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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1385.

Investigation of A.S.F. Steel Track Links
for the Ram Tank.

(Copy No. 14.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Material and Object of Investigation:

Reports issued by these Laboratories on A.S.F. track links for the Ram tank have indicated that low impact values were being obtained. Sixty thousand of these track links have been produced by Electric Steels Limited at Cap de la Madeleine, Quebec, but due to the low impact strengths reported it was not known whether they should be approved for service.

At a meeting held in Ottawa, Ontario, during the month of March, 1943, it was decided to submit for impact strength determination twenty-four links selected at random from the above-mentioned sixty thousand. Accordingly, twenty-four machined square Izod bars (one from each link) and the remaining portions of the same shoes were received here on March 12th for tests.

Physical Tests:

Three 'V' notches, 0.0788 inch in depth, were machined on each bar. The remainder of the 0.397-inch-square bar was used for micro-tensile tests. Table I gives the results obtained, along with reported chemical and physical results of the heats (taken from separately cast test coupons). The physicals shown are the average obtained from two micro-tensile specimens pulled on a tensometer machine. It should be mentioned that the elongation and reduction of area figures obtained by this method are not comparable with those obtained from the regulation 0.564-inch-diameter specimen with a two-inch gauge length. The ultimate and yield strengths, however, are approximately the same as those obtained with the larger-sized specimens. The last column in Table I gives the round bar Izod impact results. These bars were machined from one of two smaller grousers of each of the twenty-four links. The square bars which were submitted were taken from the large grouser in every case.

(Table I follows on Pages 3 and 4.)

(Text continues on Page 5.)

TABLE I. - A.S.F. Track Shoes.

Heat No.	Code No.	C	Si	S	P	Mn	Mo	Yield	Ultimate	Elong. %	Red. of area, %	Izod square bar	Brinell of Izod bar	Brinell of shoe surface	Reported surface Brinell of shoe coupons	Izod round bar
A3934	PG8	0.31	0.33	0.023	0.029	1.48	0.27	⊗86,800	106,800	21.1	41.4					
								91,500	115,000	13.2	30.0	25	217	241	255	15.5
A3618	JB8	0.28	0.31	0.26	0.033	1.59	0.20	⊗96,000	112,000	17.9	32.0					
								121,500	133,500	7.0	23.5	14	269	285	241	8
A3845	FY8	0.29	0.29	0.022	0.029	1.55	0.26	⊗92,400	111,200	17.2	29.2					
								89,000	112,500	8.2	30.0	20	223	241	241	10.5
A3728	TU7	0.30	0.32	0.020	0.043	1.64	0.29	⊗101,200	122,500	17.2	29.0					
								111,200	126,500	5.5	13.0	29	241	262	268	13
A3728	TU7	0.30	0.32	0.020	0.043	1.64	0.29	⊗101,200	122,500	17.2	29.0					
								102,500	124,000	8.3	25.0	10	269	285	268	5
B3303	CB7	0.30	0.24	0.022	0.031	1.40	0.20	⊗98,000	110,400	18.7	55.8					
								90,000	110,000	5.5	19.0	21	217	241	248	11
A3891	KK8	0.25	0.35	0.019	0.038	1.44	0.30	⊗105,200	121,200	19.5	39.7					
								76,000	102,000	9.9	32.5	45	195	229	255	20
B3402	ML7	0.29	0.26	0.020	0.036	1.25	0.29	⊗90,400	110,000	17.2	26.7					
								81,250	103,500	8.2	25.0	32	201	255	262	17
B3402	ML7	0.29	0.26	0.020	0.036	1.25	0.29	⊗90,400	110,000	17.2	26.7					
								92,000	112,000	8.3	25.0	24	229	248	262	14.5
B3402	ML7	0.29	0.26	0.020	0.036	1.25	0.29	⊗90,400	110,000	17.2	26.7					
								83,500	101,500	6.2	15.0	29	212	235	262	18
A3755	WT7	0.25	0.30	0.021	0.053	1.25	0.28	⊗84,000	106,000	20.3	29.2					
								80,000	105,000	8.1	15.0	33	201	255	248	18

(Continued on next page)

TABLE I. = A.S.F. Track Shoes. (cont'd.)

Heat No.	Code No.	C	Si	S	P	Mn	Mo	Yield	Ultimate	Elong. %	Red. of area, %	Izod square bar	Brinell of Izod bar	Brinell of shoe surface	Reported surface Brinell of test coupons	Izod round bar
A3755	WT7	0.25	0.50	0.021	0.053	1.25	0.28	(*)84,000	106,000	20.3	29.2					
								82,000	104,500	11.0	30.0	34	212	229	248	15.5
A3585	FT7	0.28	0.31	0.023	0.038	1.25	0.23	(*)99,200	115,200	17.9	30.4					
								84,500	109,000	12.0	29.0	32	207	255	241	16
B3330	ET7	0.25	0.46	0.023	0.038	1.31	0.23	(*)85,200	106,000	21.1	38.4					
								85,000	106,500	11.0	31.0	32	207	241	255	14
A3680	OT7	0.29	0.34	0.024	0.054	1.25	0.23	(*)90,000	108,400	15.6	27.6					
								91,500	114,000	8.4	27.5	18	223	241	248	15
A3680	OT7	0.29	0.34	0.024	0.054	1.25	0.27	(*)90,000	108,400	15.6	27.6					
								86,500	106,500	8.5	23.0	28	201	255	248	17
A3718	ST7	0.28	0.36	0.018	0.049	1.27	0.28	(*)90,800	111,600	19.5	36.4					
								92,500	111,000	5.5	15.7	37	229	255	252	21
B3228	TY6	0.27	0.30	0.027	0.046	1.25	0.28	(*)91,600	116,000	17.9	25.5					
								95,500	115,000	7.5	18.0	26	223	277	275	15.5
B3204	RH7	0.34	0.43	0.018	0.043	1.30	0.24	(*)112,000	126,400	16.4	26.1					
								105,000	127,500	5.0	16.0	13	255	269	241	11.5
A3722	TE7	0.29	0.42	0.016	0.054	1.23	0.24	(*)94,000	114,400	17.9	33.2					
								93,500	112,500	9.3	25.0	23	223	241	248	9
B3604	HL8	0.30	0.28	0.019	0.034	1.26	0.22	(*)86,000	105,200	19.5	39.2					
								85,000	107,000	9.6	26.3	45	217	241	228	21
B3192	PX8	0.25	0.29	0.020	0.049	1.25	0.30	(*)90,800	110,400	21.1	37.0					
								92,500	111,250	8.0	21.0	39	223	255	235	18.5
B3467	TF6	0.25	0.34	0.023	0.048	1.30	0.24	(*)108,400	118,000	16.4	32.4					
								81,500	103,000	7.1	22.5	32	207	255	248	21.5
A3222	SQ5	0.31	0.38	0.017	0.047	1.26	0.28	(*)110,400	128,800	18.7	31.2					
								110,000	130,000	10.7	37.5	33.5	262	277	244	19

N.B. 1. Chemical analyses are those reported by Electric Steels Ltd. for the heat of steel.

2. The physical properties marked with an asterisk (*) are those reported by the firm for the heat of steel. These are taken from 0.564-inch-diameter specimens with 2-inch gauge lengths, machined from separately cast test coupons.

Microscopic Examination:

Specimens were taken from each square impact bar and examined in the unetched condition under the microscope. The inclusions of the bars which gave poor impact values did not differ from those seen in the good impact bars. Figures 1, 2, and 3 (X500 magnification), of the nital-etched specimens of the square impact bars having values of 14, 45 and 33.5 foot pounds respectively, indicate relatively little difference in structure. They are all tempered martensite. The structures of the round Izod bars were also of the same character.

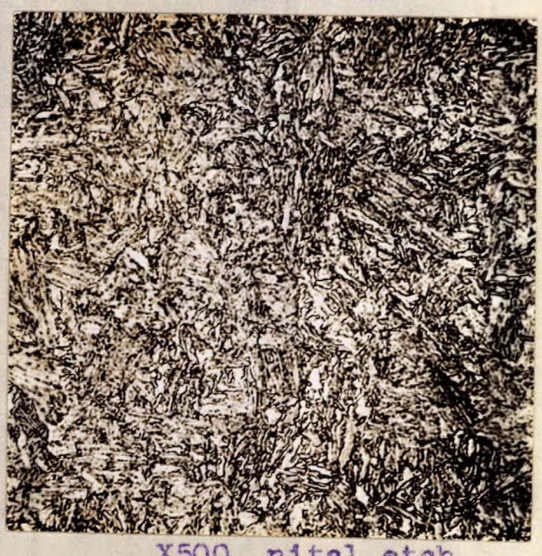
Figure 1.

X500, nital etch.
STRUCTURE OF SQUARE IMPACT SPECIMEN
FROM HEAT OF A3618.

Figure 2.

X500, nital etch.
STRUCTURE OF SQUARE IMPACT SPECIMEN
FROM HEAT B3604.

Figure 3.



X500, nital etch.
STRUCTURE OF SQUARE IMPACT
SPECIMEN FROM HEAT A3222.

Discussion:

Table I indicates an apparent discrepancy in the impact results. The values obtained with the standard square bars were approximately double the values for the round bar in the majority of the twenty-four shoes tested. In these Laboratories the practice has been to use the round-bar impact specimen, since it is easier to machine. Results issued in previous reports on these links were obtained with the round bar specimen (0.450-inch diameter, 'V' notch, 0.130-inch depth).

It is stated in the literature© that no difference in results should be obtained when using either the square or the round standard bars.

A check test was carried out to verify the report made in the literature. A 1.30 per cent nickel wrought steel was quenched and drawn. A standard square bar (10 mm. square) and a standard round bar were machined and tested. The results obtained with both specimens were identical.

The square specimens which were submitted had been machined from the large grousers. The round specimens were taken from one of the two small grousers on each shoe. A square specimen was machined from the other small grouser on the shoes corresponding to A3891 and A3722. The results obtained with these two square specimens were 21 and 14 foot pounds respectively. These correspond closely to the round bar values of 20 and 9 foot pounds and not to the square bar values of 46 and 23 foot pounds (See Table I).

A possible explanation for variation in results would be that the submitted square bars come from the thickest

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(Discussion, cont'd) -

section of the casting, which is not so severely quenched as were the smaller grousers from which all the specimens machined in these Laboratories were taken. The fact that the smaller sections gave poor impact results should be noted, since the main body of the A.S.F. link is of relatively thin section. These links may be exposed to enemy projectiles or flying bomb fragments and would be prone to shatter. Impact stresses may also be encountered in covering rough ground. It is understood that a field test is being carried out on these links. Such a test should, of course, be equivalent to service. If it is visualized that the link should be required to stand considerable drops onto large boulders, such a condition should be included in the test in view of the suspicion that the impact properties of these links may be marginal. If the track withstands shock suitably in service (which is the ultimate test), then it may be assumed the large quantity of links which this track represents are satisfactory.

CONCLUSIONS:

1. The square bar Izod impact results show that shoes from three different heats gave values below 15 foot pounds. These bars were machined from the large grouser (the thickest section of the shoe).

2. The round bar Izod impact results taken from the small grousers give lower values; ten of these are below 15 foot pounds.

3. The impact values appear to vary with the position in the link in which they are machined.

4. The Brinell hardness figures indicate that the

(Conclusions, cont'd) -

shoes have not been hardened throughout. The steel seems to lack the hardenability necessary for the complete hardening of the thicker sections.

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SLG:GHB.