
PAVEMENT CONDITION SURVEYS OF ULTRATHIN WHITETOPPING PROJECTS

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USE OF CONCRETE OVERLAYS ON ASPHALT (WHITETOPPING) IN THE UNITED STATES

Portland cement concrete overlays of existing asphalt pavements, often called "whitetopping," is an established rehabilitation method used extensively throughout the United States. In 1994, a survey of projects (1) documented 189 concrete resurfacings of asphalt pavement on highways, airfields, streets and county roads. These whitetopping projects were geographically spread throughout the United States with projects in 33 states. With few exceptions the concrete overlay thickness ranged from 100 mm (4 in.) (city streets) to 450 mm (18 in.) (airfields).

AN EARLY EXPERIMENT WITH ULTRATHIN WHITETOPPING (UTW)

While whitetopping is an established technique, most concrete overlays of asphalt pavements have been 100 mm (4 in.) or greater in thickness. Less documentation exists on whitetopping projects less than 100 mm (4 in.) thick (2,3,4,5,6).

To examine the use of ultrathin concrete overlays on asphalt, an experiment was undertaken in Louisville, Kentucky, beginning September 1991 (2). The experiment included the construction of two thicknesses of concrete overlay, 90 mm (3 1/2 in.) and 50 mm (2 in.), on the access road to a waste disposal landfill. The access road serves 400 to 600 trucks per day, 5 1/2 days per week. It was viewed as an accelerated test as this rate of truck loadings is 20 to 100 times greater than the number of trucks experienced by many lower volume roads, streets and parking areas in the United States. Pavement performance was monitored for thirteen weeks.

Some of the significant findings (3) from the Louisville UTW experiment included:

1. Ultrathin whitetopping 50 to 90 mm (2 to 3 1/2 in.) thick can carry traffic loadings typical on many low-volume roads, residential streets, and parking lots.
2. Bond occurs between the concrete overlay and the existing asphalt. Such bonding significantly reduces the calculated stresses in the concrete overlay.
3. Corner cracking was the predominant pavement distress.
4. Joint spacing has a significant effect on the rate of corner cracking. Pavement with joints spaced at 0.61 m (2 ft) showed considerably less cracking than pavement with 1.83 m (6 ft) joint spacing for 50 mm (2 in.) thick whitetopping.

ULTRATHIN WHITETOPPING DEFINED

When describing pavement thickness, terms such as "thick" and "thin" are relative and depend on the viewpoint and experience of the user. For UTW, a more definitive description is needed. Based on the Louisville experiment and subsequent experience, ultrathin whitetopping can be defined as:

A concrete overlay 50 mm to 100 mm (2 in. to 4 in.) thick with closely spaced joints bonded to an existing asphalt pavement.

ULTRATHIN WHITETOPPING IN THE UNITED STATES

Following the interest generated by the Louisville UTW experiment, a number of ultrathin whitetopping projects were built. Table 1 (7) presents a partial list of UTW projects built from 1992 - 1995.

A few of these projects included investigations of the underlying subgrade, base and asphalt characteristics prior to placing the concrete overlay and some projects are being observed for pavement performance at regular intervals. Pavement distress and performance monitoring and recording are being done on a regular basis on:

- I-85 Truck Weigh Station near Lavonia, Georgia (by Georgia DOT)
- Highway 21 near Belle Plaine, Iowa (by Iowa State University)
- 119th Street in Leawood, Kansas (by Kansas DOT)
- Albermarle County Route 29, Virginia (by Virginia DOT)

Most of the other projects, however, were built with very little investigation of the existing pavement materials, thickness or condition. Other than occasional observations by interested individuals, no systematic approach was established for monitoring pavement performance on most projects listed in Table 1.

PAVEMENT CONDITION SURVEYS USING THE PAVER SYSTEM PROTOCOL

Recognizing that many pavement engineers and specifying agencies would be interested in the performance of UTW sections, nine projects were selected from Table 1 for pavement condition surveys. Upon site visits, it was determined that two of the projects (I-85 Weight Station and Cusick Street) should each be separated into two projects because of significant differences in materials (I-85 Weigh Station) or performance (Cusick Street). This resulted in eleven projects for study.

These projects were selected for these reasons:

1. They are some of the first UTW sections constructed in the U.S.
2. They are constructed with concrete of similar proportions.
3. They are located in relatively close proximity.
4. With one exception, the roadways are of similar use.
5. It was not necessary to stop traffic to conduct the pavement condition survey.

A system for determining pavement condition should be objective and repeatable and should identify distresses that effect the pavement's structural integrity and functional condition. The PAVER System (8) meets these criteria. The pavement is visually observed for nineteen separate concrete pavement distresses. The type, amount and severity of distress is observed and recorded. Additionally, a composite numerical index from 0 to 100 is calculated. This composite index is called the Pavement Condition Index (PCI). The pavement's general rating based on PCI is shown in Table 2.

All panels of all eleven projects were surveyed for 18 of the 19 PAVER System concrete pavement distresses. Joint sealant damage was not recorded because the joints were intentionally left unsealed. Distress type and severity (high, medium or low) were recorded individually for each panel. Most of the condition surveys were made in July or August 1995 and again in July or August 1996.

A MicroPAVER (9) record is maintained for each project. This allows the calculation of the Pavement Condition Index. No deduction is taken for the lack of joint sealant material. Additionally, written records are maintained which note the type and severity level of distress in each panel. A separate written record is maintained for each yearly survey, allowing a comparison of distress from year to year.

PROJECT DESCRIPTIONS

Belvoir Avenue - Chattanooga, Tennessee

This two lane intersection approach was overlaid with fibrous ultrathin whitetopping on November 10, 1993. Approximately 29 m (95 ft) of intersection approach was milled and 63 to 75 mm (2 1/2 to 3 in.) of fibrous

concrete was placed, 6.1 m (20 ft) wide. No asphalt cores were taken prior to the overlay, therefore the remaining asphalt thickness is unknown. The concrete overlay was jointed in 1.5 m x 1.5 m (5 ft x 5 ft) squares, resulting in 76 panels for the 177 m² (1900 ft²) ultrathin whitetopping overlay. Belvoir Avenue intersects with Brainerd Road at this location.

28th Street - Chattanooga, Tennessee

This intersection approach was overlaid with fibrous ultrathin whitetopping on July 28, 1992. The street is four lanes wide, two lanes each direction. The inside lane in one direction was milled and approximately 63 to 75 mm (2 1/2 to 3 in.) of UTW was placed over a length of 46 m (150 ft) and width of 4.6 m (15 ft). No cores to determine remaining asphalt thickness or condition were taken. In subsequent investigation, two cores were taken. In one core, no asphalt was found, indicating the milling operations had removed all of the asphalt in that area. At the other core location, about 225 mm (9 in.) of poor quality, low strength bituminous material was found. The UTW was jointed transversely at 1.5 m (5 ft) and longitudinally at 1.1 m (3.75 ft) creating 120 panels totaling 209 m² (2,250 ft²) in area.

Green Street - Athens, Tennessee

This intersection approach is approximately 58 m (190 ft) long. The outside lane of this four lane roadway (two lanes each direction) was milled and about 63 mm (2 1/2 in.) of fibrous UTW was placed on January 12, 1994. The width of the UTW section varies near the intersection. The UTW extends into the intersection some distance, so that the last six panels receive traffic from two directions. For most of the area, the UTW is three panels wide with longitudinal joints typically at 1.1 m (3.67 ft) spacing. The section is 63 panels long with transverse joints at 0.9 m (3 ft) spacing. The UTW section widens near the intersection, resulting in five sections that are four panels wide and one section that is five panels wide. The total number of panels is 196 and the total area is approximately 200 m² (2,156 ft²). No cores were taken to determine remaining asphalt thickness or condition after milling. The roadway has an uphill grade of about 8% at this location. The intersecting street is North Jackson Street.

Tennessee State Highway 56 - McMinnville, Tennessee

This fibrous UTW intersection approach is 11.0 m (36 ft) wide, approximately 49 m (162 ft) long with sawed joints at 0.9 m (3 ft) spacing in each direction. The total number of panels is 648. The total UTW area is 542 m² (5,832 ft²). The roadway carries three lanes of one-way traffic. The existing asphalt was milled and 63 to 75 mm (2 1/2 to 3 in.) of UTW was placed on September 18, 1993. No cores were taken to establish the remaining asphalt thickness or condition. The intersecting street is Highway 70 South.

Concord Street - Knoxville, Tennessee

This 34.1 m (112 ft) long fibrous UTW intersection approach is jointed transversely at 1.2 m (4 ft). The 3.2 m (10.6 ft) wide section is three panels wide. The longitudinal widths of the panels are 1.0, 1.0 and 1.2 m (3.25, 3.33 and 4 ft). The asphalt surface was milled and a fibrous UTW overlay approximately 88 to 100 mm (3 1/2 to 4 in.) thick was placed on November 13, 1992. No cores were taken to establish the remaining asphalt thickness or condition. The roadway is at a down grade of 3% - 4% in the UTW section. The intersecting street is Kingston Pike.

Cusick Street - Maryville, Tennessee

This intersection approach is about 38 m (124 ft) long, two lanes wide. The outside lane is 3.7 m (12 ft) wide, with longitudinal joints at 1.2 m (4 ft) spacing. The inside lane is 3.0 m (10 ft) wide, divided into 1.5 m (5 ft) sections by a longitudinal joint. Transverse joints are spaced at 1.2 m (4 ft) in both lanes. The total UTW area is 253 m² (2,728 ft²), with 138 m² (1,488 ft²) in the outside lane and 115 m² (1,240 ft²) in the inside lane. The outside lane of UTW was placed on August 3, 1993; the inside lane of UTW was placed on the following day. Fibrous concrete was used for both lanes. Milling was done within 24 hours before the first concrete was placed. The UTW is 63 to 75 mm (2 1/2 to 3 in.) thick. No cores were taken to determine the remaining asphalt thickness or condition. Cusick Street intersects with Harper Avenue at this location. Because of the differing UTW performance and joint spacing, this project is divided into two sections for reporting - Cusick Street (outside lane) and Cusick Street (inside lane).

I-85 Weigh Station - Near Lavonia, Georgia

This UTW project consists of two pavement sections. The approach side to the truck scale consists of about 200 m² (2,148 ft²) of UTW, approximately 50 mm (2 in.) thick, jointed in 0.6 m x 0.6 m (2 ft x 2 ft) squares. There are a total of 537 such panels. The leave side of the truck scale consists of 49 m² (532 ft²) of UTW, also approximately 5 mm (2 in.) thick jointed in 0.6 m x 0.6 m (2 ft x 2 ft) squares for a total of 133 panels. Both UTW sections were placed on May 26, 1993. The approach side UTW consists of fibrous concrete with mixture proportions similar to that shown in Table 3. The leave side UTW contains no fibers. After milling, the remaining asphalt thickness was reported to be about 280 mm (11 in.). The Georgia Department of Transportation reviews the condition of these sections on a regular basis, reporting cumulated traffic in terms of 80 kn. (18,000 lb.) equivalent single axle loads (ESALs). Because of the varying concrete mixture proportions and pavement condition, this project is divided into two sections for this report - I-85 Weigh Station (approach side) and I-85 Weigh Station (leave side).

Wesley Chapel Road - DeKalb County Georgia

This fibrous UTW intersection approach is approximately 63 mm (2 1/2 in.) thick. It consists of 111 panels, each 1.2 m x 1.2 m (4 ft x 4 ft) in size for a total area of 165 m² (1,776 ft²). The northbound section of Wesley Chapel Road consists of left turn lane, right turn lane, and two through traffic lanes at this location. The UTW section constitutes 45 m (148 ft) of the outside through lane approaching the intersection. The concrete overlay was placed on September 22, 1993. The precise thickness of remaining asphalt is unknown, but known to be in excess of 200 mm (8 in.). The UTW is at an upgrade of about 4%.

Marbut Road - DeKalb County Georgia

This 76 m (250 ft) long fibrous UTW intersection approach was constructed on September 21, 1993. The transverse joints are spaced at 1.2 m (3.83 ft). The longitudinal joints average 1.1 m (3.5 ft) spacing. There are 260 panels totaling approximately 325 m² (3,500 ft²). The UTW is 63 to 75 mm (2 1/2 to 3 in.) thick. The remaining asphalt thickness and condition is unknown. Marbut Road intersects Lithonia Industrial Boulevard at this location at an average down grade of about 4%.

PROJECT CONCRETE MIXTURE PROPORTIONS

All of the UTW projects surveyed for this report were constructed with concrete of similar mixture proportions. Typical concrete mixture proportions are shown in Table 3. It is important to note that a wide variety of other concrete mixture proportions have been used for projects listed in Table 1. Table 3 is provided for general information and indicates only the typical proportions of the concrete for these specific UTW projects and should not be misconstrued for any other conclusion. Except for the typical mixture proportioning information shown in Table 3, there are no other known concrete properties to report at this time.

TYPICAL CONSTRUCTION PROCEDURES

All of the projects were constructed in a similar manner. The existing asphalt was milled to produce the desired thickness of concrete overlay. In most cases, milling was done 24 to 48 hours before paving. The milled asphalt surface was usually broomed to remove debris prior to placing of the concrete. Sometimes the surface of the asphalt was flushed with water to aid in cleaning. No bonding agent was applied. Concrete, produced in a commercial ready mix concrete operation, was placed directly on the milled asphalt surface. The concrete was struck off and consolidated with a vibrating screed. The concrete surface was usually bullfloated, then textured with a broom. White pigmented curing compound was applied. Joints were always sawed, usually using an early sawing technique. Ambient air temperatures varied from project to project from less than 4.5° C (40° F) to over 32° C (90° F) during the overlay construction.

TRAFFIC LOADINGS

The weight and number of vehicles using a concrete pavement is known to have a significant effect on pavement performance. Detailed traffic information is available for only two of these sections - I-85 Weigh Station

(approach side) and I-85 Weigh Station (leave side). The Georgia Department of Transportation has monitored the number of vehicles (all vehicles were trucks) and has provided a estimated 80,000 N (18,000 lb.) equivalent single axle load estimate for these two sections.

Traffic on the other sections was estimated from traffic volume measurements or observations. The Tennessee Department of Transportation has measured traffic volumes and estimated the percentage of truck estimates for five of the projects (Green Street, Tennessee S.H. 56, Concord Street, and the two Cusick Street sections). For the other projects (Belvoir Avenue, Wesley Chapel Road, and Marbut Road), an estimate of traffic volume and percentage of truck traffic has been made from observations.

As no truck weight measurements are available (except on I-85 Weigh Station sections), the distribution of axle load weights for estimating ESALs is not known. A constant factor of 0.75 ESAL/truck has been used to estimate ESALs for all projects except I-85 Weigh Station. On the I-85 Weigh Station projects, the applied ESALs estimated by Georgia DOT is presented. It is important to note that all loads on the I-85 project are fully-loaded trucks near or above the legal load limit in the State of Georgia.

Based on this available information and assumptions, the traffic loading on these projects is shown in Table 4.

RESULTS OF PAVEMENT CONDITION SURVEYS

The UTW pavement sections were surveyed for condition using the PAVER System protocol. The most prominent distresses included corner cracking, linear cracking and divided slab. With the exception of the 28th Street project in Chattanooga, Tennessee, the majority of cracking was of low severity. Excluding 28th Street, 94% of the cracks and divided slabs were of low severity, 6% were of medium severity and none were of high severity in the 1996 condition surveys. On the Marbut Road project, 97 of 260 panels contained shrinkage cracks that were visible shortly after paving which have remain unchanged. The amount of observed cracking and the corresponding Pavement Condition Index is summarized for all sections except 28th Street in Table 5.

OBSERVATIONS ABOUT PAVEMENT CONDITION

A large number of factors can influence the performance of concrete pavements. Additionally, for ultrathin whitetopping, the thickness and condition of the existing asphalt, pavement subgrade support properties, spacing of joints in the overlay and degree of bonding between the asphalt and concrete overlay have been analytically shown (10) to significantly effect stresses (and resulting cracking) in the concrete overlay. In this study, the lack of information about the existing asphalt (condition and thickness) and foundation support properties is particularly limiting to further analysis of UTW performance. Therefore, only general observations can be offered.

28th Street - Chattanooga, Tennessee

This UTW pavement was surveyed July 1995, approximately three years after construction. It was in poor condition with considerable cracking. Many of the medium and high severity divided panels were sunken and uneven. Twenty of the 120 panels had been previously replaced. It can probably be assumed that these 20 panels were badly cracked before they were replaced. Therefore, these 20 panels were considered as high severity divided slabs for determining the PCI. The pavement distress in July 1995 is shown in Table 6.

The PCI in July 1995 was 32 (Poor). The section was almost unserviceable and was not resurveyed in 1996. Cores taken from the pavement after construction indicate no asphalt or asphalt in very poor condition underlying the concrete overlay. This section is not representative of a proper UTW section. Therefore, this section should be further investigated on its own and will not be considered further in this study.

Pavement Condition Index (PCI) and Pavement Age

Figure 1 shows the relationship of Pavement Condition Index to age (years). For each pavement section studied (10 total) there are three known or estimated PCI values - one at time of construction (estimated), one in 1995 and one in 1996 for a total of 30 data points.

Figure 1 shows that the PCI is decreasing with time, as would be expected. While it is too early to anticipate the remaining pavement life with much confidence, this observer is of the opinion that these ten UTW pavements, with no unexpected change in traffic loadings, will serve eight to twelve years before the Pavement Condition Index drops below 55 (Good).

Pavement Condition Index (PCI) and ESALs

Figure 2 shows the relationship of Pavement Condition Index to total accumulated ESALs. Again, for each section there are three known or estimated PCI values - one at the time of construction (estimated), one in 1995 and one in 1996 for a total of 30 data points.

Figure 2 generally shows that PCI is decreasing with increasing ESALs, as would be expected. Closer examination, however, reveals three of the four sections with the lowest PCI also have low ESAL accumulations. The two sections with the highest PCI have accumulated the most ESALs. This is in conflict with expected behavior and warrants more study.

Two sections with high PCI and high accumulated ESALs are at the I-85 Weigh Station in Georgia. There are five characteristics of these sections worth noting:

1. All loads are fully loaded trucks.
2. All trucks move at low speeds across the UTW section as they approach or leave the scales.
3. The total number of vehicles is significantly less on these sections than the other section, although the weight per vehicle is considerably more.
4. The underlying asphalt pavement has been cored for thickness and found to be at least 225 mm (11 in.) thick.
5. The pavement was jointed in 0.61 m x 0.61 m (2 ft x 2 ft) squares, smaller than all other projects.

Joint spacing and underlying asphalt thickness have been analytically shown to effect overlay stresses and resulting cracking. The I-85 sections have the smallest panel size of all projects surveyed. Although underlying asphalt thickness of the other projects is not known at this time, it is likely that most, if not all, are substantially less than 225 mm (11 in.).

Concentration of Cracking Near Approach and Leave Ends

Observations of the location of cracks within the ten UTW sections indicates a significant concentration of cracking near the approach and leave ends. Cracking in the end panels (first and last panels) of the sections is summarized in Table 7. The information in Table 7 clearly shows evidence of increased cracking in end panels. For instance, the total percentage of cracked panels in the Belvoir Avenue UTW section in 1996 was 21%. However, 75% of the first and last panels were cracked, indicating that the end panels were cracked at a much higher proportion than those in the remainder of the section. The average cracking for all sections in total was 14% in 1996, while 44% of all end panels contained cracks. This increased cracking in the end panels could be attributed to:

- 1) impact loading from vehicles moving across the junction of the asphalt roadway and concrete overlay, particularly when the junction is not smooth.
- 2) vehicle loads rolling across the concrete overlay's free edge.
- 3) debonding of the concrete overlay at the free edge.
- 4) a combination of these factors.

Cracking and Panel Size

The relationship between panel size and the percentage of total cracking on these projects is shown in Figure 3. A clear relationship is hard to discern from these ten projects at this time, although the general trend is toward more cracking with larger panels. Undoubtedly, several factors are contributing to the variable amount of cracking. It is interesting to note, however, that the two sections with the highest percentage of cracking also have the largest panel size. The amount of cracking is less when the panel area is less than or equal to about 1.5 m² (16 ft²).

CONCLUSIONS

Since its inception in 1991, ultrathin whitetopping use has increased throughout the United States. Regular observations of performance are being made on at least four projects by the specifying agency or an associated research agency.

Additionally, yearly pavement condition surveys are being made on ten UTW sections in Georgia and Tennessee using the PAVER System protocol. Most of these projects were built in 1992 or 1993, with two rounds of visual distress monitoring now available. Based on these observations, the following conclusions are offered:

1. Most sections (9 of 10) rate EXCELLENT according to PAVER System criteria.
2. All sections have maintained a rating of VERY GOOD or better according to PAVER System criteria.
3. With no unexpected change in traffic loadings, these ten sections can be expected to serve eight to twelve years before the P.C.I. drops below 55 (Good).
4. Large majority (94%) of cracking is of low severity and does not appear to be effecting pavement ride. Most cracks are less than 0.5 mm (0.02 in.) wide.
5. The first and last panels (approach and leave ends) contain a higher percentage of cracking than the remainder of the sections.
6. The apparent relationship between PCI and accumulated traffic loads (ESALs) contradicts expected behavior. The two sections with highest ESALs have the highest PCI while three of five sections with the lowest PCI have low ESAL estimates.
7. Sections with the highest PCI have the smallest panel size and significant underlying asphalt thickness.
8. Future studies of UTW performance should include information about the of underlying asphalt thickness and condition and other information about base and subgrade properties.

TABLE 1 Partial List of UTW Projects (1992 - 1995)

State	Location	Construction Date	Thickness mm	(in.)	Approx. Size m ²	(yd ²)
Georgia	Truck weigh station near Lavonia (I-85)	May 93	65	(2½)	235	(280)
Georgia	Marbut Rd. (DeKalb Co.)	Sep 93	75	(3)	325	(390)
Georgia	Wesley Chapel Rd. (DeKalb County)	Sep 93	75	(3)	170	(200)
Georgia	Westview and Holderness (Atlanta)	Jun 95	75	(3)	200	(240)
Illinois	Holiday Inn Parking Lot (Decatur)	Oct 94	75	(3)	22,600	(27,000)
Iowa	Highway 21 (Victor to Belle Plaine)	Jun 94	50	(2)	13,400	(16,000)
Kansas	119th Street (Leawood)	Apr 95	50	(2)	14,000	(16,534)
Minnesota	Trunk Hwy. 169 (Mankato)	Jul 95	75	(3)	220	(265)
Missouri	Spirit of St. Louis G.A. Apron (St. Louis)	Dec 94	90	(3½)	11,700	(14,000)
New Jersey	I-295 Exit Ramp (Bordertown)	Aug 94	75	(3)	1950	(2,320)
No. Carolina	Wrightsville Beach street	Jul 94	65	(2½)	920	(1,100)
No. Carolina	Wrightsville Beach street	Jul 94	65	(2½)	920	(1,100)
Ohio	Taylor Sta Rd (Franklin Co.)	Jul 95	50	(2)	465	(555)
Pennsylvania	6th and Linden (Allentown)	Aug 94	75	(3)	225	(270)
Pennsylvania	8th and Linden (Allentown)	Aug 94	75	(3)	315	(375)
Pennsylvania	Allentown Bethlehem Easton Airport	Nov 94	75	(3)	150	(180)
Pennsylvania	Route 22 Ramp onto I-83	Oct 95	90	(3½)	1,160	(1,385)
Pennsylvania	Route 30 (Lancaster)	Oct 95	90	(3½)	334	(400)
Tennessee	First Street and Woodland (Nashville)	May 92	65	(2½)	280	(335)
Tennessee	S. Hickory and 28th St. (Chattanooga)	Jul 92	75	(3)	210	(250)
Tennessee	Concord Road (Knoxville)	Nov 92	90	(3½)	135	(160)
Tennessee	Cusick St. (Maryville)	Aug 93	75	(3)	290	(345)
Tennessee	Highway 56 (McMinnville)	Oct 93	75	(3)	210	(250)
Tennessee	Belvoir Ave. (Chattanooga)	Nov 93	75	(3)	170	(200)
Tennessee	Green St. (Athens)	Jan 94	75	(3)	210	(250)
Tennessee	Lamar Ave. and Winchester (Memphis)	Dec 94	90	(3½)	2,700	(3,200)
Tennessee	Lamar Ave. and Shelby Drive (Memphis)	Dec 94	90	(3½)	2,700	(3,200)
Tennessee	Highway 51 and Watkins (Memphis)	Dec 94	90	(3½)	2,300	(2,800)
Tennessee	Popular and Kirby (Memphis)	Dec 94	90	(3½)	2,300	(2,800)
Tennessee	US Hwy 11, Paul Huff Pkwy (Cleveland)	Aug 95	75	(3)	490	(580)
Tennessee	Stage Road & Covington Pike (Memphis)	Dec 95	75	(3)	4,000	(4,800)
Virginia	Co. Rt. 29 (Albermarle Co.)	Jun 95	50	(2)	4,500	(5,300)

Table 2 General Rating Based on PCI

PCI	General Rating
86-100	Excellent
71-85	Very Good
56-70	Good
41-55	Fair
26-40	Poor
11-25	Very Poor
0-10	Failed

TABLE 3 Typical Concrete Mixture Proportions for UTW Project Surveyed

Ingredient or Property	Amount or Value	
Cement (ASTM C 150, Type I)	474 kg/m ³	800 lb./cy)
Coarse Aggregate (#8 Crushed Limestone)	10700 kg/m ³	(1799 lb./cy)
Fine Aggregate (Natural Sand)	950 kg/m ³	(1152 lb./cy)
Total Air Content	4% - 6%	
Polypropylene Fibers	1.8 kg/m ³	(3 lb./cy)
Water/Cement Ratio	.33	
Admixtures	Varied as needed for slump control and construction conditions	

TABLE 4 Estimated Traffic Loadings on UTW Sections

Project	Estimated Vehicles/Day on UTW	Estimated % Trucks	Estimated Total Vehicles on UTW* (millions)		Estimated Total Trucks on UTW* (thousands)		Estimated ESALs on UTW** (thousands)	
			1995	1996	1995	1996	1995	1996
Belvoir Avenue	2,000	4	1.21	1.95	48	78	36	59
Green Street	4,200	6	2.28	3.84	137	230	103	173
Tennessee S.H. 56	4,800	6	3.18	4.96	191	298	143	224
Concord Street	2,070	4	2.09	2.65	84	106	63	80
Cusick St. (outside)	5,600	4	4.19	6.03	168	241	126	181
Cusick St. (inside)	3,740	4	2.79	4.02	112	161	84	121
I-85 Weigh (approach)		100	.07	.11	73	105	300	430
I-85 Weigh (leave)		100	.07	.11	73	105	300	430
Wesley Chapel Road	5,250	5	3.42	5.52	171	276	129	207
Marbut Road	800	20	.33	.52	66	194	50	78

*From construction date to condition survey date

**80 kn. (18,000 lb.) Equivalent Single Axle Load from construction date to condition survey date

TABLE 5 Condition of Ten Ultrathin Whitetopping Sections

Section	Number of Panels (Total)	Percent of Panels Containing Distress				Pavement Condition Index (PCI)			
		Corner Breaks		Linear Cracking		Divided Slabs		Total Cracking	
		1995	1996	1995	1996	1995	1996	1995	1996
Belvoir Avenue	76	7	11	5	9	1	1	13	21
Green Street	195	2	5	1	3	0	0	3	8
Tennessee S.H. 56	648	3	6	5	6	1	3	9	15
Concord Street	84	1	1	1	2	0	0	2	3
Cusick St. (outside)	93	6	6	9	9	0	1	15	16
Cusick St. (inside)	62	23	27	16	19	5	5	44	51
I-85 Weigh (approach)	537	0	0	2	2	0	0	2	2
I-85 Weigh (leave)	133	0	0	7	8	0	1	7	9
Wesley Chapel Road.	111	0	3	5	6	1	2	7	11
Marbut Road	260	3	3	1	2	0	2	4	7
								90	86
								97	93
								89	86
								96	94
								93	89
								75	71
								97	97
								95	93
								95	92
								95	91

TABLE 6 Summary of Distress on 28th Street, Chattanooga, Tennessee (1995)

Distress Type	Number (percent) of Panels with Distress
Divided Slab - Low Severity	8 (7)
Divided Slab - Medium Severity	21 (18)
Divided Slab - High Severity	29 (24)
Linear Crack - Low Severity	5 (4)
Linear Crack - Medium Severity	3 (2)
Joint Spall - Low Severity	11 (9)
Joint Spall - Medium Severity	1 (1)

TABLE 7 Concentration of Cracking in End Panels

Project	Total Number of Panels	Number of End Panels	Percent of End Panels with Cracks (1996)	Percent of Total Panels with Cracks (1996)
Belvoir Avenue	76	8	75	21
Green Street	195	6	0	8
Tennessee S.H. 56	648	24	63	15
Concord Street	84	6	0	3
Cusick St. (outside)	93	6	67	16
Cusick St. (inside)	62	4	100	51
I-85 Weigh (app.)	537	16	0	2
I-85 Weigh (leave)	133	14	14	9
Wesley Chapel Road.	111	6	67	11
Marbut Road	260	8	50	7
Average =			44%	14%

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