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EXAMINATION OF SUPERSTON 70 PROPELLER MATERIAL

by

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SUMMARY OF RESULTS

Tensile, impact, and chemical analyses results on cast test bars of Superston 70 propeller alloy submitted by the Department of Transport revealed that the material properties were in complete agreement with the claims made by the manufacturers.

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INTRODUCTION

By letter of May 11th, 1965, (Ref. 9172-6 (S.Con.) Mr. A.R. Webster, Chief, Ship Construction Division, Shipbuilding Branch of the Department of Transport, requested information on the properties of test coupons of a marine propeller alloy obtained from Stone Manganese Marine Ltd. (subsequently designated S.M.M.). The material, designated Superston 70, was recently introduced by S.M.M. as the latest modification of the range of Superston manganese bronze propeller alloys, having significantly improved mechanical properties over established alloys such as Superston 40 and Superston 60.

The Mines Branch undertook a critical examination of the samples of Superston 70 to compare the results obtained with those claimed by the manufacturers. The testing involved chemical analysis, metallographic examination, hardness, tensile and impact property evaluation.

MATERIAL

Two cast test coupons were supplied in the form of 1 in. diameter cylinders 8 in. long, and identified with the markings "Superston 70 B1902". Judging from the appearance of the cast and sawn surfaces it is probable that these test bars were separately-cast in a bottom gated, full web-type vertical casting. The bars were sectioned to provide test pieces in the manner shown in Figure 1, and a sample of the turnings was used for chemical analysis.

1. CHEMICAL ANALYSIS

Results

The composition of the test coupons was found to agree exactly with that indicated by S.M.M.[1] for the principal alloy components as shown in Table 1.

2. TENSILE PROPERTIES

With the material available, it was possible to machine only one 0.505 in. diameter, 2 in. gauge length tensile specimen. The properties of this bar, and the properties claimed by the manufacturers are shown in Table 2.

3. IMPACT PROPERTIES

Charpy V-notch impact specimens were machined from one test coupon in the manner shown in Figure 1, and tested at temperatures between -80°C and 25°C (-112°F and 77°F). All specimens showed complete fracture. The results are shown in Table 3 and graphically illustrated in Figure 2. From the latter, it is evident that the Mines Branch test data are consistently lower than those indicated by S.M.M. by about 5 ft-lb.

The fracture surfaces of the impact test specimens were crystalline in appearance with cleavage facets of the order of 0.5 mm in diameter. The amount of fibrous fracture surface was small (~10% at 25°C) and confined to the edge opposite the notch. Although these fracture facets are indicative of a relatively brittle material, this is contradicted by room temperature elongation and reduction of area, the values of the impact energy absorbed, and by the fact that there was a significant contraction in width at the root of the notch at all test temperatures.

4. METALLOGRAPHY

A transverse section of the test coupon was polished for microscopic examinations. It appeared clean and free of porosity and dross inclusions. The microstructure revealed after etching (Figure 3), is shown to consist of almost equal volumes of alpha and decomposed beta, typical of a high manganese, aluminum bronze of this composition, with extensive fine precipitation of secondary constituents. The original equi-axed beta grain size was clearly evident at low magnification, having an average grain diameter of 0.4 mm. It is of interest to note that the impact specimens showed crystalline facets of this order of magnitude.

DISCUSSION

The chemical analysis and tensile mechanical properties of the test coupons meet the published claims of the manufacturers and agree closely with the properties given by S.M.M. for the melt from which these bars were cast.

The impact properties of the coupons are lower than those given by S.M.M. for this alloy, but are still greater than 15 ft-lb at -50°C (-58°F). There appears to be no transition temperature, as such, in which the material changes from a ductile to a brittle material, and although some of the fracture characteristics appear brittle, the material has good tensile ductility and satisfactory energy absorption characteristics compared with other accepted copper alloys such as the more common aluminum bronzes. It will, of course, be appreciated that the impact results are not necessarily indicative of the performance of large castings of thick section, but it should be noted that these alloys are relatively insensitive to section thickness effects.

Though it may be of academic interest only, the apparent relationship between the impact fracture surface facets and the original beta grain size of the alloy suggests that factors affecting the grain size of the high temperature phase, e.g., rate of cooling of the casting, welding, the presence of grain growth inhibitors, etc., may thus indirectly affect the impact resistance of the alloy at low temperatures.

CONCLUSIONS

1. The chemical composition and tensile mechanical properties of two test coupons of Superston 70, marked B1902, meet the values claimed for this material by the manufacturers.

2. The Charpy V-notch properties of the test material range smoothly from 12 ft-lb at -80°C (-112°F) to 24 ft-lb at 25°C (77°F).

REFERENCES

1. Correspondence between Stone Manganese Marine Ltd., England, and Department of Transport, Ottawa, Canada (April/May 1965).

2. S.M.M. Newsletter No. 4 (January 1964).

RT:bb

TABLE 1

Chemical Analysis of Superston 70

	Mines Branch	S.M.M. Report[1]
Copper	71.73	Balance
Manganese	15.08	15.11
Aluminum	7.67	7.68
Iron	3.01	3.08
Nickel	2.41	2.48
Silicon	0.022	-
Total	99.92	

TABLE 2

Tensile Properties of Superston 70

	S.M.M. General Range[2]	Mines Branch	S.M.M. Report[1]
Ultimate Strength kpsi	100-114	106.4	108
0.1% Permanent Set kpsi	45-46	47.5	48
0.2% Proof Stress kpsi	-	50.8	-
Elongation %	20-35	24.5	27
Reduction of Area %	-	25.8	-
Brinell Hardness		174	

TABLE 3

Impact Test Results on Superston 70

Test Temperature °C	Test Temperature °F	Energy Absorbed ft-lb
-80	-112	12
-40	-40	16
-25	-13	21
-15	+5	19
+0	+32	21, 22
+25	+77	24, 24

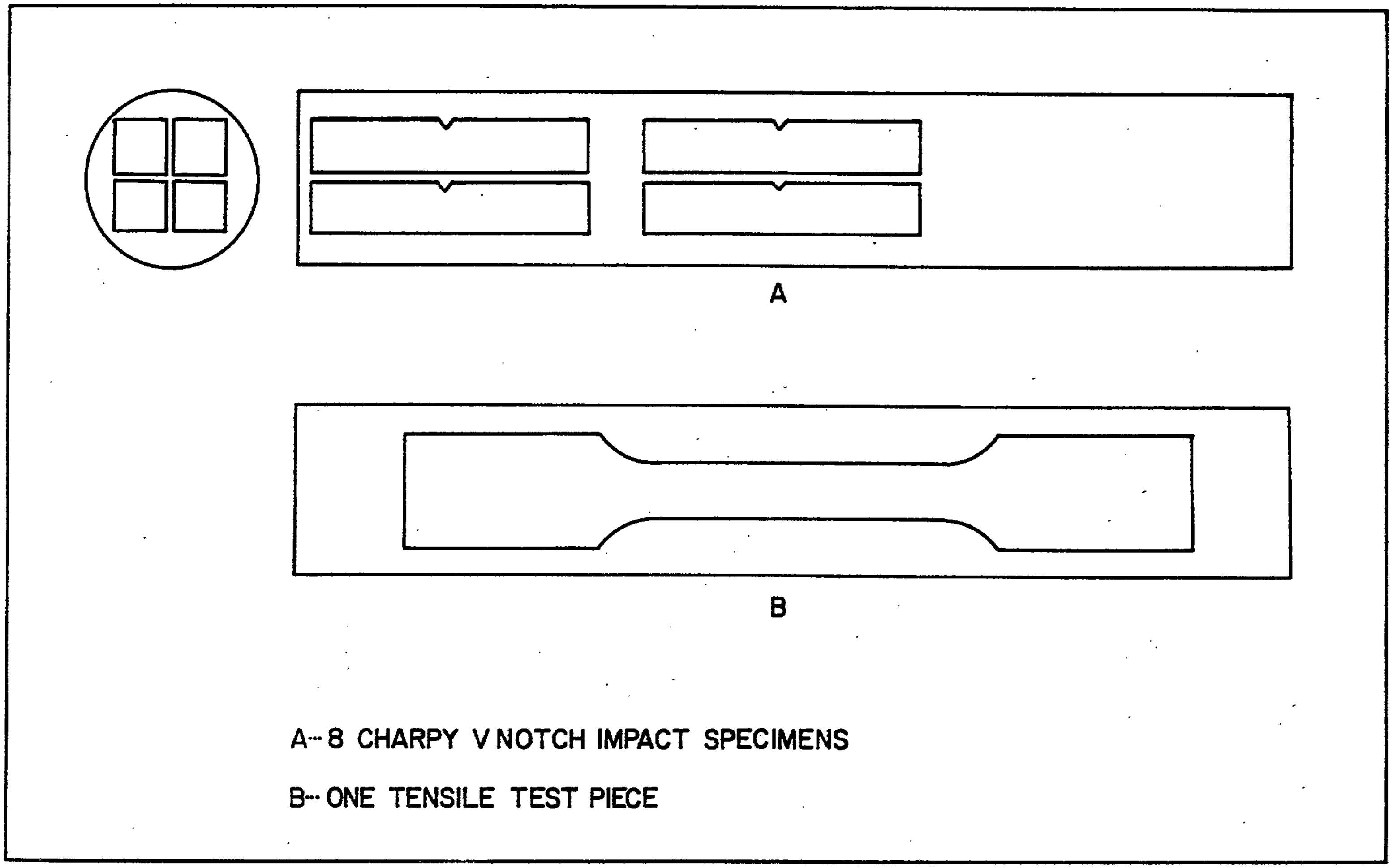

Figure 1. Method of sectioning two test bars of Superston 70 for mechanical test specimens.

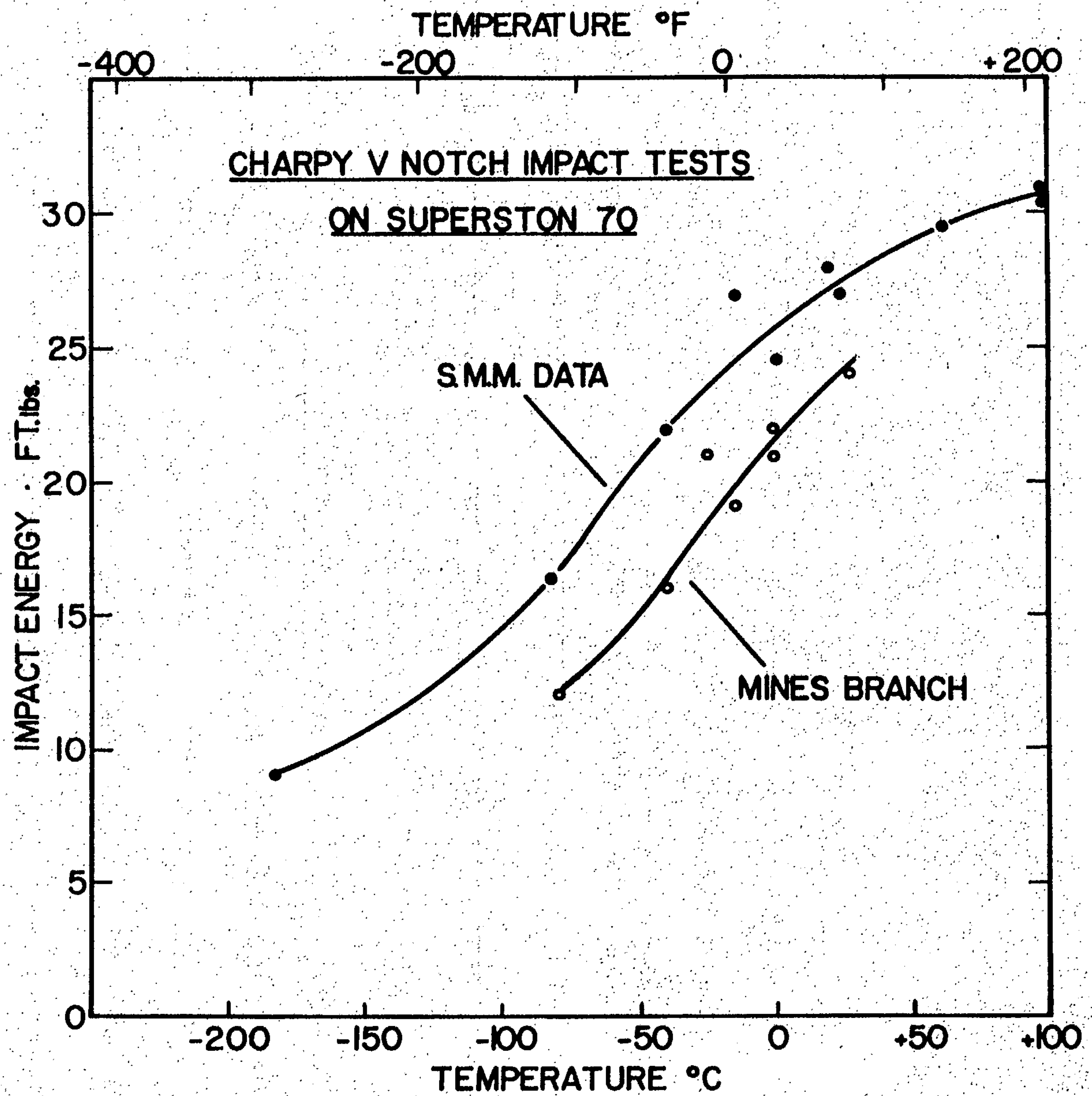

Figure 2. Impact resistance data on Superston 70.

X750 Etched 10% ammonium persulphate

Figure 3. Microstructure of transverse section of test bar Superston 70, B1902. Alpha crystallites in decomposed beta matrix with widespread precipitation of compounds in the alpha phase.