

File

FILE COPY

O T T A W A

March 22, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1818.

Metallurgical Examination of Bulletproof
Plate for Carrier Floor.

O T T A W A

March 22, 1945.

R E P O R T
of the
ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1818.

Metallurgical Examination of Bulletproof
Plate for Carrier Floor.

Origin of Request:

On March 1, 1945 a request was received from the Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, for a metallurgical investigation of two pieces of plate from a sandwich panel for the bottom of Universal and Windsor carriers. The covering requisition was No. 690 (AEEDB Lot No. 583, Report 31, Section B, Test No. 1).

The outer layer was of 7-mm. bulletproof plate (Specification I.T. 100, let down to 45-50 long tons per square inch). The inner layer (the normal carrier floor) was 1/8-inch bulletproof plate.

Mr. W. J. Cox of the Structures Section, Division of Mechanical Engineering, National Research Council, Ottawa, stated in a letter (File No. 12-M.2-75) that the carrier had

Origin of Request, cont'd) -

been subjected to two land mine explosions.

There was a slight bulge in the 7-mm. plate when received at these Laboratories. The thinner plate was bent but it was not known whether this was due to the explosions.

Chemical Analysis:

Chemical analysis showed the plates to have the following composition:

		<u>7-mm.</u> <u>Plate</u>	<u>1/8-inch</u> <u>Plate</u>
		- Per Cent -	- Per Cent -
Carbon	-	0.24	0.24
Manganese	-	0.77	0.43
Silicon	-	0.63	0.44
Sulphur	-	0.020	0.022
Phosphorus	-	0.054	0.055
Nickel	-	0.88	0.41
Chromium	-	0.85	0.98
Molybdenum	-	0.16	Trace.
Vanadium	-	Nil.	0.34

These compositions correspond to no alloy in the S.A.E. series. Specification I.T. 100 only limits the carbon content to 0.30 per cent. Acceptance is based on ballistic performance.

Mechanical Properties:

Tensile tests were made on specimens cut parallel to the direction of rolling. Results are shown below:

<u>Plate</u>	<u>Maximum</u> <u>stress,</u> <u>p.s.i.</u>	<u>0.2 per</u> <u>cent proof</u> <u>stress,</u> <u>p.s.i.</u>	<u>Elongation,</u> <u>per cent</u> <u>in</u> <u>2 inches</u>	<u>Per cent</u> <u>reduction</u> <u>of</u> <u>area</u>	<u>Vickers</u> <u>pyramid</u> <u>numeral,</u> <u>30-kg.</u>
7-mm.	100,000	73,200	23.5	62.9	
	98,800	75,000	23.0	64.9	221
1/8-in.	189,000	168,000	7.0		
	195,600	165,400	8.0	47.0	412
	193,200	165,100	7.0		
	195,400	164,000	8.0		

The measurement of reduction of area on the 1/8-inch

(Mechanical Properties, cont'd) -

bulletproof plate was difficult, due to the type of fracture exhibited by this plate (see Figure 1). Four specimens were pulled in Templin grips and a fifth was pulled using self-aligning grips. One specimen was macro-etched to determine the cause of this peculiar fracture but nothing of significance was observed. Reduction of area was measured on each side of the fracture and the average taken. The results, in all probability, are low.

Figure 1.



FRACTURES IN 1/8-INCH BULLETPROOF
PLATE TEST SPECIMENS.

(Approximately $\frac{3}{4}$ full size).

Micro-Examination:

A metallographic examination revealed the presence of duplexed sulphide-silicate inclusions in both plates, although to a slightly greater extent in the 7-mm. plate (see Figures 2 and 3). Fragmented oxide inclusions were also observed in both samples.

(Continued on next page)

(Micro-Examination, cont'd) -

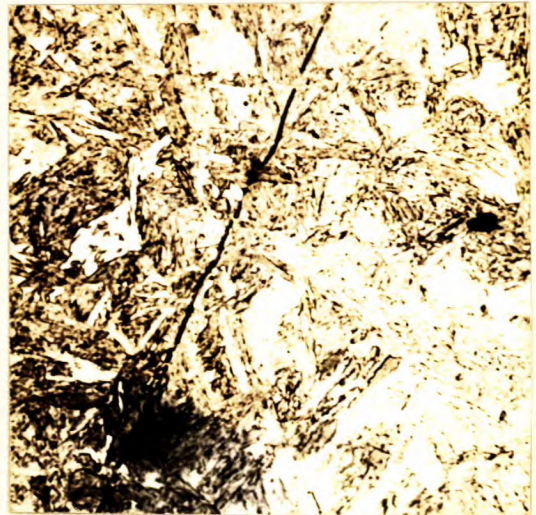
Figure 2.



X500, nital etch.

STRUCTURE OF 7-mm. PLATE.

Figure 3.



X500, nital etch.

INCLUSIONS IN DECARBURIZED
ZONE OF 1/8-INCH PLATE.

The structure of the 1/8-inch bulletproof plate consisted of a tempered martensite (Figure 4). The structure of the 7-mm. plate was also martensitic but the drawing temperature was evidently quite high, a fact which is borne out by the hardness values. It should be noted that Figure 3 represents the decarburized zone of the 1/8-inch plate while Figure 4 shows the core.

Figure 4.



X500, nital etch.

STRUCTURE OF CORE OF 1/8-INCH
BULLETPROOF PLATE.

- Page 5 -

(Micro-Examination, cont'd) -

While neither plate could be classified as "dirty"
the inclusions were very long.

oooooooooooo
oooooo
oo

TCH:GHB.