

1012

STEEL SAMPLING, 76 STRUCTURES



LAST COPY  
DO NOT REMOVE FROM LIBRARY

MICHIGAN DEPARTMENT OF  
STATE HIGHWAYS AND TRANSPORTATION

**STEEL SAMPLING, 76 STRUCTURES**

**C. J. Arnold**

**Research Laboratory Section  
Testing and Research Division  
Research Project 75 F-146  
Research Report No. R-1018**

**Michigan State Highway Commission  
Peter B. Fletcher, Chairman; Carl V. Pellonpaa,  
Vice-Chairman, Hannes Meyers, Jr., Weston E. Vivian  
John P. Woodford, Director  
Lansing, August 1976**

This report covers the results of physical and chemical evaluations of more than 300 specimens removed from 76 bridges, statewide. The project was initiated by a letter to M. N. Clyde from M. Rothstein, dated July 21, 1975. Subsequently, a list of bridges was furnished to the Research Laboratory by the Design Division.

Samples were removed from the structures by a Testing and Research Division field crew during the winter of 1975-76. Removal was done by sawing, to prevent changes in physical properties due to the removal process. Tensile specimens were prepared and tested in the Laboratory, and chemical analyses were done by the Kawin Co. in Chicago.

Most of the specimens were machined to the standard 0.505-in. diameter tensile bar. In the few cases, where the flange was too thin for the round specimen, flat plate specimens were prepared. A 2-in. gage length was used for all cases. Physical properties from the two types of test bar are comparable.

The specimens were tested for yield and ultimate strength on the 20,000-lb capacity MTS electrohydraulic machine, with automatic printout of the load-strain curve. Since there was a large amount of data, and the load-strain characteristics varied considerably, all yield strength data are reported at 0.2 percent strain for the sake of uniformity. Some specimens exhibited a definite yield point "knee" that is somewhat higher than the value at 0.2 percent strain. The load-strain curves have been retained, so if there are specific sites where design calculations indicate critical or borderline values, the traces can be examined again before making a final determination.

The attached tables show the results of the evaluation to date, and are submitted for use in calculating revised load capacities. Tensile and yield strengths are provided for all locations requested, with the exception of one beam on B02 of 23092, M 99 over the Grand River, where yield and ultimate strength data were lost due to an equipment problem. Since the other three specimens were well above minimum requirements, thickness is the same, and chemistry is quite similar, we can safely assume that the missing yield strength is comparable to the others.

Samples were removed from the outside edges of the flanges, near the ends of the beams. Therefore, the results of the tests are not directly comparable to the usual steel strengths reported by the steel companies, since their samples are removed from the web, as per the ASTM procedure.

Limited experimentation here in the Laboratory has shown that the yield strength may vary by as much as 20 percent with location in the beam, and is lower in the central portion of the flange. Since the flange is the

most highly stressed part of the beam, and may have considerably lower yield strength than that reported by the steel company's tests on the web, it might be well to consider this factor when making overload calculations on structures. While the specimens tested in this experiment were removed from the edge of the flange and may indicate a higher yield strength than would be found near the middle of the flange, the results reported are probably quite comparable to the yield strengths usually reported for new steel. Since most of the specimens exceeded the minimum specified yield strength by several thousand psi, Design staff may wish to consider this factor more closely on those few locations where the indicated yield strengths are marginal.

The scope of this project was expanded slightly from that requested, to provide some very valuable research information related to the impact resistance of the steel from the older structures. Beam samples were made large enough to allow for four Charpy specimens from each sample. Machining of the Charpy impact specimens is not yet complete, so no impact results are included at this time. However, preliminary results on a few structures show impact values of 50 to 150 ft-lb, which is considerably higher than for much of the steel purchased during the past several years. A complete report on the project will be issued when the remaining evaluation is completed. If there are any questions regarding the work done or the results as presented, please call on the author for further details.

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties			
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent
B03 of 27041 M 28 over Presque Isle River 1.6 miles west of Ontonagon County Line	1-1-1	0.12	0.68	0.013	0.031	42,500	59,000	72	46
	1-1-2	0.12	0.68	0.013	0.032	44,500	60,250	63	40
	1-1-3	0.16	0.80	0.018	0.035	46,500	63,000	70	43
	1-1-4	0.14	0.65	0.014	0.035	41,500	59,000	64	44
B02 of 36023 M 69 over Michigamme River 5.8 miles east of Crystal Falls	1-2-1	0.14	0.75	0.013	0.039	44,000	61,500	70	42
	1-2-2	0.14	0.72	0.014	0.041	42,000	55,600	73	42
	1-2-3	0.15	0.73	0.015	0.038	41,700	59,800	69	42
	1-2-4	0.15	0.75	0.012	0.037	44,000	61,000	70	44
X01 of 52061 M 28 over LSSI Railroad 0.7 miles east of US 41	1-3-1	0.26	0.67	0.011	0.026	40,500	69,000	64	40
	1-3-2	0.26	0.66	0.010	0.024	44,400	69,900	63	38
	1-3-3	0.26	0.65	0.011	0.023	44,300	69,200	63	40
	1-3-4	0.26	0.65	0.009	0.026	44,500	69,000	63	40
B01 of 55022 US 2, US 41 over Cedar River 0.6 miles east of Powers	1-4-1	0.15	0.76	0.017	0.030	46,800	61,700	67	40
	1-4-2	0.15	0.72	0.013	0.036	44,000	62,000	67	38
	1-4-3	0.15	0.74	0.014	0.030	41,800	61,200	63	44
	1-4-4	0.15	0.72	0.016	0.035	42,800	61,200	69	42

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
D03 of 27041 M 28 over Prosaque Isla River 1.6 miles west of Ontonagon County Line	1-1-1	East end near abutment, south bottom flange, second beam from north.	0.12	0.68	0.013	0.031	42,500	59,000	72	46
	1-1-2	East end near abutment, north bottom flange, third beam from north.	0.12	0.68	0.013	0.032	44,500	60,250	63	40
	1-1-3	East end near abutment, south bottom flange, third beam from south.	0.16	0.80	0.018	0.035	46,500	63,000	70	43
	1-1-4	East end near abutment, north bottom flange, second beam from south.	0.14	0.65	0.014	0.035	41,500	59,000	64	44
D02 of 36023 M 69 over Michiganme River 5.8 miles east of Crystal Falls	1-2-1	West end near abutment, south bottom flange, second beam from north.	0.14	0.75	0.013	0.039	44,000	61,500	70	42
	1-2-2	West end near abutment, north bottom flange, third beam from north.	0.14	0.72	0.014	0.041	42,000	55,600	73	42
	1-2-3	West end near abutment, south bottom flange, third beam from south.	0.15	0.73	0.015	0.038	41,700	59,800	69	42
	1-2-4	West end near abutment, north bottom flange, second beam from south.	0.15	0.75	0.012	0.037	44,000	61,000	70	44
X01 of 62061 M 28 over LS&I Railroad 0.7 miles east of US 41	1-3-1	East span near abutment, south bottom flange, second beam from north.	0.26	0.67	0.011	0.026	40,500	69,000	64	40
	1-3-2	East span near abutment, north bottom flange, third beam from north.	0.26	0.66	0.010	0.024	44,400	69,900	63	38
	1-3-3	East span near abutment, south bottom flange, third beam from south.	0.26	0.65	0.011	0.023	44,300	69,200	63	40
	1-3-4	East span near abutment, north bottom flange, second beam from south.	0.26	0.65	0.009	0.026	44,500	69,000	63	40
L01 of 55022 US 2, US 41 over Cedar River 0.6 miles east of Powers	1-4-1	Single span near abutment, south bottom flange, second beam from north.	0.15	0.76	0.017	0.030	46,800	61,700	67	40
	1-4-2	Single span near abutment, north bottom flange, third beam from north.	0.15	0.72	0.013	0.036	44,000	62,000	67	38
	1-4-3	Single span near abutment, south bottom flange, third beam from south.	0.15	0.74	0.014	0.030	41,800	61,200	68	44
	1-4-4	Single span near abutment, north bottom flange, second beam from south.	0.15	0.72	0.016	0.035	42,800	61,200	69	42

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B03 of 66022 M 28 over south branch Ontonagon River 4.7 miles west of US 45	1-5-1	West span near abutment, south bottom flange, second beam from north.	0.13	0.55	0.011	0.041	40,100	56,400	63	43
	1-5-2	West span near abutment, north bottom flange, third beam from north.	0.15	0.58	0.022	0.039	42,500	60,700	62	44
	1-5-3	West span near abutment, south bottom flange, third beam from south.	0.13	0.56	0.010	0.045	41,000	55,700	64	44
	1-5-4	West span near abutment, north bottom flange, second beam from south.	0.13	0.54	0.011	0.042	41,600	56,500	63	48
X01 of 02021 M 94 over Soc Line Railroad 5.2 miles southwest of Munising	2-1-1	South span near abutment, east bottom flange, second beam from west.	0.16	0.68	0.010	0.024	42,800	61,700	68	40
	2-1-2	South span near abutment, west bottom flange, third beam from west.	0.16	0.59	0.022	0.032	38,800	59,200	66	40
	2-1-3	South span near abutment, east bottom flange, third beam from east.	0.16	0.67	0.020	0.040	39,300	60,700	68	42
	2-1-4	South span near abutment, west bottom flange, second beam from east.	0.16	0.68	0.014	0.035	37,400	59,100	67	44
B01 of 17043 M 48 over Muniscong River 1.6 miles east of M 129	2-2-1	East end near abutment, south bottom flange, second beam from north.	0.17	0.61	0.012	0.037	44,700	62,300	68	42
	2-2-2	East end near abutment, north bottom flange, third beam from north.	0.20	0.65	0.010	0.032	45,500	63,500	66	43
	2-2-3	East end near abutment, south bottom flange, third beam from south.	0.17	0.64	0.010	0.044	43,500	62,000	66	43
	2-2-4	East end near abutment, north bottom flange, second beam from south.	0.17	0.65	0.009	0.040	46,500	62,500	65	41
B02 of 21024 US 2 over Rapid River 0.4 miles east of US 41	2-3-1	West span near abutment, south bottom flange, second beam from north.	0.16	0.62	0.010	0.022	32,500	54,500	70	44
	2-3-2	West span near abutment, north bottom flange, third beam from north.	0.15	0.61	0.009	0.022	33,000	54,500	72	45
	2-3-3	West span near abutment, south bottom flange, third beam from south.	0.16	0.62	0.011	0.022	33,000	55,000	70	46
	2-3-4	West span near abutment, north bottom flange, second beam from south.	0.15	0.61	0.010	0.025	33,300	55,200	70	46

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B06 of 21024 US 2 over Bull Run Creek 1.3 miles east of Nahama Junction	2-4-1	West end near abutment, south bottom flange, second beam from north.	0.21	0.74	0.009	0.021	40,500	63,000	68	42
	2-4-2	West end near abutment, north bottom flange, third beam from north.	0.20	0.62	0.009	0.025	41,300	61,200	66	42
	2-4-3	West end near abutment, south bottom flange, third beam from south.	0.20	0.62	0.011	0.022	39,000	60,500	66	43
	2-4-4	West end near abutment, north bottom flange, second beam from south.	0.20	0.73	0.009	0.020	41,200	62,800	67	42
B08 of 21024 US 2 over Little Fishdam River 2.0 miles northeast of Isabella	2-5-1	East end near abutment, south bottom flange, second beam from north.	0.19	0.62	0.012	0.026	39,000	62,000	66	41
	2-5-2	East end near abutment, north bottom flange, third beam from north.	0.20	0.63	0.013	0.022	38,000	62,000	68	42
	2-5-3	East end near abutment, south bottom flange, third beam from south.	0.20	0.64	0.014	0.019	38,000	61,500	65	42
	2-5-4	East end near abutment, north bottom flange, second beam from south.	0.19	0.62	0.013	0.019	38,500	62,000	68	44
B02 of 21031 M 35 over Ford River 4.0 miles southwest of Escanaba	2-6-1	West span near abutment, south bottom flange, second beam from north.	0.18	0.55	0.011	0.036	36,500	59,000	66	44
	2-6-2	West span near abutment, north bottom flange, third beam from north.	0.22	0.66	0.028	0.038	42,000	65,500	65	40
	2-6-3	West span near abutment, south bottom flange, third beam from south.	0.18	0.55	0.012	0.033	37,800	57,700	66	42
	2-6-4	West span near abutment, north bottom flange, second beam from south.	0.21	0.64	0.028	0.038	41,800	63,700	64	38
B02 of 21051 US 41 over Rapid River 7.2 miles north of US 2	2-7-1	North end near abutment, east bottom flange, second beam from west.	0.22	0.58	0.013	0.024	37,500	61,500	65	41
	2-7-2	North end near abutment, west bottom flange, third beam from west.	0.22	0.57	0.010	0.024	37,500	61,500	65	42
	2-7-3	North end near abutment, east bottom flange, third beam from east.	0.22	0.58	0.009	0.022	40,000	62,500	62	42
	2-7-4	North end near abutment, west bottom flange, second beam from east.	0.22	0.56	0.010	0.021	38,500	61,500	64	40



Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B02 of 48042 M 28 over west branch Sage River 5.5 miles east of M 123	2-8-1	East end near abutment, south bottom flange, second beam from north.	0.19	0.66	0.014	0.021	40,000	62,500	66	41
	2-8-2	East end near abutment, north bottom flange, third beam from north.	0.18	0.67	0.009	0.020	40,800	62,200	68	44
	2-8-3	East end near abutment, south bottom flange, third beam from south.	0.18	0.68	0.011	0.020	40,000	63,000	66	40
	2-8-4	East end near abutment, north bottom flange, second beam from south.	0.19	0.67	0.012	0.021	43,300	62,700	68	42
X01 of 49021 US 2 over Soo Line Railroad 5.0 miles west of M 117	2-9-1	Span 2 near pier 2, south bottom flange, second beam from north.	0.23	0.60	0.013	0.025	33,500	63,000	64	40
	2-9-2	Span 2 near pier 2, north bottom flange, third beam from north.	0.22	0.65	0.025	0.031	36,300	63,700	62	39
	2-9-3	Span 2 near pier 1, north bottom flange, third beam from south.	0.23	0.60	0.014	0.025	33,800	63,200	68	38
	2-9-4	Span 2 near pier 1, north bottom flange, second beam from south.	0.24	0.60	0.015	0.026	35,100	62,900	63	42
B01 of 05031 M 88 over Intermediate River in Bellaire	3-1-1	North end near abutment, west bottom flange, second beam from east.	0.16	0.61	0.018	0.027	37,500	57,000	67	44
	3-1-2	North end near abutment, east bottom flange, third beam from east.	0.16	0.66	0.013	0.020	37,000	57,500	69	43
	3-1-3	North end near abutment, west bottom flange, third beam from west.	0.16	0.61	0.011	0.032	38,000	56,000	70	45
	3-1-4	North end near abutment, east bottom flange, second beam from west.	0.15	0.61	0.008	0.028	37,500	56,000	69	43
B01 of 18031 US 27 BR over south branch Tobacco River in Clare	3-2-1	North end near abutment, east bottom flange, second beam from west.	0.13	0.67	0.013	0.024	40,100	57,400	66	43
	3-2-2	North end near abutment, west bottom flange, third beam from west.	0.15	0.72	0.010	0.021	42,600	59,900	69	43
	3-2-3	North end near abutment, east bottom flange, third beam from east.	0.15	0.71	0.014	0.020	40,000	59,000	71	42
	3-2-4	North end near abutment, west bottom flange, second beam from east.	0.13	0.66	0.010	0.024	39,500	57,500	69	44

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 51021 M 55 over Manistee River 0.1 miles east of US 31	3-3-1	South span near abutment, east bottom flange, second beam from west.	0.14	0.76	0.023	0.024	44,000	62,000	71	42
	3-3-2	South span near abutment, west bottom flange, third beam from west.	0.14	0.65	0.010	0.020	42,000	59,500	75	44
	3-3-3	South span near abutment, east bottom flange, third beam from east.	0.17	0.82	0.013	0.021	44,300	65,700	72	43
	3-3-4	South span near abutment, west bottom flange, second beam from east.	0.14	0.69	0.011	0.019	42,000	59,500	70	43
B01 of 57022 M 55 over west branch Muskegon River 3.4 miles west of Roscommon County Line	3-4-1	East end near abutment, south bottom flange, second beam from north.	0.16	0.74	0.013	0.018	38,500	59,000	69	43
	3-4-2	East end near abutment, north bottom flange, third beam from north.	0.14	0.78	0.012	0.025	36,300	57,200	70	50
	3-4-3	East end near abutment, south bottom flange, third beam from south.	0.16	0.73	0.011	0.020	38,100	58,900	69	44
	3-4-4	East end near abutment, north bottom flange, second beam from south.	0.16	0.71	0.012	0.021	36,500	59,000	68	43
B02 of 57022 M 55 over Muskegon River 1.8 miles west of Roscommon County Line	3-5-1	West span near abutment, south bottom flange, second beam from north.	0.15	0.70	0.010	0.021	41,800	61,200	70	44
	3-5-2	West span near abutment, north bottom flange, third beam from north.	0.14	0.76	0.012	0.024	40,000	59,000	72	44
	3-5-3	West span near abutment, south bottom flange, third beam from south.	0.14	0.69	0.009	0.027	45,000	61,000	70	42
	3-5-4	West span near abutment, north bottom flange, second beam from south.	0.14	0.69	0.010	0.028	43,000	59,500	72	44
B03 of 67022 US 10 over Muskegon River in Ewart	3-6-1	West span near abutment, south bottom flange, fourth beam from north.	0.14	0.63	0.013	0.024	40,800	59,200	69	44
	3-6-2	West span near abutment, north bottom flange, fifth beam from north.	0.13	0.66	0.013	0.024	43,000	60,000	71	46
	3-6-3	East span near abutment, south bottom flange, fourth beam from south.	0.13	0.66	0.013	0.016	42,000	60,000	68	43
	3-6-4	East span near abutment, south bottom flange, fifth beam from south.	0.14	0.70	0.014	0.018	49,000	64,000	68	40

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 04021 M 32 over south branch Thunder Bay River 4.7 miles east of Montgomery County Line	4-1-1	West end near abutment, south bottom flange, second beam from north.	0.22	0.75	0.022	0.025	39,900	65,500	65	40
	4-1-2	West end near abutment, north bottom flange, third beam from north.	0.22	0.73	0.018	0.028	40,500	66,000	64	40
	4-1-3	West end near abutment, south bottom flange, third beam from south.	0.22	0.76	0.020	0.027	38,700	64,800	62	41
	4-1-4	West end near abutment, north bottom flange, second beam from south.	0.22	0.75	0.023	0.027	41,800	66,700	62	40
B03 of 04021 M 32 over south branch Thunder Bay River 7.3 miles west of Alpena	4-2-1	West end near abutment, south bottom flange, second beam from north.	0.18	0.61	0.021	0.036	37,300	57,700	66	44
	4-2-2	West end near abutment, north bottom flange, third beam from north.	0.19	0.66	0.014	0.037	39,000	60,000	64	42
	4-2-3	West end near abutment, south bottom flange, third beam from south.	0.23	0.76	0.014	0.041	42,000	66,000	64	45
	4-2-4	West end near abutment, north bottom flange, second beam from south.	0.23	0.70	0.018	0.040	40,300	63,700	64	41
S03 of 20016 US 27 northbound under Fletcher Rd 2.4 miles NE of Roscommon County Line	4-3-1	West span near abutment, south bottom flange, second beam from north.	0.22	0.65	0.005	0.023	41,500	64,300	65	41
	4-3-2	West span near abutment, north bottom flange, third beam from north.	0.22	0.63	0.004	0.025	41,000	64,000	64	42
	4-3-3	West span near abutment, north bottom flange, second beam from south.	0.21	0.72	0.003	0.021	43,000	66,000	67	42
S01 of 65041 175 under Greenwood Rd 7.0 miles south of West Branch	4-4-1	Span 3 near pier 2, north bottom flange, second beam from north.	0.20	0.67	0.003	0.019	44,300	63,200	70	44
	4-4-2	Span 3 near pier 2, south bottom flange, third beam from north.	0.19	0.72	0.005	0.018	44,500	64,000	69	39
	4-4-3	Span 3 near pier 2, north bottom flange, second beam from south.	0.18	0.70	0.005	0.018	42,500	63,000	70	42

Sample No.	Location of Sample	Chemical Composition percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 69014 I 75 under Parmater Rd 3.0 miles north of M 32	4-5-1	West span near abutment, south bottom flange, second beam from north.	0.17	0.65	0.006	0.026	39,700	62,300	68	42
	4-5-2	West span near abutment, north bottom flange, third beam from north.	0.21	0.54	0.005	0.020	40,000	63,500	64	41
	4-5-3	West span near abutment, south bottom flange, third beam from south.	0.18	0.65	0.005	0.020	38,000	62,000	67	41
	4-5-4	West span near abutment, north bottom flange, second beam from south.	0.18	0.66	0.007	0.028	39,500	62,000	66	44
B01 of 19031 US 27 over Looking Glass River 5.3 miles north of Ingham County Line	5-1-1	North end near abutment, west bottom flange, third beam from east.	0.18	0.56	0.005	0.025	44,200	60,800	70	36
	5-1-2	North end near abutment, east bottom flange, fourth beam from east.	0.17	0.56	0.011	0.025	43,500	60,500	68	44
	5-1-3	North end near abutment, west bottom flange, fourth beam from west.	0.17	0.58	0.007	0.022	43,000	60,500	68	42
	5-1-4	North end near abutment, east bottom flange, third beam from west.	0.17	0.56	0.005	0.026	40,500	60,500	70	44
B04 of 34062 M 21 over Stoney Creek 1.5 miles east of Muir	5-2-1	West end near abutment, south bottom flange, second beam from north.	0.18	0.66	0.012	0.031	39,800	58,200	65	45
	5-2-2	West end near abutment, north bottom flange, third beam from north.	0.20	0.68	0.009	0.042	40,000	61,500	65	42
	5-2-3	West end near abutment, south bottom flange, third beam from south.	0.18	0.65	0.008	0.034	37,500	59,000	66	42
	5-2-4	West end near abutment, north bottom flange, second beam from south.	0.17	0.63	0.007	0.033	41,500	58,500	67	42
B03 of 34062 M 21 over Maple River 1.0 miles east of Muir	5-3-1	West end near abutment, south bottom flange, second beam from north.	0.21	0.68	0.018	0.045	41,400	61,600	63	40
	5-3-2	West end near abutment, north bottom flange, third beam from north.	0.22	0.71	0.036	0.050	40,800	58,700	63	41
	5-3-3	West end near abutment, south bottom flange, third beam from south.	0.23	0.73	0.036	0.050	43,000	67,000	64	38
	5-3-4	West end near abutment, north bottom flange, second beam from south.	0.19	0.63	0.022	0.044	40,800	62,200	65	41

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
D01 of 34062 M 21 over Prairie Creek 2.6 miles east of M 66	5-4-1	West end near abutment, south bottom flange, second beam from north.	0.21	0.71	0.010	0.030	40,000	62,000	70	42
	5-4-2	West end near abutment, north bottom flange, third beam from north.	0.20	0.65	0.008	0.026	42,500	63,000	66	44
	5-4-3	East end near abutment, south bottom flange, third beam from south.	0.20	0.70	0.011	0.023	41,000	63,000	66	43
	5-4-4	East end near abutment, north bottom flange, second beam from south.	0.20	0.65	0.007	0.027	42,000	62,500	66	42
X01 of 41061 M 11 over C&O Railroad and M 21 BR in Gramville	5-5-1	Span 3 near pier 3, south bottom flange, second beam from north.	0.24	0.60	0.014	0.025	41,500	69,000	60	38
	5-5-2	Span 3 near pier 3, north bottom flange, third beam from north.	0.25	0.60	0.016	0.029	40,500	69,000	59	39
	5-5-3	Span 3 near pier 3, south bottom flange, third beam from south.	0.17	0.55	0.013	0.018	41,500	60,500	59	34
	5-5-4	Span 3 near pier 3, north bottom flange, second beam from south.	0.18	0.55	0.017	0.015	42,000	61,500	64	32
B02 of 62031 M 37 over White River 0.3 miles south of White Cloud	5-6-1	North end near abutment, east bottom flange, second beam from west.	0.17	0.62	0.030	0.042	36,000	57,500	67	44
	5-6-2	North end near abutment, west bottom flange, third beam from west.	0.18	0.64	0.035	0.046	36,200	59,800	68	40
	5-6-3	North end near abutment, east bottom flange, third beam from east.	0.17	0.63	0.032	0.046	37,500	59,000	68	44
	5-6-4	North end near abutment, west bottom flange, second beam from east.	0.17	0.63	0.031	0.046	34,000	57,000	68	41
B03 of 70041 M 45 over Sand Creek 2.7 miles west of Kont County Line	5-7-1	West end near abutment, north bottom flange, second beam from north.	0.14	0.61	0.012	0.037	36,500	55,500	72	46
	5-7-2	West end near abutment, south bottom flange, third beam from north.	0.17	0.79	0.018	0.050	48,300	66,700	69	37
	5-7-3	West end near abutment, north bottom flange, third beam from south.	0.14	0.62	0.012	0.044	39,000	57,500	70	45
	5-7-4	West end near abutment, south bottom flange, second beam from south.	0.13	0.62	0.011	0.035	40,500	55,500	72	46

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 70064 I 90 under old US 16 2.5 miles southeast of Muskegon County Line	5-8-1	Span 2 near pier 1, south bottom flange, second beam from north.	0.26	0.47	0.014	0.029	47,800	68,500	56	28
	5-8-2	Span 2 near pier 1, north bottom flange, third beam from north.	0.26	0.48	0.010	0.024	37,900	66,200	54	32
	5-8-3	Span 2 near pier 1, south bottom flange, third beam from south.	0.26	0.46	0.012	0.027	38,400	65,800	54	36
	5-8-4	Span 2 near pier 1, north bottom flange, second beam from south.	0.28	0.46	0.013	0.025	46,400	66,800	54	35
B01 of 06072 US 28 over north branch Pine River 1.8 miles northeast of Standish	6-1-1	Single span near abutment, south bottom flange, second beam from north.	0.22	0.58	0.009	0.041	35,500	60,500	61	41
	6-1-2	Single span near abutment, north bottom flange, third beam from north.	0.22	0.57	0.012	0.039	36,500	60,000	64	42
	6-1-3	Single span near abutment, south bottom flange, third beam from south.	0.20	0.53	0.010	0.038	34,500	58,000	65	42
	6-1-4	Single span near abutment, north bottom flange, second beam from south.	0.21	0.58	0.012	0.040	40,500	60,000	64	40
B01 of 09011 M 84 over Dutch Creek 5.7 miles southwest of Bay City P.O.	6-2-1	South end near abutment, east bottom flange, second beam from west.	0.18	0.86	0.016	0.045	46,500	64,000	69	42
	6-2-2	South end near abutment, west bottom flange, third beam from west.	0.16	0.83	0.016	0.044	43,800	63,200	69	42
	6-2-3	South end near abutment, east bottom flange, third beam from east.	0.12	0.56	0.010	0.041	49,500	64,000	66	41
	6-2-4	South end near abutment, west bottom flange, second beam from east.	0.17	0.85	0.016	0.045	45,300	64,200	69	40

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B02 of 09032 M 84, M 13 over west channel Saginaw River in Bay City	6-3-1C	Span 2 near pier 1, north bottom cover plate, second girder from north.	0.24	0.53	0.008	0.030	40,300	65,500	55	37
	6-3-2C	Span 2 near pier 1, north bottom cover plate, third girder from north.	0.24	0.52	0.007	0.028	42,100	64,800	59	37
	6-3-3C	Span 2 near pier 1, north bottom cover plate, third girder from south.	0.24	0.53	0.008	0.029	40,500	64,500	60	38
	6-3-4C	Span 2 near pier 1, north bottom cover plate, second girder from south.	0.24	0.53	0.007	0.030	41,000	64,800	57	36
	6-3-1F	Span 2 10 ft from pier 1, north bottom flange, second girder from north.	0.24	0.57	0.026	0.037	40,100	64,400	58	40
	6-3-2F	Span 2 10 ft from pier 1, north bottom flange, third girder from north.	0.23	0.58	0.026	0.034	39,000	63,700	59	38
	6-3-3F	Span 2 10 ft from pier 1, north bottom flange, third girder from south.	0.25	0.57	0.026	0.039	39,400	64,800	58	41
	6-3-4F	Span 2 10 ft from pier 1, north bottom flange, second girder from south.	0.23	0.59	0.026	0.036	39,700	64,000	58	37
B01 of 09033 M 13 over Kawkawlin River in Kawkawlin	6-4-1	Span 2 near north abutment, east bottom flange, second beam from west.	0.17	0.62	0.014	0.030	39,500	61,500	65	38
	6-4-2	Span 2 near north abutment, west bottom flange, third beam from west.	0.17	0.56	0.011	0.034	41,300	60,700	67	42
	6-4-3	Span 2 near north abutment, east bottom flange, third beam from east.	0.16	0.55	0.014	0.034	43,500	61,500	66	34
	6-4-4	Span 2 near north abutment, west bottom flange, second beam from east.	0.15	0.67	0.016	0.032	42,000	60,000	67	44
B01 of 25011 M 13 over Mistoquay Creek 2.3 miles north of M 21	6-5-1	Single span near abutment, east bottom flange, second beam from west.	0.19	0.70	0.026	0.031	37,500	61,000	64	42
	6-5-2	Single span near abutment, west bottom flange, third beam from west.	0.23	0.78	0.014	0.025	41,500	64,000	66	39
	6-5-3	Single span near abutment, east bottom flange, third beam from east.	0.22	0.71	0.011	0.024	40,500	64,000	66	41
	6-5-4	Single span near abutment, west bottom flange, second beam from east.	0.22	0.74	0.011	0.026	42,000	64,500	65	41

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
S02 of 25031 US 23 under Lahrng Rd 1.6 miles north of Penon	6-6-1	West span near abutment, south bottom flange, second beam from north.	0.20	0.67	0.020	0.032	45,000	66,000	65	40
	6-6-2	West span near abutment, north bottom flange, third beam from north.	0.20	0.67	0.016	0.034	44,000	65,000	65	40
	6-6-3	West span near abutment, south bottom flange, third beam from south.	0.21	0.64	0.014	0.025	42,000	66,000	66	42
	6-6-4	West span near abutment, north bottom flange, second beam from south.	0.21	0.63	0.014	0.027	43,500	66,500	66	42
B04 of 73051 M 13 over Flint River 7.2 miles south of M 46	6-7-1	South span near abutment, east bottom flange, second beam from west.	0.22	0.58	0.014	0.025	38,300	61,700	65	43
	6-7-2	South span near abutment, west bottom flange, third beam from west.	0.22	0.57	0.014	0.024	37,500	62,000	66	44
	6-7-3	South span near abutment, east bottom flange, third beam from east.	0.21	0.56	0.016	0.020	40,000	61,500	67	40
	6-7-4	South span near abutment, west bottom flange, second beam from east.	0.21	0.57	0.013	0.024	40,500	62,500	65	42
B05 of 73051 M 13 over Birch Run outlet drain 7.1 miles south of M 46	6-8-1	Span 2 near pier 1, east bottom flange, second beam from west.	0.23	0.56	0.014	0.029	39,100	63,900	64	42
	6-8-2	Span 2 near pier 1, west bottom flange, third beam from west.	0.22	0.55	0.011	0.026	42,000	64,000	63	40
	6-8-3	Span 2 near pier 1, east bottom flange, third beam from east.	0.23	0.55	0.013	0.022	40,500	64,500	60	39
	6-8-4	Span 2 near pier 1, west bottom flange, second beam from east.	0.23	0.55	0.016	0.033	40,600	64,900	63	40
S02 of 73111 I 75, US 10, US 23 under King Rd 2.6 miles southeast of M 46	6-9-1	Span 2 near pier 1, south bottom flange, second beam from north.	0.21	0.68	0.008	0.023	59,700	73,100	63	34
	6-9-2	Span 2 near pier 1, south bottom flange, third beam from north.	0.21	0.62	0.008	0.020	43,100	64,400	67	39
	6-9-3	Span 2 near pier 1, south bottom flange, third beam from south.	0.22	0.60	0.008	0.022	42,000	64,000	66	42
	6-9-4	Span 2 near pier 1, south bottom flange, second beam from south.	0.21	0.57	0.008	0.022	43,000	63,500	67	42



Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
S03 of 73111 175, US 10, US 23 under Mess Rd 0.8 miles south of M 46	6-10-1	Span 2 near pier 1, south bottom flange, second beam from north.	0.19	0.67	0.016	0.025	46,300	63,200	66	41
	6-10-2	Span 2 near pier 1, north bottom flange, third beam from north.	0.21	0.69	0.015	0.027	41,000	63,500	68	42
	6-10-3	Span 2 near pier 1, south bottom flange, third beam from south.	0.20	0.69	0.015	0.026	43,000	63,000	66	42
	6-10-4	Span 2 near pier 1, north bottom flange, second beam from south.	0.19	0.68	0.013	0.026	40,200	62,300	66	44
B03 of 73131 M 63 over Cheyboyganing Crook 0.1 miles south of M 15	6-11-1	South end near abutment, east bottom flange, second beam from west.	0.18	0.68	0.014	0.020	48,700	64,300	71	44
	6-11-2	South end near abutment, west bottom flange, third beam from west.	0.19	0.70	0.016	0.018	46,500	65,500	66	40
	6-11-3	South end near abutment, east bottom flange, third beam from east.	0.19	0.69	0.010	0.022	52,000	65,500	68	42
	6-11-4	South end near abutment, west bottom flange, second beam from east.	0.18	0.68	0.013	0.020	48,800	64,200	63	41
S08 of 76023 1 69 under Durant Rd 0.8 miles northeast of M 71	6-12-1	Span 2 near south expansion hinge, east bottom flange, second beam from west.	0.28	0.67	0.010	0.023	37,800	67,700	61	40
	6-12-2	Span 2 near south expansion hinge, east bottom flange, third beam from west.	0.27	0.75	0.009	0.022	41,000	68,500	63	39
	6-12-3	Span 2 near south expansion hinge, east bottom flange, third beam from east.	0.28	0.66	0.008	0.025	42,000	67,000	62	41
	6-12-4	Span 2 near south expansion hinge, east bottom flange, second beam from east.	0.28	0.67	0.008	0.027	40,500	67,500	62	40
E02 of 76041 M 71 over Shiwassee River 2.3 miles northwest of I 69	6-13-1	East span near abutment, south bottom flange, second beam from north.	0.22	0.66	0.008	0.020	40,000	62,500	67	42
	6-13-2	East span near abutment, north bottom flange, third beam from north.	0.26	1.10	0.014	0.020	44,000	75,500	68	35
	6-13-3	East span near abutment, south bottom flange, third beam from south.	0.20	0.75	0.036	0.017	41,500	66,000	66	40
	6-13-4	East span near abutment, north bottom flange, second beam from south.	0.25	1.11	0.018	0.018	46,800	74,400	67	40

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 09032 M 84, M 13 over east channel Saginaw River in Bay City	6-14-1	Third floor beam north end, east flange.	0.15	0.60	0.010	0.016	45,500	60,500	68	43
	6-14-2	West end of east span, south flange, second beam from north.	0.22	0.50	0.014	0.019	38,500	60,500	61	38
	6-14-3	East end of east span, north flange, second beam from north.	0.20	0.50	0.016	0.017	37,800	62,200	62	40
	6-14-4	East end of east span, north flange, second beam from south.	0.22	0.49	0.013	0.018	35,600	61,900	62	38
	6-14-5	West end of east span, south flange, second beam from south.	0.19	0.50	0.013	0.017	37,500	60,000	65	36
	6-14-6	Third floor beam south end, west flange.	0.16	0.58	0.016	0.016	41,200	59,400	70	42
S02 of 03034 I 196, US 31 under 130th Ave in Douglas	7-1-1	West end near abutment, south bottom flange, second beam from north.	0.23	0.61	0.010	0.024	40,000	65,500	64	40
	7-1-2	West end near abutment, north bottom flange, third beam from north.	0.22	0.60	0.013	0.022	42,500	65,500	64	40
	7-1-3	West end near abutment, south bottom flange, third beam from south.	0.24	0.62	0.012	0.025	42,000	65,500	64	38
	7-1-4	West end near abutment, north bottom flange, second beam from south.	0.24	0.63	0.013	0.020	41,500	65,500	64	41
S03 of 11015 I 94 under Kruger Rd 1.1 miles south of Union Pier	7-2-1	East end near abutment, south bottom flange, second beam from north.	0.23	0.70	0.015	0.027	46,000	72,000	61	38
	7-2-2	East end near abutment, north bottom flange, third beam from north.	0.22	0.66	0.013	0.028	41,300	64,700	65	41
	7-2-3	East end near abutment, south bottom flange, third beam from south.	0.23	0.66	0.016	0.022	40,000	65,000	65	41
	7-2-4	East end near abutment, north bottom flange, second beam from south.	0.22	0.67	0.015	0.024	40,800	65,200	64	41

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
S05 of 11015 I 94 under Lakeside Rd 1.3 miles south of Lakeside	7-3-1	South end near abutment, west bottom flange, second beam from east.	0.22	0.68	0.020	0.027	42,800	68,300	64	36
	7-3-2	South end near abutment, east bottom flange, third beam from east.	0.22	0.61	0.004	0.020	42,000	65,500	65	41
	7-3-3	South end near abutment, west bottom flange, third beam from west.	0.22	0.68	0.004	0.021	41,500	66,800	65	41
	7-3-4	South end near abutment, east bottom flange, second beam from west.	0.22	0.63	0.003	0.017	41,500	65,500	63	41
S06 of 11015 I 94 under Warren Woods Rd 1.0 miles southeast of Lakeside	7-4-1	East end near abutment, south bottom flange, second beam from north.	0.24	0.64	0.003	0.023	41,000	66,000	64	40
	7-4-2	East end near abutment, north bottom flange, third beam from north.	0.22	0.64	0.009	0.027	42,000	66,000	63	40
	7-4-3	East end near abutment, south bottom flange, third beam from south.	0.26	0.65	0.008	0.023	42,500	66,500	65	41
	7-4-4	East end near abutment, north bottom flange, second beam from south.	0.24	0.63	0.003	0.024	39,500	64,500	64	42
S05 of 11111 I 196 under Riverside Rd 0.5 miles north of Riverside	7-5-1	West end near abutment, south bottom flange, second beam from north.	0.26	0.68	0.003	0.021	42,100	69,000	63	36
	7-5-2	West end near abutment, north bottom flange, third beam from north.	0.21	0.66	0.003	0.021	42,000	63,000	66	42
	7-5-3	West end near abutment, south bottom flange, third beam from south.	0.27	0.66	0.003	0.026	39,000	67,000	61	36
	7-5-4	West end near abutment, north bottom flange, second beam from south.	0.26	0.67	0.003	0.028	40,000	68,000	62	35
B02 of 03023 M 89 over Schnable River 4.8 miles northwest of Otsago	7-6-1	East end near abutment, south bottom flange, second beam from north.	0.13	0.53	0.003	0.034	41,500	57,500	69	45
	7-6-2	East end near abutment, north bottom flange, third beam from north.	0.13	0.52	0.003	0.030	44,000	58,000	71	44
	7-6-3	East end near abutment, south bottom flange, third beam from south.	0.13	0.68	0.003	0.034	44,500	60,000	71	46
	7-6-4	East end near abutment, north bottom flange, second beam from south.	0.13	0.50	0.003	0.031	40,000	58,500	65	44

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B03 of 03072 M 40 over south Branch Creek 4.0 miles southeast of Ottawa County Line	7-7-1	East end near abutment, north bottom flange, second beam from south.	0.20	0.49	0.005	0.032	38,500	59,000	66	42
	7-7-2	East end near abutment, south bottom flange, third beam from south.	0.19	0.46	0.004	0.030	36,000	59,000	64	40
	7-7-3	East end near abutment, north bottom flange, third beam from north.	0.21	0.53	0.002	0.035	40,000	60,500	67	44
	7-7-4	East end near abutment, south bottom flange, second beam from north.	0.19	0.46	0.003	0.035	36,000	59,000	64	43
B04 of 03072 M 40 over north Branch Creek 2.4 miles southeast of Ottawa County Line	7-8-1	East end near abutment, south bottom flange, second beam from north.	0.20	0.58	0.002	0.037	40,000	59,500	66	42
	7-8-2	East end near abutment, north bottom flange, third beam from north.	0.19	0.46	0.005	0.036	36,500	59,500	64	39
	7-8-3	East end near abutment, south bottom flange, third beam from south.	0.20	0.47	0.005	0.028	36,500	59,500	64	36
	7-8-4	East end near abutment, north bottom flange, second beam from south.	0.19	0.46	0.002	0.033	35,500	58,000	64	42
S11 of 11015 I 94 under Browntown Rd 2.6 miles south of Bridgman	7-9-1	West span near pier 2, south bottom flange, second beam from north.	0.23	0.78	0.016	0.023	42,500	69,500	65	40
	7-9-2	West span near pier 2, north bottom flange, third beam from north.	0.24	0.80	0.013	0.025	42,600	70,300	63	34
	7-9-3	West span near pier 2, south bottom flange, third beam from south.	0.23	0.81	0.013	0.024	42,300	68,700	65	40
	7-9-4	West span near pier 2, north bottom flange, second beam from south.	0.24	0.80	0.016	0.022	42,000	68,000	64	36
B01 of 13031 M 66 over Nottawascope River in Athens	7-10-1	North end near abutment, east bottom flange, second beam from west.	0.21	0.63	0.028	0.054	38,300	62,900	62	40
	7-10-2	North end near abutment, west bottom flange, third beam from west.	0.20	0.71	0.022	0.032	40,000	64,500	68	42
	7-10-3	North end near abutment, east bottom flange, third beam from east.	0.21	0.69	0.017	0.032	40,800	65,700	65	42
	7-10-4	North end near abutment, west bottom flange, second beam from east.	0.22	0.71	0.022	0.030	39,100	63,900	65	44

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
S03 of 13074 I 69 under "N" Drive north 3.8 miles north of I 94	7-11-1	Span 3 near pier 2, south bottom flange, second beam from north.	0.18	0.32	0.008	0.022	38,000	62,000	68	43
	7-11-2	Span 3 near pier 2, north bottom flange, third beam from north.	0.18	0.34	0.007	0.022	37,800	61,700	67	40
	7-11-3	Span 3 near pier 2, north bottom flange, second beam from south.	0.18	0.32	0.008	0.022	36,000	61,000	69	42
B01 of 13092 M 99 over Kalamazoo River south limits of Albion	7-12-1	North end near abutment, west bottom flange, second beam from east.	0.24	0.60	0.028	0.027	41,500	67,500	63	39
	7-12-2	North end near abutment, east bottom flange, third beam from east.	0.23	0.59	0.025	0.024	41,700	69,300	61	39
	7-12-3	North end near abutment, west bottom flange, third beam from west.	0.24	0.59	0.024	0.024	39,500	68,000	62	38
	7-12-4	North end near abutment, east bottom flange, second beam from west.	0.24	0.58	0.031	0.024	38,800	68,200	60	40
B05 of 78042 M 60 and M 66 over Notkawa Creek 1.2 miles east of junction M 66	7-13-1	West end near abutment, south bottom flange, second beam from north.	0.21	0.57	0.009	0.033	36,000	59,000	65	44
	7-13-2	West end near abutment, north bottom flange, third beam from north.	0.18	0.63	0.011	0.027	35,000	57,500	68	44
	7-13-3	West end near abutment, south bottom flange, third beam from south.	0.17	0.65	0.007	0.027	36,300	57,800	68	46
	7-13-4	West end near abutment, north bottom flange, second beam from south.	0.24	0.62	0.009	0.024	38,300	61,800	63	36
B01 of 78052 M 66 over Prairie River 2.1 miles south of south junction M 86	7-14-1	South end near abutment, east bottom flange, second beam from west.	0.19	0.64	0.021	0.027	39,500	59,000	67	43
	7-14-2	South end near abutment, west bottom flange, third beam from west.	0.19	0.65	0.017	0.044	49,500	59,500	67	44
	7-14-3	South end near abutment, east bottom flange, third beam from east.	0.20	0.68	0.026	0.033	37,800	60,200	66	42
	7-14-4	South end near abutment, west bottom flange, second beam from east.	0.18	0.66	0.018	0.033	41,300	58,700	66	44

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B02 of 78061 M 86 over Prairie River 5.4 miles southeast of M 60	7-15-1	West end near abutment, south bottom flange, second beam from north.	0.15	0.74	0.052	0.046	45,700	63,100	64	42
	7-15-2	West end near abutment, north bottom flange, third beam from north.	0.17	0.75	0.056	0.054	44,000	63,300	65	42
	7-15-3	West end near abutment, south bottom flange, third beam from south.	0.15	0.72	0.056	0.051	47,400	64,500	62	42
	7-15-4	West end near abutment, north bottom flange, second beam from south.	0.16	0.73	0.052	0.046	44,900	63,700	65	42
B01 of 78081 M 216 over Flowerfield Creek 1.0 miles west of US 131	7-16-1	Single span near abutment, south bottom flange, second beam from north.	0.20	0.57	0.004	0.033	45,800	63,000	62	38
	7-16-2	Single span near abutment, south bottom flange, third beam from north.	0.20	0.60	0.020	0.034	50,000	65,600	59	38
	7-16-3	Single span near abutment, south bottom flange, third beam from south.	0.13	0.61	0.023	0.042	48,100	62,100	62	36
	7-16-4	Single span near abutment, south bottom flange, second beam from south.	0.20	0.56	0.015	0.038	45,600	64,100	56	40
S07 of 47065 I 96 under Chilson Rd 3.0 miles southeast of M 155	8-1-1	South end near abutment, west bottom flange, second beam from east.	0.23	0.61	0.011	0.024	40,300	65,200	63	42
	8-1-2	South end near abutment, west bottom flange, third beam from east.	0.25	0.64	0.012	0.023	40,500	65,500	65	40
	8-1-3	South end near abutment, east bottom flange, third beam from west.	0.23	0.61	0.009	0.023	39,300	65,200	61	42
	8-1-4	South end near abutment, east bottom flange, second beam from west.	0.25	0.71	0.010	0.025	46,300	68,200	64	36
S05 of 47013 US 23 southbound under Grand River Ave 0.5 miles south of I 96	8-2-1	East end near abutment, south bottom flange, second beam from north.	0.19	0.65	0.009	0.025	40,500	61,000	68	42
	8-2-2	East end near abutment, north bottom flange, third beam from north.	0.26	0.64	0.010	0.031	41,300	66,700	62	36
	8-2-3	East end near abutment, south bottom flange, third beam from south.	0.26	0.65	0.013	0.022	42,000	67,000	64	41
	8-2-4	East end near abutment, north bottom flange, second beam from south.	0.18	0.64	0.008	0.026	40,300	61,200	65	44

	Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties			
			C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent
B02 of 23052 M 50 over Thorapple River 9.5 miles northwest of Charlotte	8-3-1	West end near abutment, south bottom flange, second beam from north.	0.16	0.56	0.012	0.027	36,500	56,500	67	43
	8-3-2	West end near abutment, north bottom flange, third beam from north.	0.16	0.53	0.011	0.024	34,500	54,000	69	44
	8-3-3	East end near abutment, south bottom flange, third beam from south.	0.16	0.54	0.014	0.029	37,000	56,000	68	43
	8-3-4	East end near abutment, north bottom flange, second beam from south.	0.16	0.54	0.013	0.026	36,000	56,500	68	46
B02 of 23092 M 99 over Grand River 2.2 miles southwest and south of Ingham County Line	8-4-1	North end near abutment, east bottom flange, second beam from west.	0.18	0.65	0.015	0.047	39,500	59,000	66	43
	8-4-2	North end near abutment, west bottom flange, third beam from west.	0.20	0.85	0.036	0.044	42,500	67,000	62	38
	8-4-3	North end near abutment, east bottom flange, third beam from east.	0.18	0.64	0.015	0.046	39,000	59,000	67	42
	8-4-4	North end near abutment, west bottom flange, second beam from east.	0.16	0.80	0.019	0.045	N/A	N/A	64	44
B02 of 38071 M 50, US 27 BR over Grand River 3.0 miles southeast of Jackson	8-5-1	North end near abutment, east bottom flange, second beam from west.	0.11	0.61	0.020	0.043	42,800	57,700	70	44
	8-5-2	North end near abutment, west bottom flange, third beam from west.	0.11	0.62	0.019	0.041	42,000	58,000	69	44
	8-5-3	North end near abutment, east bottom flange, third beam from east.	0.14	0.70	0.017	0.034	42,000	62,000	69	41
	8-5-4	North end near abutment, west bottom flange, second beam from east.	0.15	0.70	0.015	0.030	41,000	61,500	69	42
S06 of 47013 US 23 northbound under Grand River Ave 0.5 miles south of I 90	8-6-1	Span 2 near pier 1, south bottom flange, second beam from north.	0.19	0.68	0.010	0.033	50,500	68,000	69	40
	8-6-2	Span 2 near pier 1, north bottom flange, third beam from north.	0.23	0.72	0.011	0.026	43,000	68,500	65	39
	8-6-3	Span 2 near pier 1, south bottom flange, third beam from south.	0.23	0.73	0.011	0.026	44,800	65,700	68	40
	8-6-4	Span 2 near pier 1, north bottom flange, second beam from south.	0.20	0.65	0.009	0.029	44,000	69,000	64	39

Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties				
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent	
B01 of 58033 US 23 under Milwaukee Rd 3.7 miles north of M 50	8-7-1	Span 2 near pier 1, south bottom flange, second beam from north.	0.19	0.64	0.010	0.025	47,800	65,200	65	42
	8-7-2	Span 2 near pier 1, north bottom flange, third beam from north.	0.20	0.63	0.011	0.025	45,000	65,500	69	42
	8-7-3	Span 2 near pier 1, south bottom flange, third beam from south.	0.19	0.61	0.010	0.024	44,800	65,200	67	44
	8-7-4	Span 2 near pier 1, north bottom flange, second beam from south.	0.18	0.60	0.008	0.021	49,000	65,000	68	43
B03 of 47061 I 96 BL over south branch Shiawassee River 1.9 miles west of Howell	8-8-1	South end near abutment, west bottom flange, second beam from east.	0.19	0.71	0.034	0.031	39,500	63,500	65	42
	8-8-2	South end near abutment, east bottom flange, third beam from east.	0.15	0.52	0.031	0.021	42,300	59,200	70	44
	8-8-3	South end near abutment, west bottom flange, third beam from west.	0.14	0.55	0.027	0.018	36,300	57,200	69	44
	8-8-4	South end near abutment, east bottom flange, second beam from west.	0.18	0.73	0.029	0.020	38,000	61,000	68	43
B07 of 63022 I 96 under Novi Rd in Novi	9-1-1	North end near abutment, east bottom flange, second beam from west.	0.26	0.69	0.010	0.026	41,800	66,200	63	41
	9-1-2	North end near abutment, west bottom flange, third beam from west.	0.25	0.70	0.012	0.025	40,500	66,000	62	39
	9-1-3	North end near abutment east bottom flange, third beam from east.	0.25	0.71	0.005	0.016	42,100	66,300	65	40
	9-1-4	North end near abutment, west bottom flange, second beam from east.	0.26	0.70	0.009	0.021	40,100	66,000	64	40
B01 of 82141 M 102 casbound over Rouge River 0.1 miles west of US 24	9-2-1	West end near abutment, north bottom flange, third beam from south.	0.17	0.61	0.029	0.038	36,900	58,500	64	44
	9-2-2	West end near abutment, south bottom flange, fourth beam from south.	0.18	0.59	0.024	0.035	44,100	68,600	55	39
	9-2-3	West end near abutment, north bottom flange, fourth beam from north.	0.18	0.60	0.025	0.041	37,700	61,200	58	40
	9-2-4	West end near abutment, south bottom flange, third beam from north.	0.17	0.59	0.024	0.037	37,400	61,000	60	40



Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties			
		C	Mn	P	S	Yield Strength, psi	Ultimate Strength, psi	Reduction of Area, percent	Elongation, percent
B02 of 82141 M 102 westbound over Rouge River 0.1 miles west of US 24	9-3-1	0.17	0.58	0.017	0.024	35,200	57,400	63	40
	9-3-2	0.17	0.59	0.024	0.036	37,400	58,300	63	43
	9-3-3	0.14	0.56	0.016	0.022	33,400	51,600	67	42
	9-3-4	0.24	0.51	0.023	0.040	37,800	61,500	59	36
B01 of 77011 M 19 over Belle River 0.3 miles north of Macomb County Line	9-4-1	0.21	0.48	0.016	0.026	40,900	62,400	57	41
	9-4-2	0.20	0.47	0.017	0.027	39,800	62,200	59	42
	9-4-3	0.20	0.46	0.015	0.023	40,700	62,900	59	42
	9-4-4	0.22	0.50	0.019	0.022	40,200	64,700	56	40
B01 of 77052 M 29 over Belle River in Marine City	9-5-1	0.23	0.60	0.020	0.033	42,400	65,100	57	41
	9-5-2	0.24	0.59	0.023	0.033	43,300	66,100	58	40
	9-5-3	0.24	0.66	0.049	0.034	45,600	70,600	56	40
	9-5-4	0.24	0.67	0.046	0.033	44,100	69,900	60	40

ASTM Designation	Properties					
	Mechanical		Chemical Composition, percent			
	Tensile Strength, psi	Yield Strength, psi	C Maximum	Mn	P Maximum	S Maximum
A7-33T	60,000 to 72,000	33,000	—	—	0.04	0.05
A-36	58,000 to 80,000	36,000	0.26	—	0.04	0.05