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MICHIGAN
STATE HIGHWAY DEPARTMENT
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EVALUATION OF THE LATERAL STABILITY OF POSTS FOR DEEP BEAM GUARD RAIL

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Highway Research Project
55 F-39

Research Laboratory
Testing and Research Division
Report No. 230
June 23, 1955

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At the request on March 4, 1955 of Mr. C. B. Laird of the Road Construction Division, a study was undertaken by the Research Laboratory to determine the relationships between transverse load strength and embedment length of guard rail posts, and to compare the relative stability of three types of guard post sections.

A preliminary investigation of test sites was made by Frank Skebensky, Road Project Engineer. For convenience in obtaining construction equipment, it was necessary to conduct the work in Detroit, Michigan on the right-of-way for the Edsel Ford Expressway near St. Aubin. A choice of two sites was possible, but both of these were underlain with assorted debris. As a last resort, it was decided to use the best of these two sites, the northwest corner of Wideman St. and Harper Avenue, and remove the top several feet of material in the hope that more uniform material would be encountered below this level. Even though several feet of material were removed before the posts were placed, the soil profile still consisted of approximately three feet of a mixture of cinders, broken brick, broken concrete and miscellaneous industrial debris, underlain by approximately two feet of firm clay.

Five of each of the following three types of guard post sections were subjected to testing:

1.) 6" x 4" x 8½#/ft., WF, 5'-9" long, embedded a length of 3'-8".

2.) 6" x 4" x 8½#/ft., WF, 6'-9" long, embedded a length of 4'-8".

3.) 6" x 8" oak, 7'-0" long, embedded a length of 4'-11".

The steel posts were driven into the ground, while for the oak posts a hole was dug and backfilled by compacting with a pneumatic hammer, which is the usual practice.

A transverse load was applied to each specimen 1-1/2 foot above ground line by means of a type D-8 Caterpillar tractor. All loads were gradually applied to the posts except for three, (one of each type) in which case the load was applied suddenly. All loads were measured by recording strains in a previously calibrated eyebar. The strains in the eyebar were obtained by SR-4 strain gages which were electrically connected to a Brush oscillograph. Thus a continuous record was obtained of the tension in the eyebar. The displacement of each specimen was measured at a point 1-foot above ground line at various magnitudes of applied loading.

The maximum transverse load and method of failure for each test specimen are shown in Table 1. The individual and average maximum transverse load for those posts subjected to a gradually applied loading condition are depicted in Figure 1. The average load-displacement curves for the three types of guard posts are shown in Figure 2. It may be noted from this figure that there was a greater average displacement for a given load for the wood posts than the steel posts. This may be explained by the fact that the steel posts were driven in undisturbed soil, while the wood posts were placed in a hole which was dug and then backfilled. Even though the backfilling of the hole was compacted, it probably did not give as dense a condition as that in the undisturbed soil. Pictures of the soil condition and typical failure of one of the steel sections are shown in Figures 3 and 4 respectively.

The results of the test indicate the average transverse load resistance of the oak sections to be 46 percent greater than that of the long steel sections, and 64 percent greater than that of the short steel sections. The average transverse load resistance of the long steel sections was 12 percent greater than that of the short steel sections. However, due to the heterogeneous nature of the soil at the test site, these figures are not to be construed as absolute values. They indicate only comparative results for the particular soil condition encountered.

An analytical analysis of the problem reveals the transverse load capacity as a function of the shearing resistance of the soil, and varying approximately as the square of the length of embedment. Obviously, the best guard post design would be one in which the load resistance of the guard rail, the soil, and the post itself are approximately equal. The complete solution to this problem would involve a more elaborate study and testing program. It is hoped that similar tests may be conducted in the near future at a site where soil conditions are more favorable for reliable results."

TABLE 1

TABULATION OF TEST RESULTS

POST NO.	POST TYPE	EMBEDMENT LENGTH	MAX. TRANSVERSE LOAD APPLIED 1'-6" ABOVE GROUND LINE	METHOD OF FAILURE
1	steel	3'-7½"	5700#	Pulled out of soil (no structural damage)
2	steel	4'-7½"	7400#	Compression flange buckled, 1.4' below G.L.
3	oak	4'-11"	15800#	Pulled out of soil (no structural damage)
4	steel	3'-7½"	9900#	Pulled out of soil (no structural damage)
5	steel	4'-7 1/8"	10600#	Compression flange buckled 0.8' below G.L.
6	oak	4'-10 3/8"	13800#	Tensile failure (knot) 1.2' below G.L.
7	steel	3'-7¼"	9100#	Compression flange buckled, 0.9' below G.L.
8	steel	4'-7"	11900#	Compression flange buckled, 0.7' below G.L.
9	oak	4'-10½"	18800#	Pulled out of soil (no structural damage)
10	steel	3'-7"	11100#	Compression flange buckled, 1.0' below G.L.
11	steel	4'-7¼"	10500#	Compression flange buckled 0.7' below G.L.
12	oak	4'-11"	10600#	Pulled out of soil (no structural damage)
* 13	steel	3'-8"	11800#	Pulled out of soil (no structural damage)
* 14	steel	4'-8¼"	11700#	Compression flange buckled, 1.6' below G.L.
* 15	oak	4'-8"	6700#	Pulled out of ground (no structural damage)

* These three guard posts were subjected to a suddenly applied loading in lieu of a gradually applied loading condition.

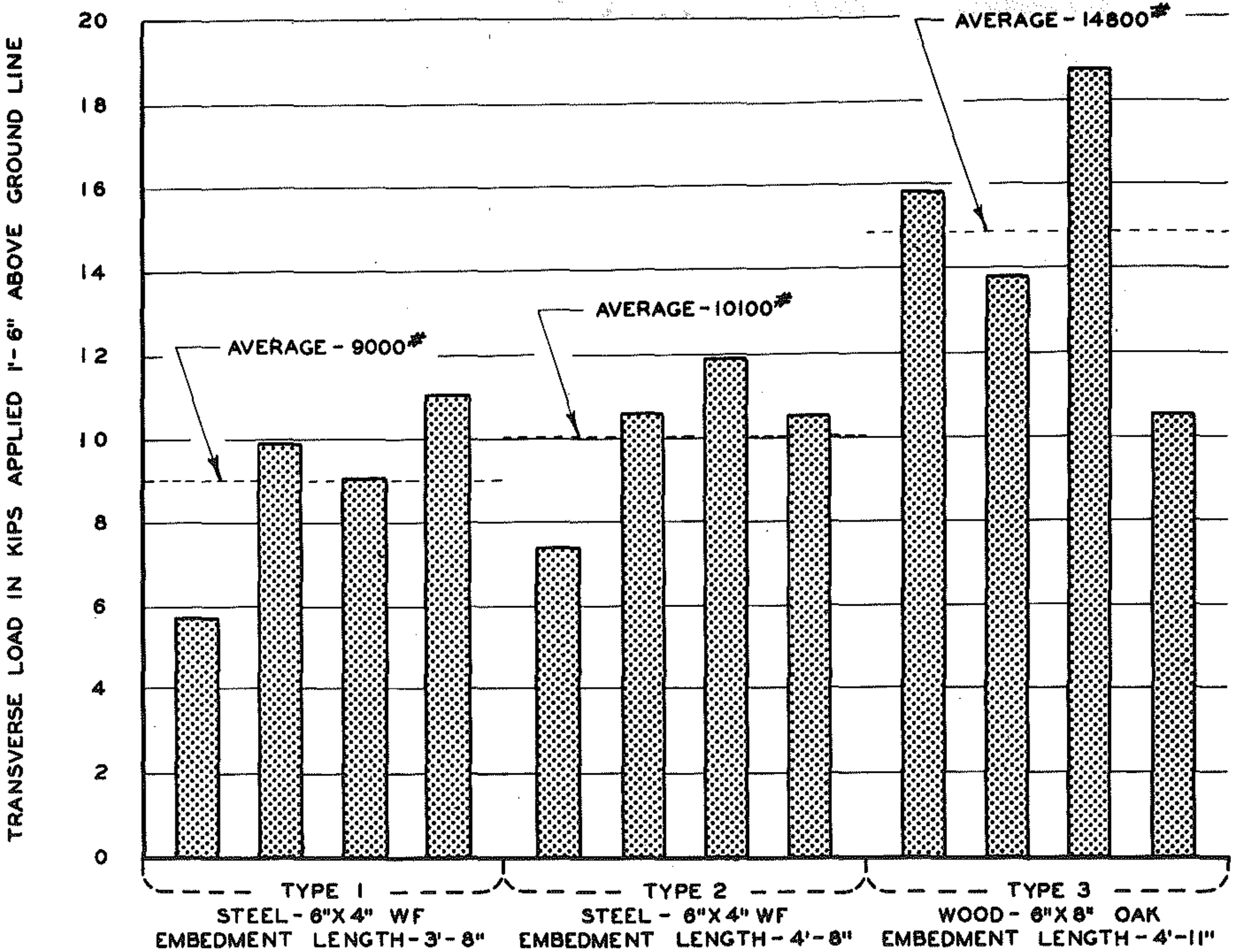

FIGURE 1

MAXIMUM TRANSVERSE LOADS FOR EACH OF THE THREE TYPES OF GUARD POSTS. (GRADUALLY APPLIED LOADS)

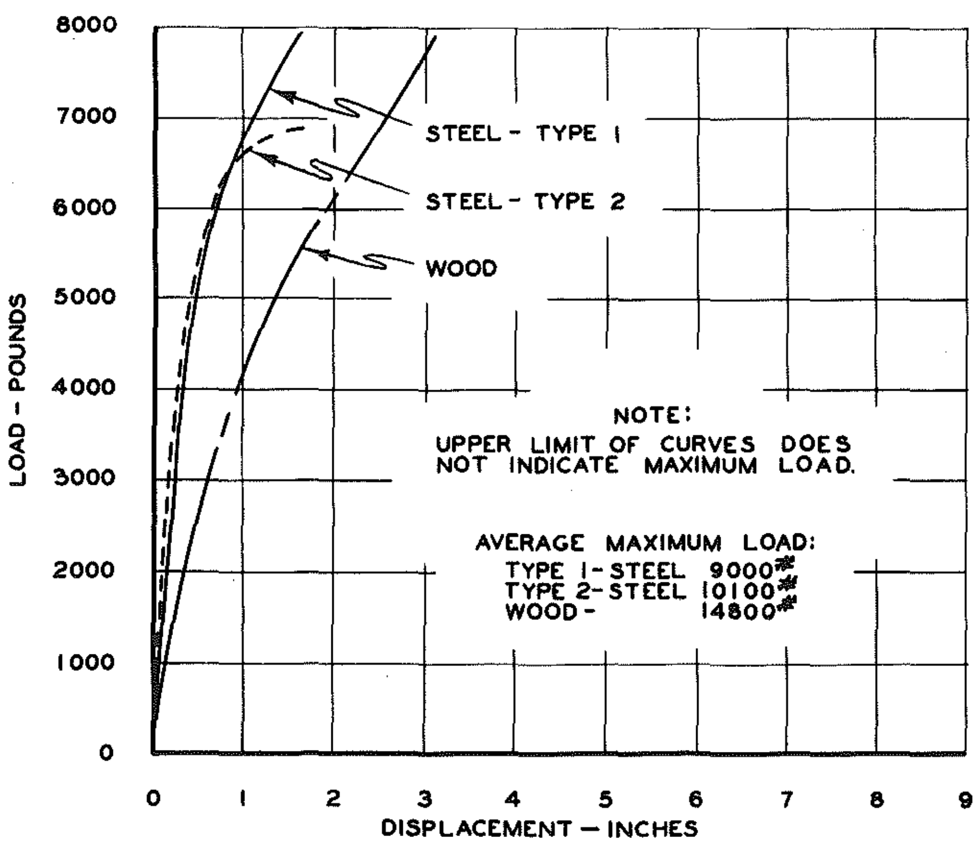

FIGURE 2

AVERAGE DISPLACEMENT OF EACH OF THE THREE TYPES OF GUARD POST.

Figure 3. Picture showing general condition of upper soil layer.

Figure 4. Picture showing typical failure condition of steel post.