

THE PROPERTIES OF SEMIPRODUCTS OF 1460 ALLOY (Al-Cu-Li-Sc) AND 1421 ALLOY (Al-Mg-Li-Sc) AT 293K AND 77K*

J.N. FRIDLANDER¹, W. BOZICH²

1 - All-Russian Institute of Aviation Materials, 17 Radio Street, 107005, Moscow, Russia

2 - Boeing-McDonnell Douglas Aerospace Co., 5301 Bolsa Avenue, Huntington Beach, California
92647

Abstract

The mechanical properties - YS, UTS, elongation, fracture toughness for sheet of 3.0 mm thickness, extruded panel of 2.2 mm and 4.8 mm thickness of 1460 alloy (3.0%Cu - 2.0%Li - 0.1%Sc), as well as waffle panel of 1421 alloy (5.2%Mg - 2.1%Li - 0.17%Sc) were studied at room temperature (293K) and liquid nitrogen (LN) temperature (77K). The properties of these semiproducts were studied depending on specimens location - between stiffeners and under stiffeners, in three directions - longitudinal (L), transverse (LT) and 45° to rolling or extrusion direction.

Keywords: *Aluminium-lithium alloys, low temperatures, yield strength, ultimate tensile strength, relative elongation, fracture toughness.*

Introduction

In Russia the extruded panels and forged waffle panels are widely used for aviation and rockets.

1460 and 1421 alloys were alloyed with the small additions of scandium in order to refine a grain and nonrecrystallized structure obtaining. It leads to increase of ultimate tensile strength and, especially, of yield strength. Scandium increases a weldability significantly.

Materials and experimental procedures

The following semiproducts were produced of 1460 alloy for testing:

- the rolled sheets of 3.0 mm thickness stretched by 1.5%;
- the extruded panels with stiffeners having a thickness of skin of 2.2 and 4.8 mm stretched by 1.5% (Fig.1).

The forged waffle panels with stiffeners of 3.5 ÷ 4.5 mm thickness and with skin thickness of 6.0 ÷ 7.0 mm were produced of 1421 alloy (Fig.2).

The strength, plastic properties and fracture toughness were determined on the standard specimens cut in L, LT directions and 45° to rolling or extrusion direction. In a case of extruded panel and waffle panel the specimens were cut both from areas between stiffeners and under stiffeners.

The mechanical properties and fracture toughness were determined at 293K and 77K.

Results and discussion

As compared with the tests results obtained at room temperature the strength of 1460 alloy sheet and extruded panel at LN temperature is higher, but the fracture toughness is near to the same. The ductility of materials at room temperature is high enough, in particular at 45° to rolling or extrusion direction, but at 77K the elongation is decreased especially for LT direction in specimens cut under stiffeners of extruded panel (Table 1).

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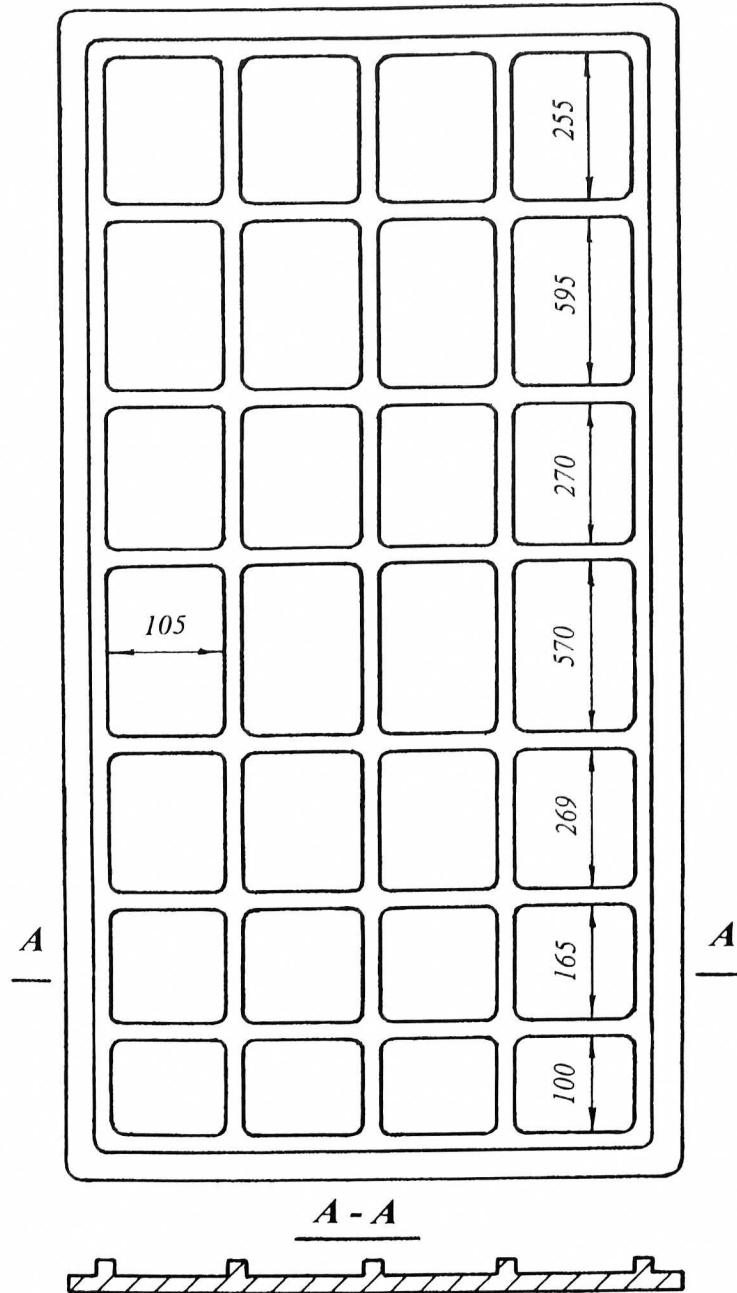


Fig. 1. Sketch of 1460 alloy extruded panel with stiffeners

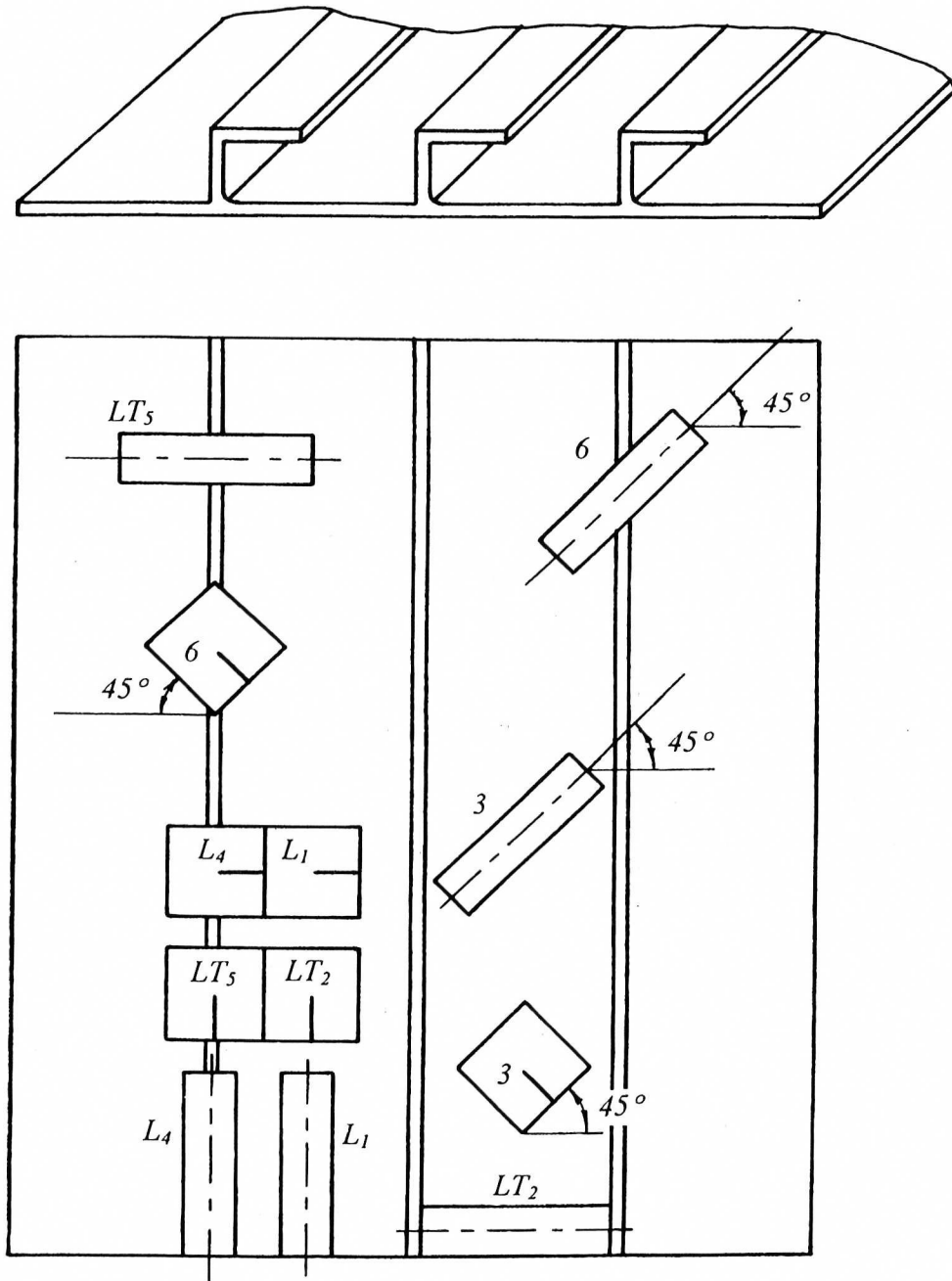


Fig. 2. Sketch of 1421 alloy forged waffle panel and diagram of the specimens cutting

Table 1. The results of tensile tests of extruded panels of 2.2 and 4.8 mm thickness and sheet of 3.0 mm thickness of 1460 alloy

Direc- tion	Property	Extruded panel 4.8 mm				Extruded panel 2.2 mm				Sheet 3.0 mm	
		between stiffeners		under stiffeners		between stiffeners		under stiffeners		293K	77 K
		293K	77 K	293K	77K	293K	77 K	293K	77K		
L	UTS, MPa	592	628	618	698	574	643	598	685	592	664
	YS, MPa	470	497	560	606	454	537	475	535	534	596
	El, %	8.4	5.4	4.8	3.3	8.2	5.2	7.4	7.4	4.7	4.6
LT	UTS, MPa	577	613	532	577	595	617	576	594	593	672
	YS, MPa	497	553	451	506	490	531	469	501	527	588
	El, %	3.9	1.6	2.2	1.1	5.9	2.1	7.7	3.4	5.7	4.6
45°	UTS, MPa	549	583	526	557	538	589	517	576	555	630
	YS, MPa	431	444	436	436	423	470	373	426	470	519
	El, %	9.4	6.1	2.8	3.1	10.9	8.0	11.8	7.9	9.4	10.5

The fracture toughness at room temperature is higher for sheets and thin (2.2 mm) panel as compared with thick (4.8 mm) panel. The fracture toughness value at 77K is the same (Table 2).

The corrosion resistance of 1460 alloy sheet and thin panel specimens is higher than that of thick panel specimens.

Table 2. The results of fracture toughness tests of extruded panels of 2.2 and 4.8 mm thickness and sheet of 3.0 mm thickness of 1460 alloy

Direc- tion	Property	Extruded panel 4.8 mm				Extruded panel 2.2 mm				Sheet 3.0 mm	
		between stiffeners		under stiffeners		between stiffeners		under stiffeners		293K	77 K
		293K	77 K	293K	77K	293K	77 K	293K	77K		
L	K_{Ic}, K_c^* MPa \sqrt{m}	12.5	12.3	10.4	11.4	19.6	15.4	23.1*	19.1	27.7*	18.2
LT	K_{Ic}, K_c^* MPa \sqrt{m}	14.3	14.5	16.8*	14.0	32.5*	23.9*	29.3*	30.3*	29.3*	21.5
45°	K_{Ic}, K_c^* MPa \sqrt{m}	13.9	21.5*	14.2	14.0	15.8	14.9	23.9*	20.0*	25.1*	22.0

Conclusion

1421 alloy has the lower strength, approximately same plasticity and fracture toughness and much better corrosion resistance compared to 1460 alloy.

References

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