File

FILE COPY

O T T A W A   October 26th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1726.

Examination of Magnesium Alloy Outer Casting for
Tail Wheel Shock Strut of a Mosquito Aircraft.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A   October 26th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1726.

Examination of Magnesium Alloy Outer Casting for Tail Wheel Shock Strut of a Mosquito Aircraft.

==========

Origin of Sample and Object of Investigation:

An outer casting for a mosquito aircraft tail wheel shock strut was received (with letter, File No. 938BY-2-5 (AMAE DAI)) from Air Commodore A. L. Johnson for Chief of Air Staff, Department of National Defence for Air, Ottawa, Ontario, on September 22nd, 1944. This magnesium alloy part, said to be Class 1, Radiological Category A, was one of several which had failed after a service life of approximately ten hours. Request was made for an examination to determine whether or not the material was above suspicion.

Chemical Analysis:

The analysis of the material was found by chemical methods to be as follows:

		As Found	Specification D.T.D. 289
		- Per Cent -	
Aluminium	-	8.60	8.5 max.
Zinc	-	2.15	3.5 max.
Manganese	-	0.17	0.5 max.
Silicon	-	0.23	
Copper	-	0.03	Other elements,
Iron	-	0.022	1.0 max.
Lead	-	0.03	
Tin	-	None detected.	
Nickel	-	None detected.	

Macro-Examination:

Figure 1 is a photograph of the casting as received. In Figure 2 (a close-up of the fractured surface), the break is seen to have some typical fatigue characteristics. The nucleus of failure was not noticeable.

Figure 1.

CASTING AS RECEIVED.

(Approximately 1/6 actual size).

-

(Macro-Examination, cont'd) -

Figure 2.

CLOSE-UP OF PART OF FRACTURE.

(Approximately ½ actual size).

-

Mechanical Tests:

Two flat test bars were machined from the thin barrel wall of the casting and broken in tension. Results were:

		Ultimate Tensile Strength, p.s.i.	0.2% Proof Stress, p.s.i.	Elongation, per cent in 2 inches
Bar No. 1	-	27,900	17,600	Not obtained.
Bar No. 2	-	30,100	23,400	1.5

In Bar No. 2 a casting defect which looked like a dross or oxide inclusion was noticed on the fractured surface and for some distance (roughly 3/8 inch) down the bar. In the casting this defect would be on or near the exterior surface.

The Vickers hardness (10-kilogram load) of this part was 75.

-

Microscopic Examination:

Microscopic examination showed that the structure consisted largely of a lamellar precipitation of beta.

The casting defect noticed during the mechanical tests was found, when examined microscopically, to consist of cavities with numerous connecting stringers. Figure 3, a photomicrograph of it, shows that there is very little beta precipitation in the defective region, but the normal structure may be seen at the top and bottom of the picture.

Figure 3.

X100, etched in
2 per cent nital.

PHOTOMICROGRAPH OF DEFECTIVE AREA.

Black voids at A are cavities.
Note connecting stringers.

No defects, other than that described, were found during the microscopic examination.

Discussion of Results:

Except for a slightly high aluminium content, the composition follows D.T.D. 289 specification. This excess aluminium would not be expected to appreciably affect the quality of the casting.

In material of this kind, with its comparatively low ductility (about 1.5 per cent elongation in two inches), fatigue, impact and tensile failures might all appear somewhat similar. It would seem, however, from the appearance of the fracture and from the fact that failures occur within a certain range of time rather than at random, that fatigue was the mode of failure.

The large amount of lamellar beta in the micro-structure, the proof stress and the hardness would tend to indicate that this casting had been aged after the solution heat treatment. It is not possible to be definite about this ageing, however, because the larger-than-usual amount of aluminium and a fairly slow cool in the solution heat treatment may have combined to give these effects.

Macroscopic and microscopic examinations indicate that the defect found in this part is an oxide or dross inclusion. A defect of this type would act as a notch and, if present in a critical area, would contribute to failure, especially failure by fatigue.

Conclusions:

1. The failure appears to be of the fatigue type.

2. There are indications that this casting has been aged. If this is so, and if design considerations do not necessitate a high proof stress, it would appear desirable to change the practice and use the casting in the solution-heat-treated state, because the fatigue strength would be

(Conclusions, cont'd) -

approximately the same and the impact strength would be increased.

3. Defects of a type similar to the one found in this part may have contributed to failure. In view of the number of breakages occurring, however, it would seem most unlikely that, even if no defects of this type were present, this casting would have been absolutely reliable. A change in section thickness or, if skin stresses are responsible for failure, a change in design or material, would seem necessary.

ooooooooooo
ooooo
o

LPT:GHB.