INVESTIGATION OF SNOW FENCE POST BREAKAGE

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Research Project R-63 G-132
Research Report No. R-462

Michigan State Highway Department
John C. Mackie, Commissioner
Lansing, June 1964

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Physical and chemical tests of galvanized posts for snow fences have been completed as a result of serious problems in post breakage during driving and pulling, as reported by James Merrifield, District 7 Maintenance Superintendent. At the Office of Testing and Research staff meeting of December 2, 1963, the problem was referred to the Research Laboratory Division at the request of C. J. Olsen.

Chemical and Physical Testing

A broken post (Sample No. 63 MR-283) was received from the Testing Laboratory on December 6, 1963. Two other samples were subsequently obtained: 64 MR-18 was a post from the Kalamazoo Maintenance Garage that broke during pulling, and 64 MR-19 was a new post from the Mason Maintenance Garage. All samples were from Purchase Order No. 3198 supplied by the Missouri Rolling Mill Corp., St. Louis, Mo.

The posts are classified under Departmental specifications as No. 2 light posts. The specifications require that snow fence posts be made from billet-steel bars for concrete reinforcement (ASTM Designation:

A 15), or rail steel bars for concrete reinforcement (ASTM Designation: A 16). Chemical analysis of the sample posts gave results as follows:

Element	63 MR-283	64 MR-18	64 MR-19
Carbon	0.85	0.84	0.55
Manganese	0.67	0.80	0.76
Silicon	0.02	0.17	0.10
Sulfur	0.03	0.03	0.03
Phosphorous	0.04	0.04	0.02

Steel with the carbon content of samples 63 MR-283 and 64 MR-18 is in the tool and spring steel category, should have high tensile and yield strengths, high hardness, and high resistance to deformation, but would tend to be brittle. Sample No. 64 MR-19, with its lower carbon content, would have lower strength and hardness values, and be less brittle, if subjected to identical heat treating and forming operations.

ASTM A 15 or A 16 do not list complete chemical requirements; however, ASTM A 1-58T Specifications for Carbon-Steel Rails list the following requirements:

Element	Nominal Weight, lb per yd			
	61 to 80	81 to 90	91 to 120	121 and over
Carbon	0.55-0.68	0.64-0.77	0.67-0.80	0.69-0.82
Manganese	0.60-0.90	0.60-0.90	0.70-1.00	0.70-1.00
Phosphorous	0.04	0.04	0.04	0.04
Silicon	0.10-0.23	0.10-0.23	0.10-1.23	0.10-0.23

The carbon content range of the samples indicates that they were fabricated from more than one type of rail steel, with values from the lower minimum for the lightest rail to the upper maximum for the heaviest rail.

The microstructure of all samples is largely pearlitic, except for about 25-percent ferrite in 64 MR-19. This microstructure would be expected in the as-rolled condition for steels with these carbon contents. The austenite grain size of all samples is ASTM No. 3 as determined by methods given in ASTM E 112-58T. Steel with this relatively coarse grain size could be expected to be quite brittle. Photomicrographs of the microstructure and grain size are shown in Figs. 1 and 2.

Hardness values of the three samples on the Rockwell "C" scale were 28, 29, and 15 for Samples 63 MR-283, 64 MR-18, and 64 MR-19, respectively. A Rockwell "C" hardness of 28 or 29 could not be considered extremely hard, but is on the high end of the normal range for the as-rolled condition of a steel with a carbon content of 0.85 percent.

Measurement of impact strength, in foot-pounds, obtained by breaking identical test bars from the three sample posts gave results of 2.5, 3.0, and 4.0 for 63 MR-283, 64 MR-18, and 64 MR-19, respectively. These measurements cannot be used as absolute values, but do serve for comparison of the samples. Sample post 64 MR-19, as expected, had a somewhat higher impact strength than the other posts.

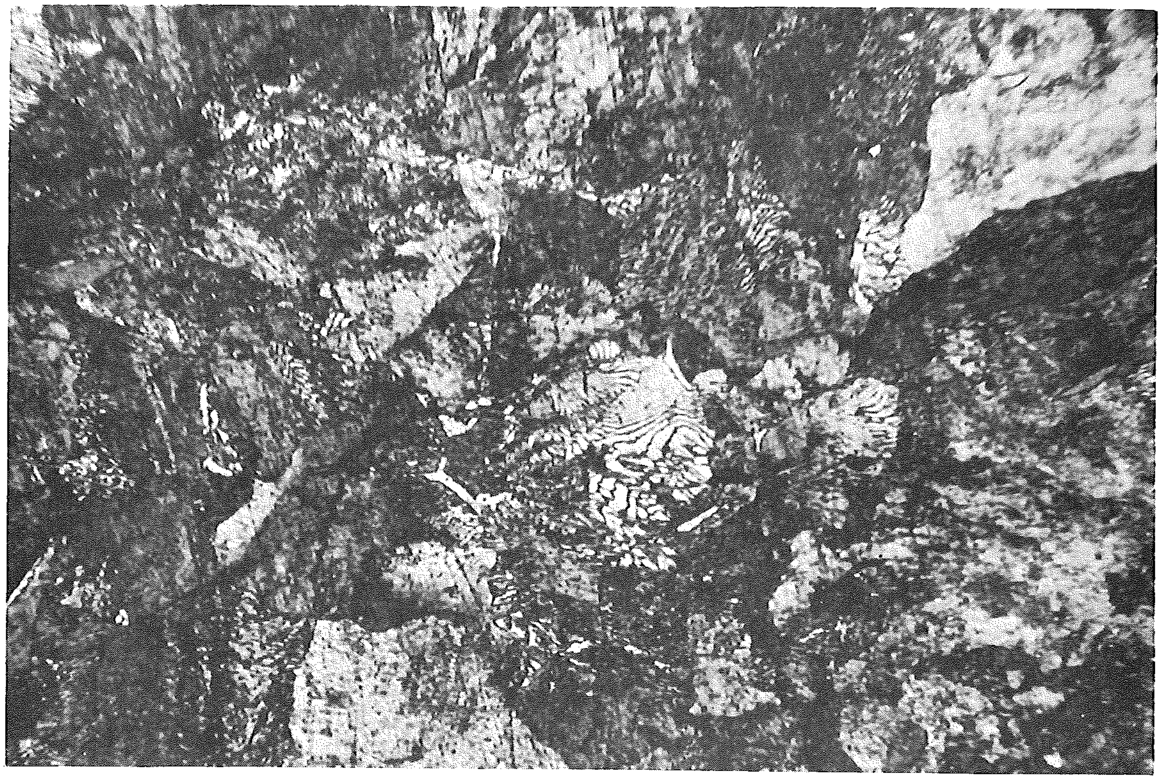

Figure 1. A typical microstructure of the sample posts at 400X. The microstructure is largely pearlitic.

Figure 2. A typical grain size at 100X. The grain size is ASTM No. 3.

In addition to the chemical testing of three galvanized post samples just described, additional chemical and physical tests were also performed with particular attention to possible effects of galvanizing.

First, an additional sample galvanized snow fence post broken in the field (64 MR-22) was received from K. C. Dunn, District 7 Materials Inspector. Next, R. L. Greenman requested galvanized and ungalvanized right-of-way fence posts from the supplier of the field snow fence post samples, the Missouri Rolling Mills. These supplier samples arrived after the following processing at the mill: six ungalvanized whole posts were cut in two sections of equal length, half of each post was galvanized, and the twelve half-posts were then shipped to the laboratory where the whole group was assigned Sample No. 64 MR-29. The samples were not paired when received, but were matched by comparison of metallurgical data. The complete chemistry of the posts was not determined, but the carbon content was estimated to range from 0.70 to 0.85 percent by studying the annealed microstructure. Impact strength measurements obtained by breaking identical test bars gave the following results, in foot-pounds:

Sample No. 64 MR-29		Galvanized Half	Ungalvanized Half
1		1.0	2.0
2		2.0	1.0
3		2.0	2.5
4		2.0	1.5
5		3.0	2.5
6		3.0	3.0
	Average	2.2	2.1

The following hardness values were found for the sample posts on the Rockwell "C" scale:

Sample No. 64 MR-29	Galvanized Half	Ungalvanized Half
1	23.3	22.9
2	22.8	24.4
3	24.1	23.2
4	24.1	23.0
5	21.5	21.3
6	16.4	16.5
Average	22.0	21.9

Examination of the grain size and microstructure revealed no visible difference between the galvanized and ungalvanized posts. Photomicrographs of galvanized and ungalvanized samples are shown in Figs. 3 and 4.

Static tensile test results for Mr. Dunn's post (64 MR-22) and the mill samples (64 MR-29) are given in Table 1. Minimum yield and ultimate tensile strengths of 50,000 and 80,000 psi, respectively, are prescribed by ASTM A 16 for re-rolled rail steel bars for concrete reinforcement. Corresponding yield and ultimate tensile strengths for the samples tested were in the range of 80,000 psi for yield and 135,000 psi for ultimate. All specimens tested revealed a mixed shear and cleavage mode of fracture more or less typical for a steel with a high carbon content. These test results indicate no significant difference between results obtained from the galvanized and ungalvanized right-of-way fence post material or the galvanized snow fence post material.

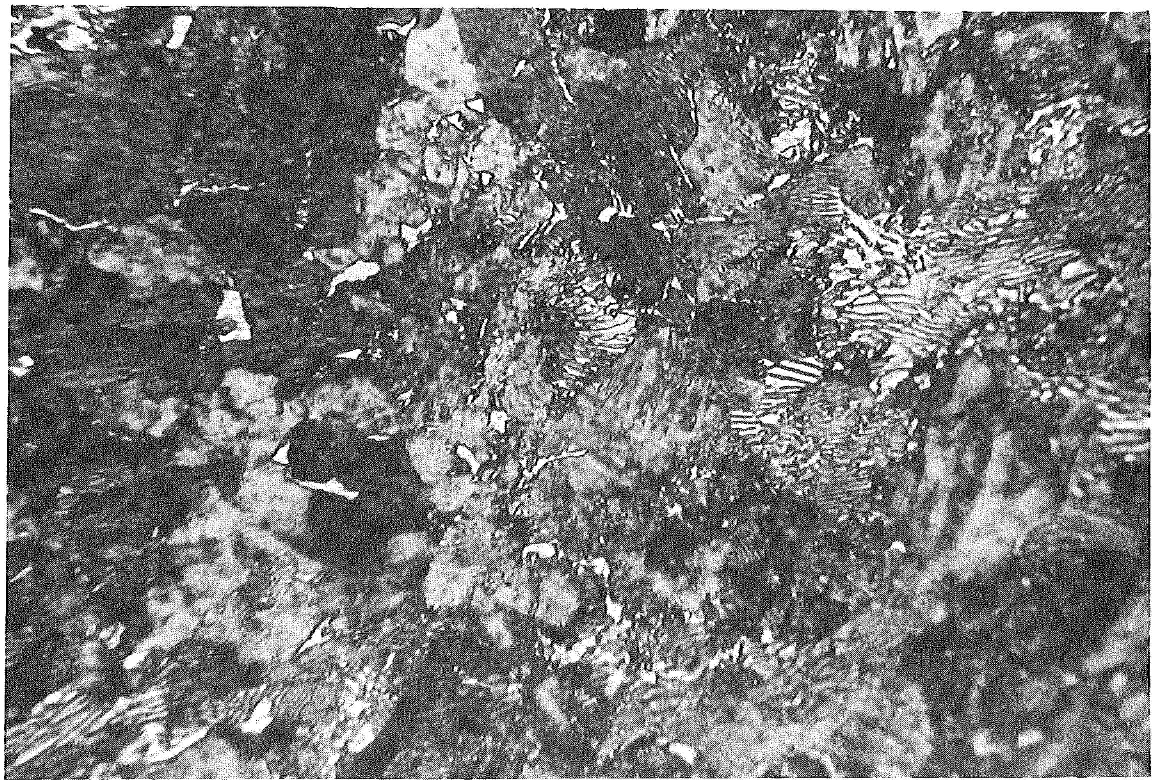

Figure 3. Microstructure of galvanized post 600X.

Figure 4. Microstructure of ungalvanized post 600X.

TABLE 1
TENSILE TEST RESULTS

	Sample No.	Yield Strength, psi*	Ultimate Tensile Strength, psi*
Galvanized Snow Fence Posts (64 MR-22)	1	84,000	141,000
	2	83,300	138,500
	Average	83,600	139,800
Galvanized Right-of-Way Fence Posts (64 MR-29)	1	87,000	136,000
	2	93,000	148,800
	3		135,200
	4		140,000
	5		135,200
	6		127,200
	Average	90,000	137,300
Ungalvanized Right-of-Way Fence Posts (64 MR-29)	1		135,000
	2		146,000
	3		132,000
	4	78,700	139,300
	5		131,500
	6	82,900	128,000
	Average	80,800	135,200

* Based on 0.2-percent offset.

Summary and Recommendations

Breakage of these posts when driven or pulled is believed to result from a combination of high carbon content (at the maximum for rail steel) and the relatively large grain size. Both these factors contribute to brittleness. High carbon content and large grain size raise the transition temperature of steel by a very considerable amount, causing critical notch sensitivity at lower temperatures, and increasing the probability of brittle fracture under shock loading. Since snow fence posts are often driven in cold weather and frozen ground, it is possible that installation temperatures may be below the transition temperature for this steel. Chemical composition tests indicate very high carbon content and large grain size in samples of the snow fence post material. Steel with a carbon content of 0.85 percent and hardness of 29 Rockwell "C," seems for example to be far better suited for use in tools than in fence posts. To quote from Carl G. Johnson's book "Metallurgy": "Carbon steels in the range of 0.70 to 0.80 percent carbon are suited for anvil faces, band saws, hammers, wrenches, cable, wire, etc."

There appears to be no reason to believe that the galvanizing process has caused the brittleness of the snow fence posts. Steels of this strength, carbon content, hardness, and grain size range should not be recommended for use as fence posts. Instead, it is advisable that posts of larger cross-section and lower-strength material be used.