LOAD CARRYING CAPACITY OF I 75 BITUMINOUS SHOULDERS IN THE FLINT AREA

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

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Michigan Transportation Commission
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As a result of a memorandum from J. W. Burge to M. L. O'Toole dated June 14, 1983, a study was conducted to determine the load capacity of selected I 75 bituminous shoulders in the Flint area. Scheduled resurfacing of selected bridge decks will require the alternate closing of two lanes of three-lane I 75. Traffic is to be condensed into two lanes, i.e., the third pavement lane and the shoulder. The purpose of this study was to determine if the existing shoulders were of adequate load capacity to temporarily carry the diverted traffic load and if not, to make appropriate shoulder design recommendations.

The location of the sites investigated, the beginning and ending stationing, and the stationing of sites that were investigated are as follows:

Location	Stationing				
	Beginning	Site 1	Site 2	Site 3	Ending
Court St, NB, north end	860+00	863+50	867+00	870+50	872+00
Court St, SB, north end	872+00	870+50	867+00	863+50	860+00
Court St, SB, south end	860+00	859+00	---	---	848+00
Flint River, NB, south end	935+00	936+50	940+00	943+50	947+00
Flint River, NB, north end	947+00	952+50	954+00	---	958+00
Flint River, SB, north end	972+00	956+50	953+50	---	952+00
Flint River, SB, south end	947+00	945+50	942+50	939+50	938+00
Flushing Rd, NB, north end	960+00	961+50	966+00	970+00	968+00
Flushing Rd, SB, north end	972+00	970+00	966+00	962+00	960+00
Brent Run, NB, south end	1384+00	1386+00	1390+00	1394+00	1396+00
Brent Run, NB, north end	1397+00	1399+00	1403+00	1407+00	1409+00
Brent Run, SB, north end	1397+00	1399+00	1403+00	---	1409+00
Brent Run, SB, south end	1384+00	1386+50	1390+00	1394+00	1396+00

Benkelman beam deflection and pavement layer thicknesses were determined for the outside shoulder at three locations in both the approach and leave side of each bridge structure. The deflection data are summarized in Table 1 and the layer thickness data in Table 2.

The deflection data indicate that most shoulders have deflection basins that are characterized by small radius of curvatures. In practical terms, this

means the shoulders have poor load capacity and the maximum deflection is, in many cases, about three times greater than that of a typical flexible pavement. The primary problem is very low base stability. Analytical analysis of the data indicates that as few as 1,000 18-kip axle load repetitions would cause the shoulders to fail. Two shoulder areas, Flint River southbound, north and south ends, should have adequate stability and strength to temporarily carry a lane of traffic. A few other shoulders have marginally adequate load capacity; however, the chance that they may hold up is not worth the risk of their becoming severely distressed while under traffic.

Analysis was made of what shoulder cross-section could be used to most economically carry the temporary traffic load. It was determined that 3.5 in. of bituminous concrete on a 6.5 in. crushed stone base (21AA) placed on the existing subbase would carry about 600,000 18-kip axle load repetitions. This should far exceed the temporary applied loading. A basic problem with the shoulders carrying a traffic load will be a lack of edge support—a condition that is worsened by the narrow lane width provided by the shoulder. To help prevent an anticipated edge cracking problem, it was recommended that the 21AA base be extended out 1 ft beyond the edge of the shoulder surface to increase lateral support. The recommended cross-section is shown in Figure 1. It was further recommended that the bituminous concrete be placed in two 170-lb lifts, have a 1,100 lb stability, and utilize 120-150 penetration asphalt.

Because of the time constraints with which the Design Division had to work, the above information was given to J. D. Barrett, Bridge Design Squad Leader on July 11, 1983 for his use in finalizing design drawings.

TABLE 1

SHOULDER LAYER DESCRIPTION AND THICKNESS

Court St Northbound, North End

Station	863+50
Bituminous concrete	3.5 in.
Gravel base	9.5 in.
Sand subgrade	
Station	867+00
Bituminous concrete	3.75 in.
Gravel base	9.5 in.
Sand subbase	13.75 in.
Firm clay subgrade	
Station	870+50
Bituminous concrete	3.5 in.
Gravel base	2.0 in.
Sand subbase	23.5 in.
Firm clay subgrade	

Court St Southbound, North End

Station	863+50
Bituminous concrete	3.75 in.
Gravel base	9.25 in.
Mixed sand subbase	24.0 in.
Medium soft clay subgrade	
Station	867+00
Bituminous concrete	4.5 in.
Bituminous stabilized base	5.5 in.
Gravely sand subbase	16.0 in.
Firm clay subgrade	
Station	870+50
Bituminous concrete	4.25 in.
Bituminous stabilized base	4.75 in.
Gravely sand subbase	15.0 in.
Firm clay subgrade	

Court St Southbound, Between Ramps

Station	859+00
Bituminous concrete	3.5 in.
Gravel base	10.5 in.
Gravel subbase	22.5 in.
Medium soft subgrade	

TABLE 1 (Cont.)

Flint River Northbound, South End

Station	936+50
Bituminous concrete	4.0 in.
Bituminous stabilized base	2.0 in.
Gravel sand subbase	13.5 in.
Firm clay subgrade	
Station	940+00
Bituminous concrete	3.75 in.
Bituminous stabilized base	5.25 in.
Gravel sand subbase	14.5 in.
Firm clay subgrade	
Station	943+50
Bituminous concrete	4.0 in.
Bituminous stabilized base	6.0 in.
Gravely sand	32.0 in.
Firm clay subgrade	

Flint River Northbound, North End

Station	952+50
Bituminous concrete	5.5 in.
Bituminous stabilized base	4.5 in.
Coarse sand subbase	19.0 in.
Firm clay subgrade	
Station	954+00
Bituminous concrete	5.0 in.
Bituminous stabilized base	4.0 in.
Coarse sand subbase	14.0 in.
Firm clay subgrade	

Flint River Southbound, North End

Station	956+50
Bituminous concrete	5.0 in.
Bituminous stabilized base	4.0 in.
Gravely sand subbase	22.0 in.
Plastic sandy loam subgrade	
Station	953+50
Bituminous concrete	4.25 in.
Bituminous stabilized base	4.75 in.
Gravely sand subbase	14.0 in.
Plastic sandy loam subgrade	

TABLE 1 (Cont.)

Flint River Southbound, South End

Station	945+50
Bituminous concrete	4.25 in.
Gravel base	6.75 in.
Sand subbase	22.0 in.
Firm silty subgrade	
Station	942+50
Bituminous concrete	3.75 in.
Gravel base	8.25 in.
Sand subbase	14.0 in.
Firm silty subgrade	
Station	939+50
Bituminous concrete	5.0 in.
Gravel base	8.0 in.
Sand subbase	13.0 in.
Firm silty subgrade	

Flushing Rd Northbound, South End

Station	952+50
Bituminous concrete	5.5 in.
Bituminous stabilized base	4.5 in.
Coarse sand subbase	19.0 in.
Firm clay subgrade	
Station	954+00
Bituminous concrete	5.0 in.
Bituminous stabilized base	4.0 in.
Coarse sand subbase	14.0 in.
Firm clay subgrade	

Flushing Rd Northbound, North End

Station	961+50
Bituminous concrete	5.0 in.
Bituminous stabilized base	5.0 in.
Sand subbase	20.0 in.
Clay subgrade	
Water at -25 in.	
Station	966+00
Bituminous concrete	4.75 in.
Gravel base	7.25 in.
Sand subbase	15.0 in.
Clay subgrade	

TABLE 1 (Cont.)

Flushing Rd Northbound, North End (cont.)	
Station	970+00
Bituminous concrete	3.5 in.
Gravel base	9.5 in.
Sand subbase	15.25 in.
Clay subgrade	
Flushing Rd Southbound, North End	
Station	962+00
Bituminous concrete	4.0 in.
Bituminous stabilized base	4.0 in.
Gravely sand subbase	19.0 in.
Stiff silty subgrade	
Station	966+00
Bituminous concrete	5.0 in.
Bituminous stabilized base	4.5 in.
Gravely sand subbase	15.50 in.
Stiff silty subgrade	
Station	970+00
Bituminous concrete	5.0 in.
Bituminous stabilized base	3.5 in.
Gravely sand subbase	21.50 in.
Stiff silty subgrade	
Flushing Rd Southbound, South End	
Station	956+50
Bituminous concrete	5.0 in.
Bituminous stabilized base	4.0 in.
Gravely sand subbase	22.0 in.
Plastic sandy loam subgrade	
Station	953+50
Bituminous concrete	4.25 in.
Bituminous stabilized base	4.75 in.
Gravely sand subbase	14.0 in.
Plastic sandy loam subgrade	
Brent Run Northbound, South End	
Station	1386+00
Bituminous concrete	2.0 in.
Bituminous stabilized base	2.0 in.
Medium fine sand	to > 64 in.

TABLE 1 (Cont.)

Brent Run Northbound, South End (cont.)

Station	1390+00
Bituminous concrete	1.75 in.
Bituminous stabilized base	5.25 in.
Loamy sand subbase	16.0 in.
Firm clay subgrade	
Station	1394+00
Bituminous concrete	1.75 in.
Low stabilized gravel base	6.25 in.
Sand subbase	11.0 in.
Firm loam	

Brent Run Northbound, North End

Station	1399+00
Bituminous concrete	1.5 in.
Gravel base	6.5 in.
Sand subbase	15.0 in.
Firm clay subgrade	
Station	1403+00
Bituminous concrete	1.5 in.
Gravel base	6.5 in.
Sand subbase	11.0 in.
Firm clay subgrade	
Station	1407+00
Bituminous concrete	1.5 in.
Gravel base	6.25 in.
Sand subbase	14.0 in.
Firm clay subgrade	

Brent Run Southbound, North End

Station	1399+00
Bituminous concrete	2.0 in.
Gravely base	3.0 in.
Sand subbase	15.5 in.
Firm clay subgrade	
Station	1403+00
Bituminous concrete	2.5 in.
Gravely base	5.5 in.
Sand subbase	13.0 in.
Firm clay subgrade	

TABLE 1 (Cont.)

Brent Run Southbound, South End

Station	1386+50
Bituminous concrete	1.5 in.
Bituminous stabilized base	4.5 in.
Fine wet sand subbase	10.0 in.
Firm clay subgrade	
Station	1390+00
Bituminous concrete	1.5 in.
Bituminous stabilized base	3.5 in.
Fine sand subbase	17.0 in.
Firm clay subgrade	
Station	1394+00
Bituminous concrete	1.5 in.
Bituminous stabilized base	5.0 in.
Fine sand subbase	8.0 in.
Firm clay subgrade	

TABLE 2
SUMMARY OF BENKELMAN BEAM DEFLECTION DATA FOR SHOULDERS ON I 75

Location	Site	Temperature, F	Tire Pressure, psi	Right Wheel Load	Left Wheel Load*	Pavement Deflection, in.					
						Maximum	1 ft	2 ft	3 ft	4 ft	5 ft
Court St, NB north end	863+50	90	84	12,290	11,140	0.0738	0.0462	0.0194	0.0080	0.0034	0.0022
	867+00	93	84	12,820	10,320	0.0778	0.0440	0.0176	0.0092	0.0056	0.0036
	870+50	95	84	12,430	10,850	0.0552	0.0295	0.0100	0.0062	0.0046	0.0028
Court St, SB north end	870+50	90	85	12,610	10,960	0.0844	0.0556	0.0256	0.0104	0.0048	0.0030
	867+00	83	85	12,480	11,070	0.0892	0.0600	0.0256	0.0128	0.0072	0.0048
	863+50	80	85	12,180	11,120	0.0676	0.0528	0.0272	0.0148	0.0084	0.0052
Court St between ramps	859+00	82	85	12,480	10,980	0.0734	0.0596	0.0292	0.0140	0.0092	0.0062
Flint River, NB south end	936+50	67	81	13,120	10,350	0.0738	0.0606	0.0316	0.0170	0.0102	0.0072
	940+00	64	81	12,730	10,670	0.0932	0.0764	0.0424	0.0208	0.0144	0.0116
	943+50	65	81	12,770	10,760	0.0774	0.0590	0.0338	0.0214	0.0188	0.0174
Flint River, NB north end	952+50	66	81	12,200	11,000	0.1052	0.0904	0.0672	0.0532	0.0436	0.0396
	954+00	69	80	12,490	11,010	0.1008	0.0844	0.0556	0.0416	0.0336	0.0288
Flint River, SB north end	956+50	78	85	12,470	10,780	0.0724	0.0572	0.0320	0.0172	0.0124	0.0100
	953+50	76	85	12,570	10,770	0.0788	0.0646	0.0316	0.0160	0.0100	0.0076
Flint River, SB south end	945+50	80	85	12,540	10,830	0.0496	0.0348	0.0208	0.0120	0.0064	0.0044
	942+50	81	85	11,970	11,250	0.0504	0.0392	0.0236	0.0132	0.0080	0.0032
	939+50	81	85	12,260	11,160	0.0652	0.0532	0.0260	0.0128	0.0072	0.0052
Flushing Rd, NB north end	961+50	69	80	12,700	10,720	0.0542	0.0406	0.0214	0.0146	0.0102	0.0078
	966+50	70	80	12,400	11,040	0.0560	0.0460	0.0272	0.0136	0.0080	0.0060
	970+00	71	80	12,000	11,410	0.0656	0.0468	0.0234	0.0116	0.0064	0.0038
Flushing Rd, SB north end	970+00	74	85	12,210	10,900	0.0928	0.0672	0.0352	0.0176	0.0112	0.0080
	966+00	75	85	12,140	11,030	0.0760	0.0628	0.0388	0.0240	0.0192	0.0168
	962+00	77	85	12,250	10,850	0.0560	0.0556	0.0456	0.0236	0.0132	0.0084

TABLE 2 (Cont.)

Location	Site	Temperature, F	Tire Pressure, psi	Right Wheel Load	Left Wheel Load*	Pavement Deflection, in.					
						Maximum	1 ft	2 ft	3 ft	4 ft	5 ft
Brent Run, NB south end	1386+00	74	82	12,190	10,800	0.0820	0.0328	0.0072	0.0026	0.0016	0.0010
	1390+00	81	82	12,720	10,650	0.0526	0.0300	0.0124	0.0044	0.0020	0.0008
	1394+00	94	82	12,880	10,470	0.1872	0.1260	0.0640	0.0200	0.0064	0.0032
	1394+50	94	82	12,880	10,470	0.1344	0.0920	0.0392	0.0136	0.0048	0.0012
Brent Run, NB north end	1399+00	92	82	12,360	11,140	0.1620	0.1144	0.0492	0.0196	0.0060	0.0024
	1403+00	108	82	12,600	10,840	0.1060	0.0700	0.0312	0.0088	0.0032	--
	1407+00	92	82	12,120	10,880	0.0800	0.0496	0.0200	0.0072	0.0008	0.0004
Brent Run, SB north end	1403+00	102	84	12,500	*9,750	0.0936	0.0504	0.0152	0.0104	0.0056	0.0032
	1399+00	100	82	12,740	10,610	0.1680	0.0976	0.0408	0.0144	0.0064	0.0040
Brent Run, SB south end	1394+00	105	82	12,300	11,670	0.200+	— Deflection Over 0.200 in. —				
	1390+00	96	82	12,370	11,000	0.0792	0.0536	0.0192	0.0040	0.0008	--
	1386+50	96	82	12,060	10,970	0.200+	— Deflection Over 0.200 in. —				

* Unless indicated by an asterisk, the right side was used for the deflection test.

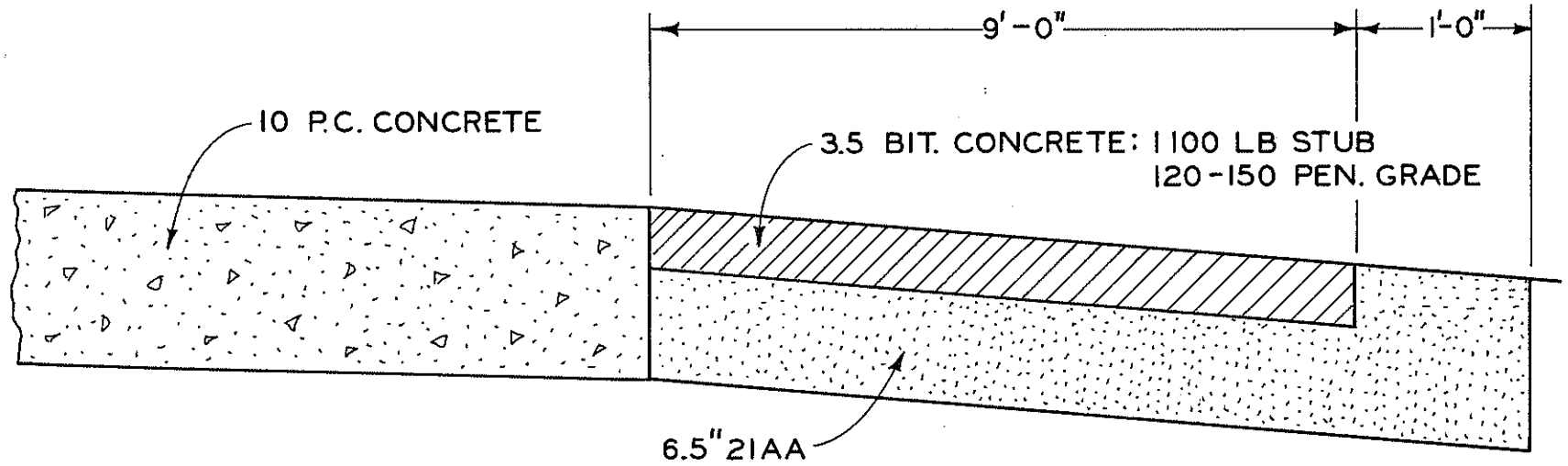

Figure 1. Recommended shoulder cross-section.