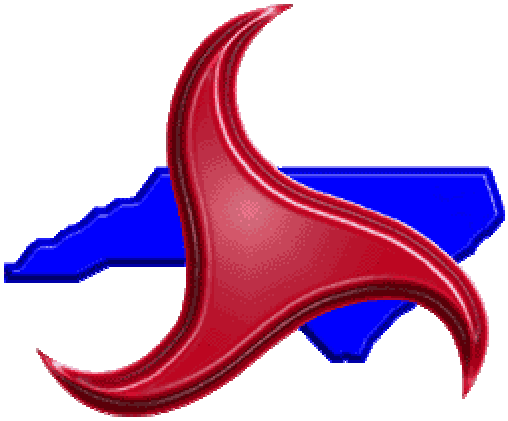
An Investigation into Across Median Crashes at Median Berm Locations



Documents Prepared By:

Safety Evaluation Group
Traffic Safety Unit
Traffic Engineering and Safety Systems Branch
North Carolina Department of Transportation

Principal Investigator

Brian G. Murphy, PE

3-23-07
Date

Traffic Safety Project Engineer

INTRODUCTION

The purpose of this study is to investigate across median crashes at median berms on freeway facilities. Berms are commonly used in wide medians to protect bridge piers. The idea is that the berms redirect errant vehicles and prevent them from striking the bridge piers. Berms can prove to be a cost-effective option as the installation and maintenance costs of guardrail around bridge piers can be avoided. In some projects, berms also allow for utilization of excess fill material that would normally have to be carried off the project. Current North Carolina Department of Transportation (NCDOT) policy states that berms are to be used on medians that are 68 feet or wider *(1,2)*. When earth berms are used, the bridge piers must be 30 feet or more from the edge of pavement. Standard drawings for the construction of median berms can be found in Appendix A of this document.

Figure 1 shows a typical median berm location.

Figure 1. Typical Median Berm

SCOPE OF PROJECT

This report attempts to address the concern of across median crashes over median berms through a quantitative look at crash data. A total of 31 median berm locations on freeways across the State were considered for this project. All locations were selected without any prior knowledge or regard for crash history. Berm locations were identified through a Median Barrier Survey *(3)* that was performed by a consultant on behalf of NCDOT in April of 2006. All berm locations studied for this project are grade separated with no interchange ramps. Median barrier is present on either side of the berm locations selected for analysis in this project.

Crash data at comparison sites was also utilized as part of this project. The comparison sites were picked to have similar traffic volumes and median widths as the berm locations. Comparison sites were picked from the same Median Barrier Survey *(3)* that was used to pick the berm sites.

Table 1 shows the median berm locations that were studied for this project.

Table 1. Median Berm Sites Analyzed

Obs	County	Route	Intersection	Mid-Year ADT	Median Width	Begin Analysis Date	End Analysis Date	Analysis Period
1	Cabarrus	I-85	SR 1790 (Winecoff)	74,000	68	1/1/1999	5/31/2006	7.42
2	Chatham	US 421	SR 1300 (Stanley Snow Camp)	10,000	68	7/1/2003	5/31/2006	2.92
3	Davidson	I-85	SR 2055 (Liberty)	49,000	68	7/1/2002	6/30/2006	4.00
4	Davidson	US 52	SR 1822 (Tall Pine)	28,000	68	12/1/2001	5/31/2006	4.50
5	Davidson	US 52	SR 1836 (Bethesda)	28,000	68	12/1/2001	5/31/2006	4.50
6	Davidson	US 52	SR 1464 (Bethesda)	28,000	68	12/1/2001	5/31/2006	4.50
7	Davie	I-40	SR 1442 (Redland)	35,000	60	5/1/2002	5/31/2006	4.08
8	Davie	I-40	SR 1441 / SR 1444 / Rainbow	35,000	60	5/1/2002	5/31/2006	4.08
9	Davie	I-40	SR 1436 (Pinebrook School)	32,000	60	5/1/2002	5/31/2006	4.08
10	Davie	I-40	SR 1407 (Woodward)	32,000	60	5/1/2002	5/31/2006	4.08
11	Davie	I-40	SR 1405 (Main Church)	32,000	60	5/1/2002	5/31/2006	4.08
12	Davie	I-40	SR 1143 (Davie Academy)	30,000	60	5/1/2002	5/31/2006	4.08
13	Forsyth	US 311	SR 2687 (Hasting)	21,000	68	3/1/2001	5/30/2006	5.25
14	Gaston	US 321	SR 1806 / SR 1802 / Cloniger	32,000	68	9/1/2003	5/31/2006	2.75
15	Gaston	US 321	US 321 Bus / NC 155	32,000	68	9/1/2003	5/31/2006	2.75
16	Iredell	I-40	SR 2163 (Cool Spring)	30,000	60	5/1/2002	5/30/2006	4.08
17	Mecklenburg	I-485	Pavillion	39,000	68	9/1/2003	5/31/2006	2.75
18	Mecklenburg	I-485	SR 2801 (Caldwell)	38,000	68	9/1/2003	5/31/2006	2.75
19	Nash	US 64	SR 1148 (West Loop)	16,000	70	9/1/2003	6/30/2006	2.83
20	Nash	US 64	SR 1148 (East Loop)	16,000	70	9/1/2003	6/30/2006	2.83
21	Nash	US 64	SR 1144	16,000	70	9/1/2003	6/30/2006	2.83
22	Nash	US 64	SR 1911	17,000	70	9/1/2003	6/30/2006	2.83
23	Nash	US 64	SR 1909	17,000	70	9/1/2003	6/30/2006	2.83
24	Randolph	I-85	SR 1004 (Trinity) / Railroad Bridge	45,000	61	6/1/2000	5/31/2006	6.00
25	Randolph	I-85	SR 1912 (Aldridge)	43,000	61	6/1/2000	5/31/2006	6.00
26	Surry	I-74	SR 1649 (Clyde Hayes)	31,000	68	12/1/2001	5/31/2006	4.50
27	Surry	I-74	SR 1602 / SR 1618 / Maple Grove Ch	31,000	68	12/1/2001	5/31/2006	4.50
28	Surry	I-74	SR 1396 (Pine Ridge)	31,000	68	12/1/2001	5/31/2006	4.50
29	Surry	I-77	SR 1397 / SR 1399 / Oak Grove Ch	23,000	68	12/1/2001	5/31/2006	4.50
30	Surry	I-77	SR 1345 / Beulah / Prison Camp	23,000	68	12/1/2001	5/31/2006	4.50
31	Surry	I-77	SR 1341 / White Dirt	19,000	68	11/1/2000	5/31/2006	5.58

CRASH ANALYSIS METHOD

The median berm locations were analyzed using crash data from the North Carolina Traffic Records Database, which contains all reported crashes in the State since 1990. A crash analysis was conducted for each median berm location. An average of 4.1 years of crash data was used for each of the berm sites. See Table 1 for exact time periods for each study.

All crashes determined to be within 500 feet of a bridge where a median berm was present were included in the analysis. The NCDOT Standard Drawings detail that median berm should be constructed to be approximately 400 feet long. Due to notoriously inaccurate measurements used in reporting crashes, all crashes determined to be within 500 feet were included in the analysis. All crashes coded to be within 0.30 miles of a bridge with median berms were scanned to determine if they involved the median berm.

FINDINGS

Table 2 below shows a summary of the crash data at each of the berm sites. A crash was classified as "berm involved" if the drawing or narrative on the crash report showed or mentioned that the berm was involved. Out of the 225 total crashes at the berm sites, only 13 were determined to be berm related. Five of those 13 crashes actually involved a vehicle going across the median. Table 3 gives a more detailed breakdown of the berm involved crashes.

Table 2. Crash Data at Berm Sites

Obs	County	Route	Intersection	Mid-Year ADT	Median Width	Analysis Period	# Total Crashes	# K_Inj Crashes	# A_Inj Crashes	# Inj Crashes	# ROR Crashes	# Across Median Crashes	Berm Involved Crashes	Exposure	Crash Rate
1	Cabarrus	I-85	SR 1790 (Winecoff)	74,000	68	7.42	28	0	0	8	8	0	0	0.379	73.803
2	Chatham	US 421	SR 1300 (Stanley Snow Camp)	10,000	68	2.92	1	0	0	0	1	0	0	0.020	49.577
3	Davidson	I-85	SR 2055 (Liberty)	49,000	68	4.00	12	0	1	7	7	0	0	0.135	88.566
4	Davidson	US 52	SR 1822 (Tall Pine)	28,000	68	4.50	4	0	0	1	3	0	0	0.087	45.937
5	Davidson	US 52	SR 1836 (Bethesda)	28,000	68	4.50	3	0	0	0	2	0	0	0.087	34.453
6	Davidson	US 52	SR 1464 (Bethesda)	28,000	68	4.50	5	0	0	3	5	0	0	0.087	57.421
7	Davie	I-40	SR 1442 (Redland)	35,000	60	4.08	9	0	0	3	7	0	1	0.099	91.061
8	Davie	I-40	SR 1441 / SR 1444 / Rainbow	35,000	60	4.08	9	0	0	4	7	0	0	0.099	91.061
9	Davie	I-40	SR 1436 (Pinebrook School)	32,000	60	4.08	31	0	1	5	22	0	3	0.090	343.058
10	Davie	I-40	SR 1407 (Woodward)	32,000	60	4.08	4	0	0	1	2	0	0	0.090	44.266
11	Davie	I-40	SR 1405 (Main Church)	32,000	60	4.08	11	0	0	2	8	0	0	0.090	121.730
12	Davie	I-40	SR 1143 (Davie Academy)	30,000	60	4.08	6	0	0	2	5	0	0	0.085	70.825
13	Forsyth	US 311	SR 2687 (Hasting)	21,000	68	5.25	6	0	0	1	5	0	1	0.076	78.735
14	Gaston	US 321	SR 1806 / SR 1802 / Cloniger	32,000	68	2.75	5	0	0	1	2	1	1	0.061	82.253
15	Gaston	US 321	US 321 Bus / NC 155	32,000	68	2.75	3	0	0	0	2	0	0	0.061	49.352
16	Iredell	I-40	SR 2163 (Cool Spring)	30,000	60	4.08	2	0	0	1	2	0	0	0.085	23.624
17	Mecklenburg	I-485	Pavillion	39,000	68	2.75	4	0	0	1	2	0	0	0.074	53.992
18	Mecklenburg	I-485	SR 2801 (Caldwell)	38,000	68	2.75	17	0	0	8	11	0	0	0.072	235.504
19	Nash	US 64	SR 1148 (West Loop)	16,000	70	2.83	3	0	0	1	3	0	0	0.031	95.837
20	Nash	US 64	SR 1148 (East Loop)	16,000	70	2.83	3	0	0	2	2	0	0	0.031	95.837
21	Nash	US 64	SR 1144	16,000	70	2.83	0	0	0	0	0	0	0	0.031	0.000
22	Nash	US 64	SR 1911	17,000	70	2.83	1	0	0	0	1	0	0	0.033	30.067
23	Nash	US 64	SR 1909	17,000	70	2.83	4	0	0	1	3	0	1	0.033	120.266
24	Randolph	I-85	SR 1004 (Trinity) / Railroad Bridge	45,000	61	6.00	22	1	1	7	13	2	3	0.187	117.869
25	Randolph	I-85	SR 1912 (Aldridge)	43,000	61	6.00	5	0	0	2	4	1	2	0.178	28.034
26	Surry	I-74	SR 1649 (Clyde Hayes)	31,000	68	4.50	4	0	0	4	3	0	0	0.096	41.491
27	Surry	I-74	SR 1602 / SR 1618 / Maple Grove C	31,000	68	4.50	2	1	0	2	1	0	0	0.096	20.746
28	Surry	I-74	SR 1396 (Pine Ridge)	31,000	68	4.50	5	0	1	4	1	0	0	0.096	51.864
29	Surry	I-77	SR 1397 / SR 1399 / Oak Grove Ch	23,000	68	4.50	9	0	0	3	6	0	0	0.072	125.827
30	Surry	I-77	SR 1345 / Beulah / Prison Camp	23,000	68	4.50	4	0	0	3	2	0	0	0.072	55.923
31	Surry	I-77	SR 1341 / White Dirt	19,000	68	5.58	3	0	0	1	1	1	1	0.073	40.927
				30,000	66	4.09	225	2	4	78	141	5	13	2.809	80.0864
					Averages						Totals				

Table 3. Detailed Breakdown of Berm Related Crashes

Crash Type	Fatal	A Inj	B Inj	C Inj	PDO	Total
Ran-off-road left, struck berm			1		2	3
Ran-off-road left, struck berm and bridge piers				1		1
Ran-off-road left, struck berm and bridge piers and overturned					1	1
Ran-off-road left, struck berm and overturned				1	1	2
Ran-off-road left, struck berm and went across median	1			1		2
Ran-off-road left, struck berm, overturned and went across median		1	1		1	3
Ran-off-road left, struck median guardrail, struck berm					1	1
Total -->	1	1	2	3	6	13

It is interesting to note that 6 out of the 13 (46%) berm related crashes involved a vehicle overturning. It is difficult to determine from the crash reports whether the vehicles overturned due to the median berm or not. It is also interesting to note that the across median crashes at these berm locations account for 4 out of the 7 (57%) injury crashes and all of the severe injury (Fatal and A Injury) crashes. Previous studies *(4)* have suggested that across median crashes tend to be 3 times more severe than other freeway crashes.

Table 4 shows a summary of the crash data at each of the comparison sites. All crashes within 500 feet of the comparison locations were included in the analysis.

Table 4. Crash Data at Comparison Sites

Obs	County	Route	Intersection	Mid-Year ADT	Median Width	Analysis Period	# Total Crashes	# K_Inj Crashes	# A_Inj Crashes	# Inj Crashes	# ROR Crashes	# Across Median Crashes	Exposure	Crash Rate
1	Cabarrus	I-85	SR 2000 (Brantley)	68,000	68	7.50	35	0	0	13	11	0	0.352	99.293
2	Cabarrus	I-85	SR 2114 (Center Grove)	68,000	68	7.50	27	0	0	9	14	0	0.352	76.597
3	Cabarrus	I-85	NC 3 / NC 136 / Concord Lake / Lake Concord	64,000	68	7.50	34	0	0	11	15	0	0.332	102.484
4	Columbus	US 74	SR 1005 (Peacock)	12,000	68	6.92	4	0	0	1	3	0	0.057	69.703
5	Columbus	US 74	SR 1552 (Smyrna)	14,000	68	6.92	4	0	0	0	3	0	0.067	59.745
6	Columbus	US 74	US 701 Bus (James B White)	12,000	68	6.92	5	0	0	1	3	0	0.057	87.129
7	Cumberland	SR 1007	SR 1415 (Yadkin)	52,000	68	6.83	18	0	0	9	13	0	0.246	73.284
8	Franklin	US 64	SR 1746 (Stallings) - Bridge #30	16,000	68	2.83	0	0	0	0	0	0	0.031	0.000
9	Franklin	US 64	SR 1748 (Lewis) - Bridge #47	16,000	68	2.83	3	0	0	0	2	0	0.031	95.837
10	Franklin	US 64	SR 1747 (Carlyle) - Bridge #67	16,000	68	2.83	4	0	0	0	4	0	0.031	127.783
11	Granville	I-85	SR 1127 (Brogden)	29,000	68	3.50	7	0	0	3	3	0	0.070	99.881
12	Halifax	I-95	SR 1002 (Gibbs)	38,000	60	4.83	16	0	1	3	7	0	0.127	126.101
13	Halifax	I-95	SR 1211 (Hardee)	38,000	60	4.83	11	0	0	3	10	0	0.127	86.694
14	Halifax	I-95	SR 1615 (Hedgepath)	39,000	60	4.83	5	0	0	4	5	0	0.130	38.396
15	Halifax	I-95	SR 1001	39,000	60	4.83	8	0	0	2	2	0	0.130	61.434
16	Halifax	I-95	SR 1612 (Ridgecrest)	39,000	60	4.83	9	1	1	5	5	0	0.130	69.113
17	Halifax	I-95	SR 1600 (Aurelian Spring)	39,000	60	4.83	10	0	0	4	4	0	0.130	76.792
18	Iredell	I-77	SR 1892 (Jennings)	30,000	68	6.00	7	0	0	1	2	0	0.124	56.256
19	Nash	US 64	SR 1151 (Bryantown) - Bridge #5	15,000	68	2.83	3	0	0	2	1	0	0.029	102.227
20	Nash	US 64	SR 1137 (Fraizer) - Bridge #18	15,000	68	2.83	7	1	0	2	4	0	0.029	238.529
21	Rowan	I-85	SR 1308 (Moose)	61,000	68	7.50	28	0	0	9	19	0	0.316	88.550
22	Rowan	I-85	SR 1221 (Old Beatty Ford)	61,000	68	7.50	17	1	0	6	9	2	0.316	53.762
23	Rowan	I-85	SR 1243 (Daugherty)	61,000	68	7.50	22	0	1	9	12	1	0.316	69.575
24	Rowan	I-85	SR 1232 (Pine Ridge)	61,000	68	7.50	28	0	2	11	13	0	0.316	88.550
25	Rowan	I-85	SR 1337 (Lentz)	61,000	68	7.50	31	0	0	9	13	0	0.316	98.037
26	Wake	US 64	SR 2337 (Debnam) - Bridge #212	17,500	68	2.83	3	0	0	0	1	0	0.034	87.623
27	Yadkin	I-77	SR 1100 (Hunting Creek)	23,000	68	4.33	5	0	0	0	2	0	0.069	72.555
28	Yadkin	I-77	SR 1103 (Marler)	28,000	68	4.33	7	0	0	2	4	0	0.084	83.439
29	Yadkin	I-77	SR 1316 (Rena)	28,000	68	4.33	13	0	0	3	11	0	0.084	154.958
				37,000	66	5.38	371	3	5	122	195	3	4.44	83.60
				Averages							Totals			

Table 5 shows a comparison of the crash data at berm and comparison sites. The chart shows that the total crash rates at the berm sites and comparison sites are very similar. Run-off-road crash rates at the berm sites tended to be higher. This may explain, to some extent, the increased across median crash rates present at the berm sites. More run-off-road crashes correspond to more opportunities for a vehicle to cross the median. The across median crash rates should be used with caution because of the very low number of observations.

Table 5. Crash Rate Comparison

	Berm Sites	Comparison Sites	Percent Above or Below Crash Rates At Comparison Sites
Total Crash Rate	80.09	83.60	-4%
Ran-Off-Road Crash Rate	50.19	43.94	14%
Across Median Crash Rate	1.78	0.68	163%

CONCLUDING REMARKS

The only practical retrofit for most median berm locations would be to install two lines of w-beam type guardrail on either side of the berm. This would likely result in an increase in the frequency of crashes, but perhaps a decrease in the severity of crashes at these locations. The question then becomes, is the increase in guardrail cost (implementation and maintenance) and the frequency of crashes worth the decreased probability that a vehicle would cross the median at berm locations? The decision to retrofit median berms would essentially be in response to 5

collisions occurring at 31 sites with an average of 4 years of crash data. With limited safety money available, it would be difficult to justify this spending.

The crash analysis shows across median crashes at berm locations are rare events. In this analysis, approximately 2% of the total crashes at median berm locations involved a vehicle crossing the median. Berm protection for median bridge piers has been a long accepted and widely used application, and there is no overwhelming evidence in this analysis to discontinue their usage.

REFERENCES

1. North Carolina Department of Transportation Roadway Design Unit and Project Services Unit, Policy and Procedures Manual: Chapter 17, Raleigh, NC, 2006

2. North Carolina Department of Transportation Roadway Design Unit, Design Manual 2002: Part 1 Chapter 1-6G, Raleigh, NC, 2002

3. Ramey Kemp & Associates, Median Barrier Survey Study – Prepared for North Carolina Department of Transportation, Raleigh, NC, 2006

4. J.M. Lynch "Saving Lives by Preventing Across Median Crashes in North Carolina", North Carolina Department of Transportation, September 1998

APPENDIX A

Standard Drawings for Median Berms

STATE OF
NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

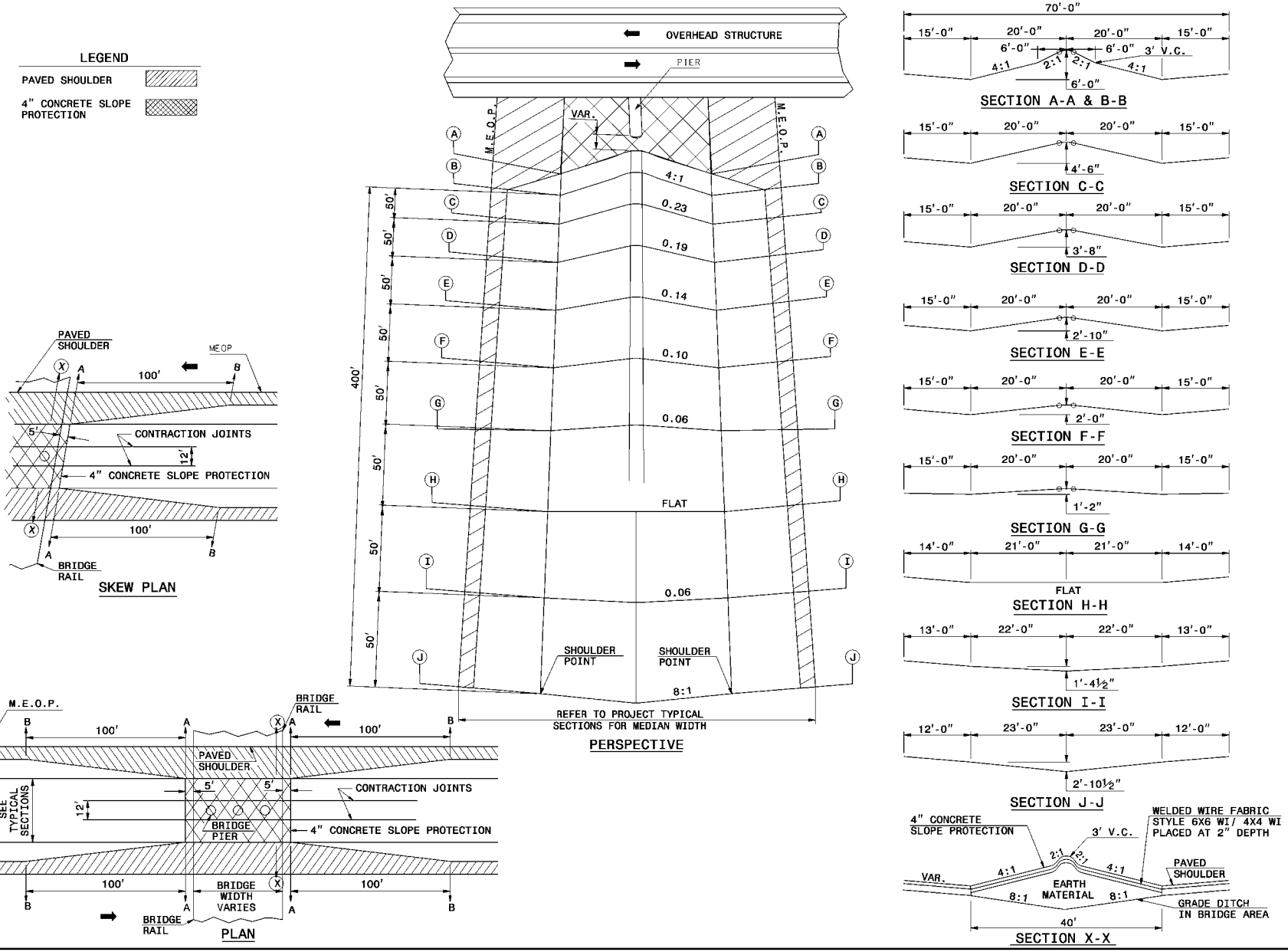
7-06

ENGLISH STANDARD DRAWING FOR

EARTH BERM MEDIAN PIER PROTECTION

SHEET 1 OF 2

225.08



STATE OF
NORTH CAROLINA
DEPT. OF TRANSPORTATION
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RALEIGH, N.C.

7-06

ENGLISH STANDARD DRAWING FOR

EARTH BERM MEDIAN PIER PROTECTION

SHEET 1 OF 2

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ENGLISH STANDARD DRAWING FOR

EARTH BERM MEDIAN PIER PROTECTION

SHEET 2 OF 2

225.08

GENERAL NOTES:

1. GRADING

   A. IN CUTS - EXCAVATE THE MEDIAN BETWEEN SECTIONS A-A AND J-J AS SHOWN IN PERSPECTIVE VIEW. EXCAVATE BETWEEN SECTIONS A-A AND A-A TO THE GRADED DITCH SHAPE SHOWN ON SECTION X-X. AFTER COMPLETION OF THE MEDIAN BRIDGE PIERS, BACKFILL THE AREA BETWEEN SECTIONS A-A AND A-A TO THE SHAPE OF THE 4" CONCRETE SLOPE PROTECTION SHOWN ON SECTION X-X.

   B. IN FILLS - CONSTRUCT THE MEDIAN BETWEEN SECTIONS A-A AND A-A TO THE GRADED DITCH SHAPE SHOWN ON SECTION X-X. AFTER COMPLETION OF THE MEDIAN BRIDGE PIERS, CONSTRUCT THE AREA BETWEEN SECTIONS A-A AND A-A TO THE SHAPE OF THE 4" CONCRETE SLOPE PROTECTION SHOWN ON SECTION X-X. THE MEDIAN EARTH BERMS BETWEEN SECTIONS J-J AND A-A, AS SHOWN IN PERSPECTIVE VIEW, MAY BE CONSTRUCTED PRIOR TO COMPLETION OF THE MEDIAN BRIDGE PIERS.

2. CONCRETE SLOPE PROTECTION

   PLACE THE 4" CONCRETE SLOPE PROTECTION IN ACCORDANCE WITH THESE DETAILS AS PART OF THE PAVING CONTRACT. PROPERLY SHAPE AND FIRMLY COMPACT EARTH MATERIAL BEFORE PLACING SLOPE PROTECTION REINFORCING AND CONCRETE. FINISH THE CONCRETE SURFACE WITH A WOODEN FLOAT.

   TRANSVERSE JOINTS: FORM A GROOVED JOINT 1" DEEP WITH $\frac{1}{8}$" RADII AT APPROXIMATELY 10' INTERVALS. LOCATE A GROOVED JOINT OR A CONSTRUCTION JOINT SO AS TO INTERSECT THE EXPANSION JOINT MATERIAL PLACED AROUND EACH PIER. NO SEALING OF THESE JOINTS IS REQUIRED. WIRE MESH TO BE LAPPED 6" AT ALL CONSTRUCTION JOINTS. SPACE CONTRACTION JOINTS AT 25' INTERVALS.

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