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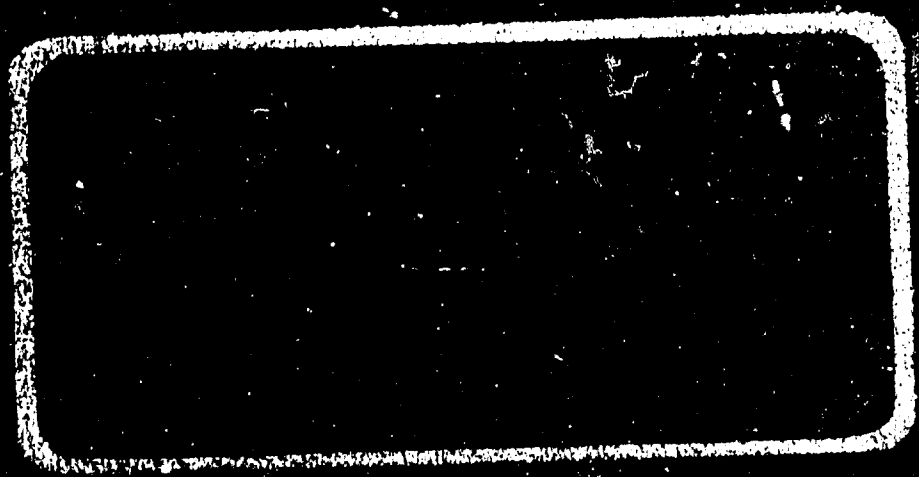

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MECHANICAL PROPERTIES, INCLUDING FRACTURE TOUGHNESS AND FATIGUE, CORROSION CHARACTERISTICS AND FATIGUE-CRACK PROPAGATION RATES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

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Contract No. F33615-68-C-1385
Project No. 7381

Second Technical Management Report
May 15, 1968 - August 15, 1968

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Abstract

A total of 38 of 40 hand forgings ordered for ~~this~~ investigation have been received to date. The alloys and tempers include 2014-T652, 2024-T852, 7075-T7352 and 7079-T652, in thicknesses ranging from 2 to 6 inches.

Preparation of specimens for the tensile, compressive, shear, bearing, fracture toughness, axial-fatigue, corrosion and fatigue-crack propagation tests have been initiated. Tensile properties in the longitudinal, long-transverse and short-transverse directions have been determined for five of the hand forgings.

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Second Technical Management Report

MECHANICAL PROPERTIES, INCLUDING FRACTURE TOUGHNESS AND FATIGUE, CORROSION CHARACTERISTICS AND FATIGUE-CRACK-PROPAGATION RATES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

I. Introduction.

The design mechanical properties, fracture toughness, corrosion characteristics and fatigue-crack propagation rates are four of the most important factors involved in the selection and efficient design of aircraft structures. Such data are needed for aluminum alloy hand forgings for several reasons: (1) much of the published design data has become obsolete by a change in the basis of specifying minimum properties, from one in which the length, width and thickness were considered, to one where only the thickness is involved; (2) the development of a technique of stress relieval by cold work in compression has resulted in relatively new tempers (TX52) for many of the alloys; and (3) there have been some significant problems with forged parts in recent years that were related to fracture and stress-corrosion characteristics.

Accordingly, the properties of hand forgings of several aluminum alloys currently being used in aircraft structures are being determined under this contract. The tests are intended to provide statistically reliable data for deriving design mechanical properties for MIL-HDBK-5, including stress-strain and compressive tangent-modulus curves. In addition, data concerning the fracture toughness, axial-stress fatigue, stress-corrosion, exfoliation and fatigue-crack propagation rates are being obtained.

This Second Technical Management Report summarizes the results of tests and the general status of the program at this time.

II. Material.

All materials with the exception of the 6x24-in. 2024-T852 and 7079-T652 hand forgings have now been received. The latter two samples are expected within the next several weeks. As previously reported, some delay was incurred in obtaining the hand forgings because of a work-stoppage at the producer's plant. The cross-sectional size, alloy, temper and identification of each sample received is listed in Table I.

The chemical compositions will be reported when available for all of the samples.

III. Procedure.

All the specimens and test procedures being used are as described in the First Technical Management Report, dated May 15, 1968.

IV. Progress During Quarter.

A. Mechanical Properties

A.1. Tensile, Compressive, Shear and Bearing

All test coupons have been sawed from 37 of the 38 hand forging samples received to date; the machining and testing of the specimens is in progress. The tensile properties determined in the longitudinal, long-transverse and short-transverse directions for five hand forgings are shown in Table II.

A.2. Fracture Toughness

The preparation of notch-bend fracture toughness specimens has begun and 18 of the 156 specimens scheduled for test are now machined.

A.3. Axial Stress Fatigue

Preparation of the axial-fatigue specimens is about to be initiated.

B. Corrosion Characteristics

Resistance to Exfoliation Attack and to Stress-Corrosion Cracking

Preparation of test specimens to investigate the corrosion characteristics of the hand forgings has been started. These specimens will be tested to study the susceptibility to exfoliation and the resistance to stress-corrosion cracking of representative hand forgings.

C. Fatigue Crack Propagation

Preliminary Investigation

The 6x24-in. 2014-T652 hand forging has been submitted to the Machine Shop for the preparation of twenty long-transverse crack propagation specimens for the preliminary investigations. These specimens will be tested to study the effects of notch geometry and specimen length on the rate of fatigue-crack propagation.

V. Results to Date.

The tensile properties determined in the longitudinal, long-transverse and short-transverse directions for five hand

forgings are shown in Table II. The tensile properties of the hand forgings exceed the applicable specified minimum values as shown in Table III.

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VI. Tables.

TABLE I

SAMPLES OF HAND FORGINGS RECEIVED AS OF AUGUST 15, 1968
(F33615-68-C-1385)

Cross-Sectional Size, in.	2014-T652 ARL Sample No.	2024-T852 ARL Sample No.	7075-T7352 ARL Sample No.	7079-T652 ARL Sample No.
2x8	341007	341017	341027	341037
3x12	341008	341018	341028	341038
4x8	341009	341019	341029	341039
4x16	341010	341020	341030	341040
5x5	341011	341021	341031	341041
5x10	341012	341022	341032	341042
5x20	341013	341023	341033	341043
6x6	341014	341024	341034	341044
6x12	341015	341025	341035	341045
6x24	341016		341036	

TABLE II

TENSILE PROPERTIES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS
(F33615-68-C-1385)

Alloy and Temper	Sample: Cross-Sect. Size, in.	Sample: Number	Sample: Direction*	Tensile Ultimate Stress, psi	Tensile Yield Stress,† psi	Elong. in 2 in. or 4D, %	Reduction, of Area, %
2014-T652	5x20	341013	L	68 500	60 700	11.5	24
			LT	64 700	57 300	5.0	7
			ST	63 900	56 100	3.8	7
2024-T852	4x8	341019	L	68 900	61 100	9.0	26
			LT	70 400	63 100	5.0	8
			ST	65 600	57 200	3.2	4
	6x6	341024	L	69 100	61 600	9.0	28
			LT	68 800	60 600	6.5	10
			ST	69 400	58 500	2.3	3
	6x12	341025	L	67 000	58 700	8.0	22
			LT	67 300	60 200	3.2	4
			ST	65 300	55 100	2.9	3
7075-T7352	4x16	341030	L	70 000	59 500	13.0	34
			LT	67 600	55 200	12.0	25
			ST	64 700	52 500	6.4	7

* L-Longitudinal; LT-Long-transverse; ST-Short-transverse
† Offset equals 0.2 per cent.

TABLE III

SPECIFIED MINIMUM VALUES FOR ALUMINUM ALLOY HAND FORGINGS TESTED
(F33615-68-C-1385)

Alloy and Temper	Thickness, in.	Direction*	Tensile Ultimate Stress, psi	Tensile Yield Stress,† psi	Elong. in 2 in. or 4D, %	Federal Specification
2014-T652	4.001-5.000	L	62 000	54 000	7	QQ-A-367g
		LT	62 000	54 000	2	
		ST	60 000	50 000	1	
2024-T852	All	L, LT, ST	---	---	-	None
7075-T7352	All	L, LT, ST	---	---	-	None

* L-Longitudinal; LT-Long-transverse; ST-Short-transverse
† Offset equals 0.2 per cent