OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

September 10, 1974

To: L. T. Oehler
Engineer of Research

From: M. A. Chiunti

Subject: Steel Strength Determination - Six Bridges.
Research Project 74 TI-201. Research Report No. R-935.

This letter transmits the results obtained from tensile and metallurgical evaluation of samples removed from six bridges containing steel of unknown properties, as requested in M. Rothstein's memo of January 31, 1974.

The purpose of this investigation was to determine the yield strength of the structural steel used in the various structures. The subject bridges have load carrying capacities that are below the 77 ton legal load limit; based on 75 percent of the assumed 30,000 psi yield strength. If the determined yield strengths are sufficiently higher, it may be possible to avoid posting the bridges for load restrictions.

Experimental Details

A total of 29 metallurgical samples were removed from the six bridges. The selected locations at each bridge, along with physical properties and chemistry, are given in Table 1. The samples were submitted to the Charles C. Kawin Metallurgical Laboratories for chemical analysis. Four tension samples were removed from each structure except for B02 of 12021 which has been widened and contains two different types of beams. Eight tension coupons were taken at this structure, four from each type of beam.

Tension samples were removed with a reciprocating saw. The samples were approximately 1 in. wide, by 9 in. long, by the thickness of the member. After sampling, the beam was cleaned and the area of removal repainted.

The yield and tensile strengths of the specimens were measured by testing in the Research Laboratory's electrohydraulic testing machine which gave an autographic printout of the stress-strain curve. Tension testing was done in accordance with ASTM Specification A-370, "Mechanical Testing of Steel Products," with the exception of specimen thickness. Instead of testing full thickness plate specimens, a subsize sheet type specimen was used with a cross-section of 0.25 by 0.50 in. A full size plate specimen would have exceeded the limitations of our equipment and would have required an

overall specimen length of 18 in., which would be impractical to remove from the structures involved. All yield strengths were measured using a rate of grip separation of 0.06 in. per minute. The yield strength was determined by the 0.2 percent offset method as described in ASTM A-370.

Samples of sufficient thickness were machined to produce two tension specimens. These are designated "A" and "B" in Table 1. Flange thickness values shown in the table are measured at the outside edge of the flange.

Results

The results of the chemical analysis and tension tests are shown in Table 1.

Average yield strengths exhibited by the samples from each structure are as follows:

Bridge No.	Average Yield Strength, psi
B02 of 12021	
Beams in Widened Portion	39,000
Original Beams	35,800
B02 of 46041	39,600
B01 of 04032	38,900
B03 of 73051	34,900
B02 of 63053	40,300
B02 of 50092	37,900

At all but one structure, the flange thickness of the interior beams was as stated in Mr. Rothstein's memo. Structure B01 of 04032 contains interior beams with a flange thickness of 1 in. instead of 0.635 in. as given.

Conclusions

The yield strength of the structural members tested are significantly higher than the assumed 30,000 psi yield strength and, therefore, it may be possible to raise or eliminate posted load limits depending on the results of design computations.

TESTING AND RESEARCH DIVISION

Manuel A. Chiunti

Highway Research Technician 09

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TABLE 1
LOCATIONS OF SAMPLE REMOVAL AND
RESULTS OF CHEMICAL ANALYSIS AND TENSION TESTS

Structure	Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties		Flange Thickness in.	Meets Requirements of ASTM A7-33T[1]	Meets Requirements of ASTM A-36[1]
			C	Mn	P	S	Yield Strength psi	Ultimate Strength psi			
B02 of 12021 US 12 over Swan Creek northeast of Bronson	1	East end near abutment inside bottom flange of south fascia beam (widened portion)	0.15	0.65	0.024	0.033	38,900	58,300	0.620		X
	2	East end near abutment, outside bottom flange, 5th beam from south (original beam)	0.20	0.62	0.016	0.038	35,600	60,400	0.600	X	
	3	East end near abutment, inside bottom flange, 4th beam from north (original fascia)	0.22	0.61	0.016	0.043	38,600	62,600	0.600	X	X
	4	East end near abutment, inside bottom flange, 3rd beam from north (widened portion)	0.16	0.64	0.024	0.032	40,900	59,600	0.620		X
	5	East end near abutment, inside bottom flange, 3rd beam from south (widened portion)	0.14	0.66	0.022	0.033	38,500	58,700	0.620		X
	6	East end near abutment, outside bottom flange, 6th beam from south (original beam)	0.21	0.62	0.016	0.042	34,900	61,900	0.600	X	
	7	East end near abutment, inside bottom flange, 6th beam from north (original beam)	0.20	0.56	0.014	0.047	34,100	59,900	0.600		
	8	East end near abutment, inside bottom flange, 2nd beam from north (widened portion)	0.15	0.65	0.022	0.033	37,700	58,300	0.620		X
B02 of 46041 M 34 over South Branch of Raisin River, southeast of Clayton	9	West end near abutment, inside bottom flange, south fascia (widened portion)	0.24	0.51	0.010	0.020	41,700	64,200	0.531	X	X
	10	West end near abutment, outside bottom flange, 2nd beam from south (original beam)	0.23	0.44	0.012	0.036	36,100	61,100	0.531	X	X
	11	East end near abutment, inside bottom flange, north fascia (widened portion)	0.24	0.51	0.012	0.019	47,200	64,900	0.531	X	X
	12	East end near abutment, outside bottom flange, 2nd beam from north (original beam)	0.23	0.44	0.012	0.034	33,600	60,200	0.531	X	
B01 of 04032 US 23 over Thunder Bay River in Alpena	13	South span near pier, outside bottom flange, 2nd beam from east	0.16	0.71	0.034	0.038	A40,600 B38,700	62,600 61,700	1.000	X	X
	14	South span near pier, inside bottom flange, 3rd beam from east.	0.18	0.73	0.017	0.042	A37,800 B39,300	61,800 61,100	1.000	X	X
	15	North span near pier, outside bottom flange, 4th beam from west	0.18	0.69	0.018	0.023	A37,500 B40,600	62,100 62,200	1.000	X	X
	16	North span near pier, outside bottom flange, 5th beam from west.	0.18	0.72	0.016	0.038	A39,100 B37,500	60,200 60,500	1.000	X	X
	17	South span near pier, inside bottom flange, east fascia beam.	0.12	0.56	0.009	0.030	[2]		1.250	[2]	[2]
B03 of 73051 M 13 over Pattie Dr 6 mi north of County Line	18	South end near abutment, inside bottom flange, west fascia beam.	0.22	0.70	0.018	0.042	A36,500 B35,300	62,300 61,500	1.100	X X	X
	19	South end near abutment, outside bottom flange, 2nd beam from west.	0.19	0.65	0.016	0.040	34,300	59,900	0.850		
	20	North end near abutment, inside bottom flange, east fascia beam	0.22	0.63	0.016	0.040	A35,000 B34,100	59,600 59,900	1.100		
	21	North end near abutment, outside bottom flange, 2nd beam from east.	0.20	0.63	0.015	0.045	34,100	58,300	0.850		

TABLE 1 (Cont.)
LOCATIONS OF SAMPLE REMOVAL AND
RESULTS OF CHEMICAL ANALYSIS AND TENSION TESTS

Structure	Sample No.	Location of Sample	Chemical Composition, percent				Mechanical Properties		Flange Thickness in.	Meets Requirements of ASTM A7-33T[1]	Meets Requirements of ASTM A-36[1]
			C	Mn	P	S	Yield Strength psi	Ultimate Strength psi			
B02 of 63053 US 10 over Clinton River in Waterford	22	South end near abutment, inside bottom flange, east fascia beam.	0.25	0.72	0.034	0.039	39,800	66,500	0.787	X	X
	23	South end near abutment, outside bottom flange, 2nd beam from east.	0.23	0.78	0.019	0.042	41,200	64,400	0.690	X	X
	24	North end near abutment, inside bottom flange, 5th beam from east.	0.20	0.65	0.020	0.027	39,300	63,500	0.787	X	X
	25	North end near abutment, outside bottom flange, 6th beam from east.	0.19	0.76	0.017	0.036	40,900	63,400	0.690	X	X
B02 of 50092 M 19 over Salt River, east of New Haven	26	North end near abutment, inside bottom flange, east fascia beam.	0.21	0.48	0.030	0.027	34,200	59,400	0.810		
	27	North end near abutment, outside bottom flange, 2nd beam from east.	0.18	0.87	0.015	0.025	42,100	65,400	0.606	X	X
	28	South end near abutment, inside bottom flange, west fascia beam.	0.23	0.65	0.030	0.025	A36,200 B37,200	65,000 66,100	0.810	X	X
	29	South end near abutment, outside bottom flange, 2nd beam from west.	0.13	0.73	0.014	0.024	39,800	59,100	0.606		X

[1] ASTM Specification Requirements (shapes)

ASTM Designation	Properties					
	Mechanical		Chemical Composition, percent			
	Tensile Strength, psi	Yield Strength, psi	C Max	Mn	P Max	S Max
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

[2] No tension sample obtained from fascia beam due to greater thickness of flange, metallurgical sample obtained for comparison purposes.