27377. All of the specimens were poured from the same heat (ES 1). Nominal chemical analysis for this aluminum alloy include the additions of Cu 4.8%, Ag 0.5%, Mg 0.25%, and Mn 0.25% (all weight percentages). Certification test data as furnished by the supplier appear in Table 1.

Specimen Preparation

Four test specimens were prepared from each of the two bracket castings (part C740301-50). Two flat stress corrosion specimens were machined from the base of each bracket and two round tensile specimens were machined from the side of each bracket as shown in Figure 1. Fourteen round tensile specimens were machined from the one aluminum alloy flange casting marked C5T27377. Figure 2 illustrates the position of each specimen obtained from the parent material. All specimens were taken from solid sections of the castings and there were no visual indications of voids or flaws.

Mechanical Properties

Tests were performed by NBS to determine the mechanical properties of the three KO1-T7 aluminum alloy castings. These determinations (tensile

strength and yield strength) compare favorably with the mechanical test results furnished by the supplier. All the mechanical tests performed by NBS exceeded the minimum requirements as stated by the manufacturer. The results appear in Table 2. The tensile properties as determined by NBS were very similar for all three castings.

Stress Corrosion Tests

Stressed and unstressed specimens were exposed in the marine atmosphere at Kure Beach, NC [80 foot (24 m) lot]. A system of weights and levers was used to obtain the desired stress on the flat stress corrosion specimens while a constant strain system was utilized to obtain the applied stress on the round test specimens. The specimens exposed in the marine atmosphere were exposed with an applied stress equivalent to 0, 50, and 75% of the yield strength of the alloy as determined by NBS. [60 Ksi (413.69 MPa)].

Results

Visual examination of the specimens after exposure in the marine atmosphere revealed the presence of heavy adherent gray corrosion products with considerable localized corrosion pits.

Both of the flat stress corrosion specimens which had been stressed at 75% of their yield strength and exposed in the marine environment failed after 37 and 249 days. A companion flat unstressed specimen which had been exposed for the same period of time was removed from exposure along with the failed sample. None of the round tensile specimens which had been exposed unstressed or stressed at 50 and 75% of the yield strength of the material had failed after 1160 days exposure in the marine atmosphere. In order to obtain an indication of the effect of corrosion attack on the alloy, a comparison was made of the tensile properties of unexposed specimens *vs.* those of specimens exposed to the marine environment. The values obtained

were then averaged and calculated as the percent loss in tensile strength due to exposure in the environment. The results, given in Table 3, indicate a small loss (from 1.6% to 11.2%) in tensile strength for the unfailed specimens as a result of exposure.

Metallography

Sections were obtained from areas at and adjacent to the fracture surfaces of the failed specimens for metallographic examination. In general, the microstructure for both specimens revealed a uniform grain size and the presence of intermetallic precipitates at the grain boundaries (Figure 3). Metallographic examination of areas at the fracture showed that the fracture surface was both intergranular and transgranular (Figure 4) with no evidence of secondary cracking.

Conclusions

The results obtained from stress corrosion tests on K01-T7 aluminum alloy indicate that the alloy may be subject to stress corrosion. Examination of failed (37 and 249 days) specimens, which had been stressed by the constant load method, showed that the fractures were both transgranular and intergranular in nature. Other specimens stressed by the constant strain method had not failed after 1160 days of exposure. Both of the failures which occurred during exposure in the marine atmosphere were from specimens removed from the brackets. However, these were the only specimens exposed utilizing a constant load system. The alloy also exhibited a considerable amount of shallow surface pitting which was accompanied by heavy adherent gray corrosion products. Since the number of specimens tested was limited by the amount of material available, due consideration should be given to further testing of this alloy under constant load conditions at the same and lesser applied stresses.

Table 1.

Certification Test Data as Furnished by the Supplier

Casting Identification	Alloy	Heat No.	Yield Strength KSI(a)	Tensile Strength KSI(a)	Percent Elongation
C5T27377	K01-T7	ES 1	58.7	62.9	5.0
C740301-50	K01-T7	ES 1	62.4	66.7	4.0
Minimum Requirements	K01-T7		50.0	60.0	3.0

(a) 1 KSI = 6.8948 MPa.

Table 2.

Results of Mechanical Tests Performed by NBS

Material	Tensile Strength Ksi(a)	Yield Strength Ksi(a)
Bracket #1 C740301-50	65.6	60.8
Bracket #2 C740301-50	65.7	60.7
Flange CST 27377	62.4	59.8
K01-T7 Minimum Requirements	60	50

(a) 1 Ksi = 6.8948 MPa.

Table 3.

Average Loss in Tensile Strength from Exposure

Specimen Origin	Exposure time, Marine Atmosphere	Applied Stress during Exposure % of Yield Strength	Tensile Strength Ksi (a)	Yield Strength Ksi(a)	Percent Loss in Tensile Strength from Exposure
Brackets C740301-50	unexposed	-	65.6	60.6	-
	37 249	0	64.6	57.1	1.6%
	37 249	75	failed	-	failed
Flange CST 27377	unexposed	-	62.4	59.8	-
	1160	0	56.8		9%
	1160	50	58.6	54.4	6.1%
	1160	75	55.4	52.2	11.2%

(a) 1 Ksi = 6.8948 MPa.

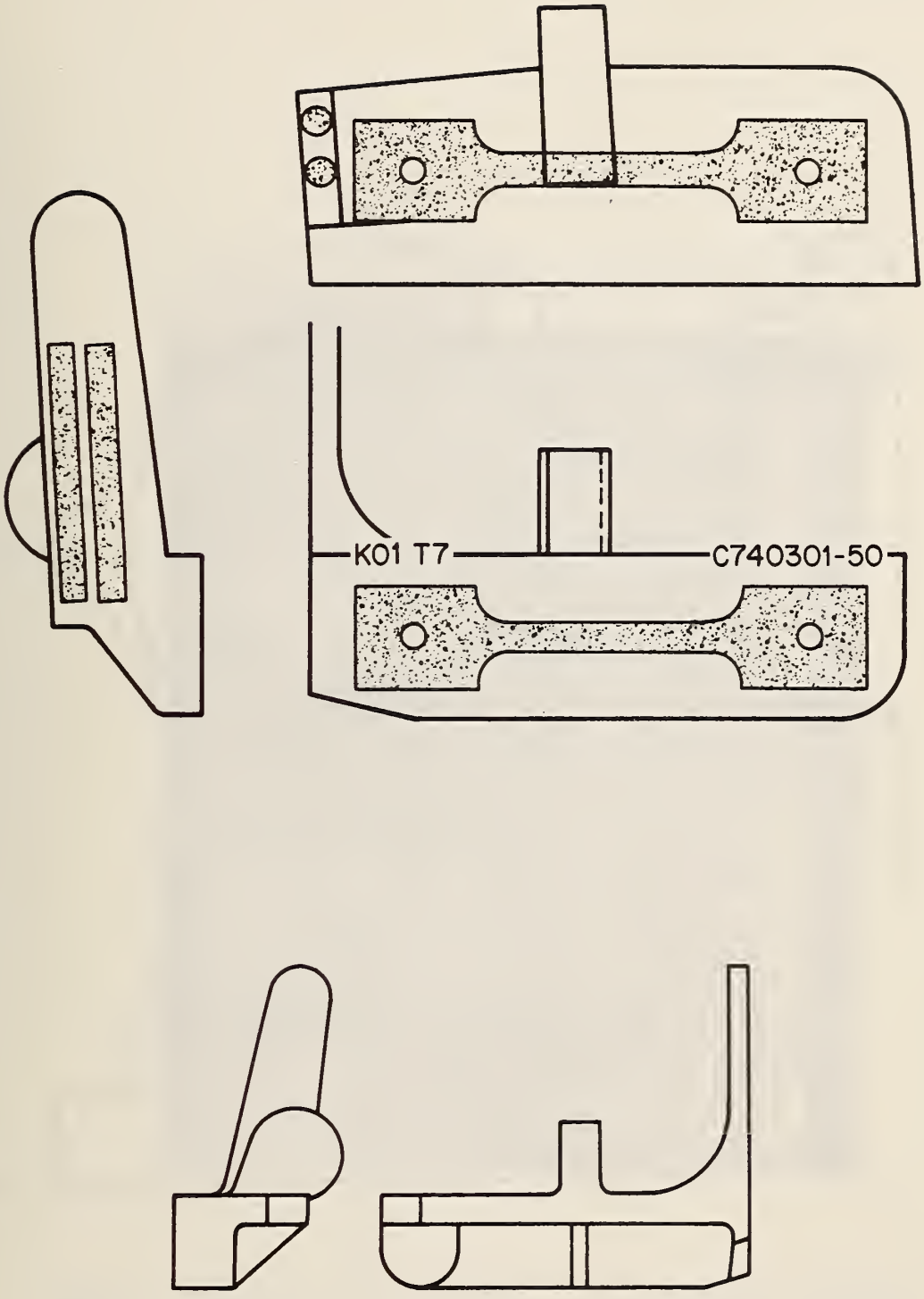

Figure 1. Drawing of bracket casting (C740301-50) showing origin of test specimens.

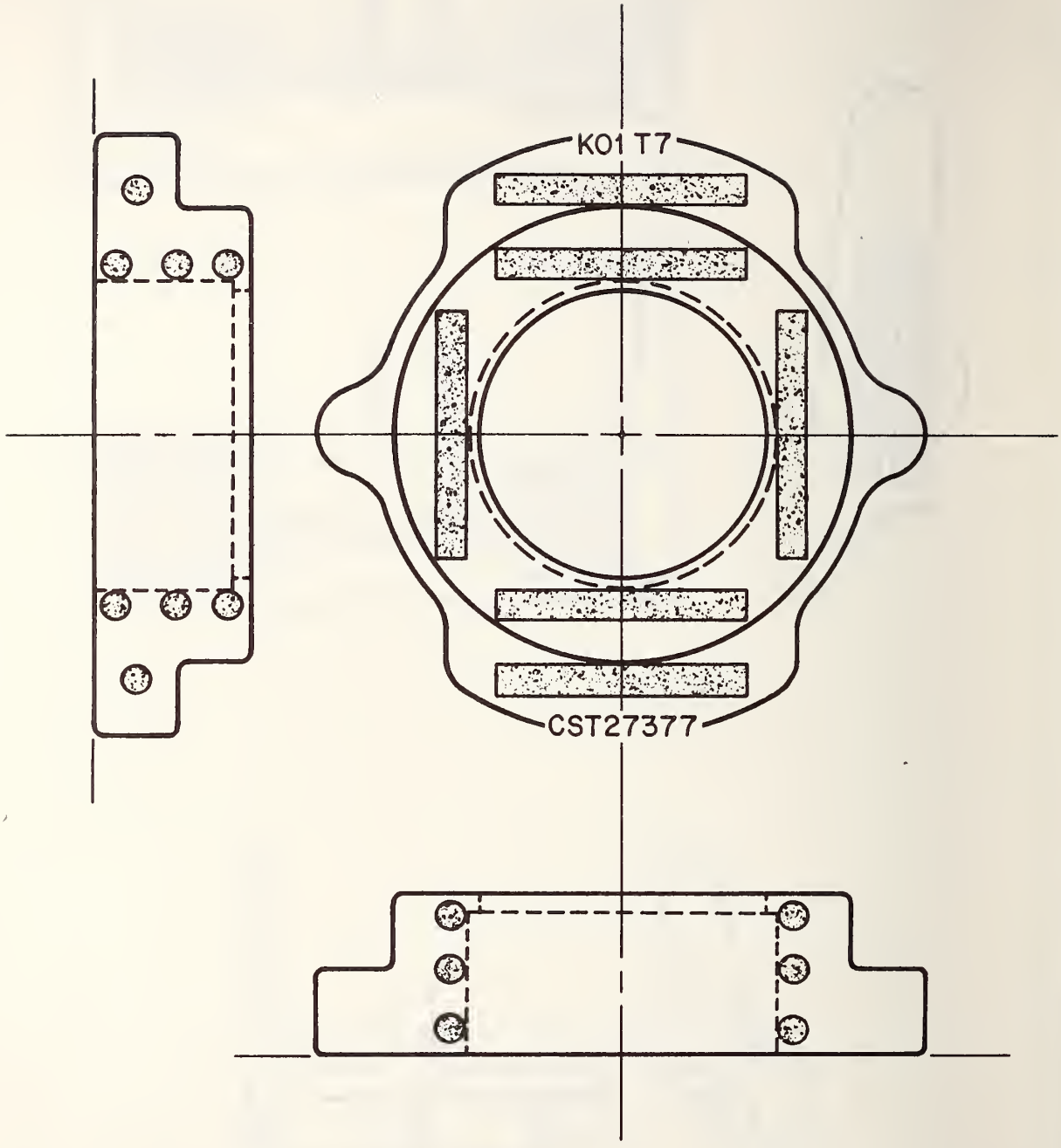

Figure 2. Drawing of flange casting (C5T27377) showing origin of test specimens.

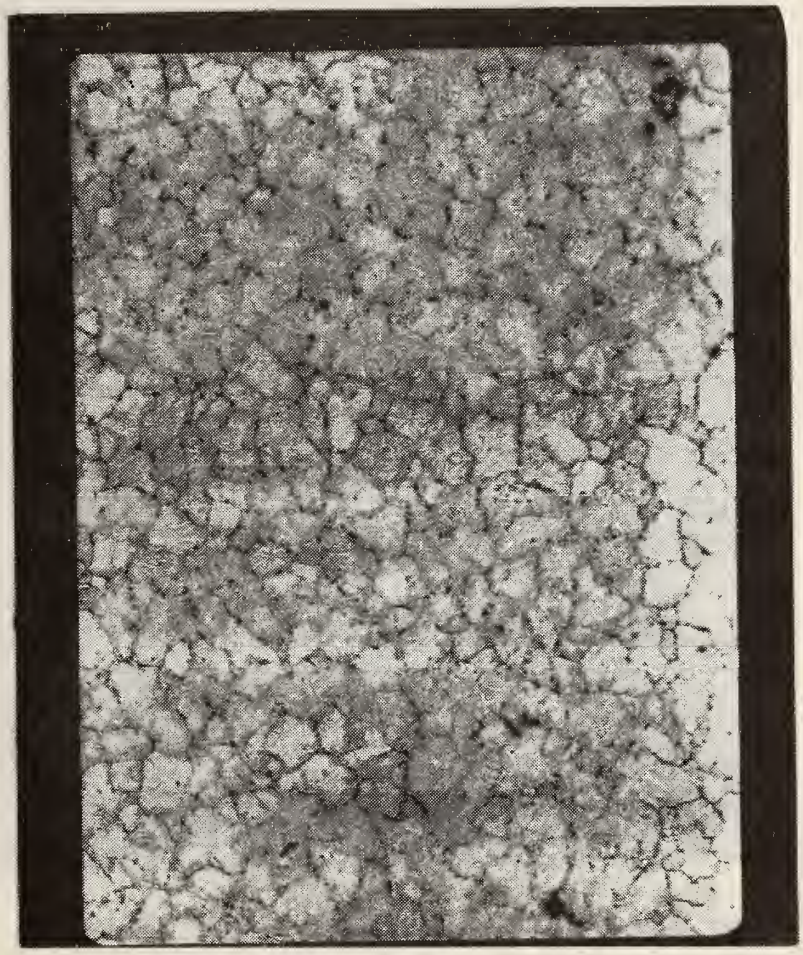

Figure 3. Microstructure of K01-T7 aluminum alloy. Etched, Keller's, etch. X50.

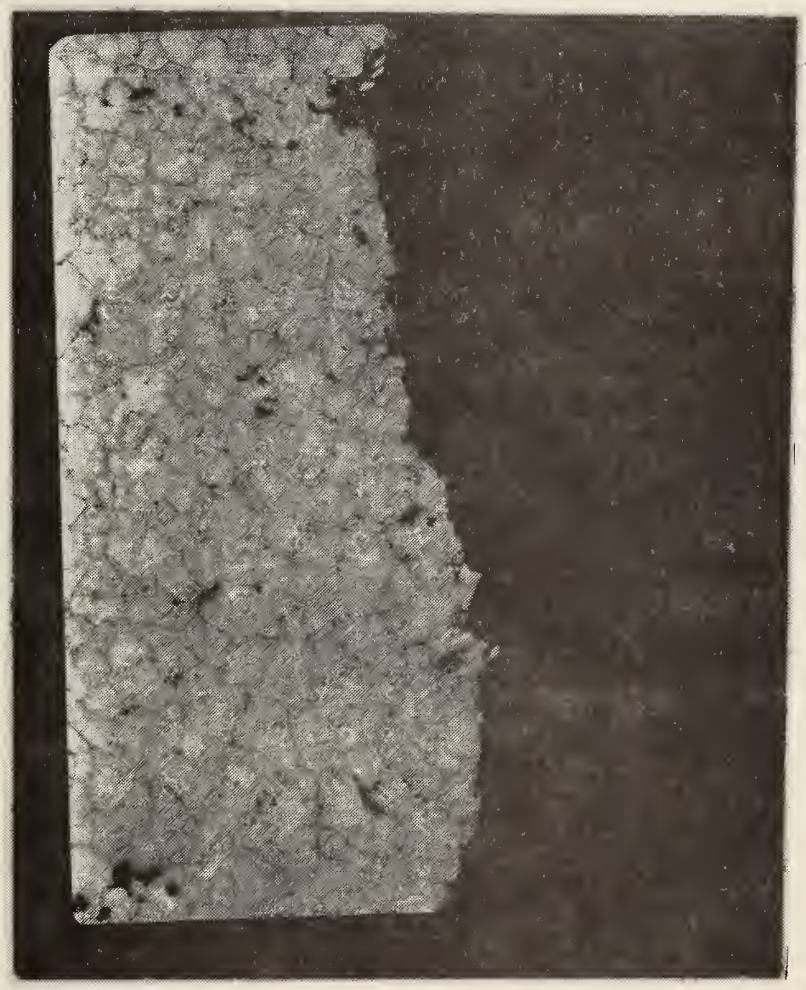

Figure 4. Fracture surface of failed K01-T7 aluminum alloy specimen after exposure for 37 days. Fracture is both intergranular and transgranular. Etched, Keller's etch. X50.

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Tensile specimens of K01-T7 aluminum alloy were stressed at fifty and seventy-five percent of the alloy's yield strength and exposed in a marine atmosphere environment. Specimens stressed by the constant load method failed after 37 and 249 days. The K01-T7 aluminum alloy may be subject to stress corrosion in a marine atmosphere environment.

KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Alloy; aluminum; atmosphere; castings; marine; mechanical properties; stress corrosion.

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