ULTRATHIN PAVEMENTS MAKING THE GRADE

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INTRODUCTION

In 1994, the Iowa Department of Transportation (Iowa DOT), Federal Highway Administration and Iowa State University joined forces to construct an 11.6 km ultrathin portland cement concrete overlay research project. This marked the beginning of the use of thin whitetopping for rehabilitation of existing asphalt roadways on primary highways in Iowa.

The research was designed to evaluate long term performance of ultrathin whitetopping. Four major variables were chosen for evaluation and 41 test sections, each 213 m in length, were constructed. Some 24 additional sections were used to transition from one set of parameters to the next.

Research efforts over the last two years have consisted of visual distress surveys conducted on a quarterly basis and measurement of overlay interface strains measured three times per year at some 35 sites on the project.

This paper provides insight into the changes in condition of the test sections which have occurred since construction over two years ago. The overall performance to date has been very good. Isolated areas of distress have been noted and are beginning to provide some trends in the data.

PROJECT DESCRIPTION

Located on Iowa Highway 21 in Iowa County, the project lies between U.S. 6 and Iowa Highway 212, a distance of 11.6 km. The existing pavement, constructed in 1961, is composed of 150 mm of rolled stone base, 175 mm of cement treated base, and topped with a seal coat. A 75 mm of asphaltic cement concrete (ACC) pavement was constructed in 1964 and a seal coat was placed in 1987. Existing traffic is estimated at 1350 vehicles per day with 13% trucks.

RESEARCH OBJECTIVES

Table 1 identifies each of the 41 test sections and 24 transitions sections constructed. Figure 1 shows the layout of each section in the research project. Table 2 lists the 41 sections which will be studied in this research and identifies the variables employed in each section.

Four major variables were incorporated into this project:

Thickness

The primary thicknesses include: 50 mm, 100 mm, and 150 mm. Three sections were constructed at 200 mm thickness including one reconstruction section at the beginning of the project. The other two 200 mm sections were differentiated through the inclusion or exclusion of dowels in the transverse contraction joints. Three sections of ACC resurfacing, 115 mm in thickness, were also constructed.

The actual constructed depths of the pavement in each section are listed in Table 3. Depths of the plastic concrete were measured near each edge (Lt and Rt) and at centerline (CL), as prescribed by Iowa Department of Transportation instructions, by inspection staff. No checks were made in the 200 mm reconstructed Section #1. Transitions in depth are noted by "T", and asphalt sections by "ACC."

Joint Pattern (transverse/longitudinal)

The research pavement joint pattern based on the Kentucky research (1) was developed in varying square sizes to evaluate panel size as it relates to thickness, particularly for very thin concrete pavement. Panels were constructed in squares of 0.6 x 0.6 m, 1.2 m x 1.2 m, and 1.8 x 1.8 m for the 50 mm, 100 mm and 150 mm depth sections. Thicker pavement sections were jointed with a conventional scheme, that is, a centerline joint and transverse joints at 3.7 m spacing. The two 200 m thick sections had spacing of 4.6 m and the reconstruction section utilized a spacing of 6.1 m.

Fiber Reinforcement

Two types of polypropolene fibers, monofilament and fibrillated, were employed in this project to evaluate their effect on distress control in the thin pavement overlay sections. Sections of equal depth and joint patterns were placed, some with and some without fibers.

This type of fiber resembles "angel hair" and each strand lengths were approximately 40 mm.

A dosage rate of 1.8 kg/m^3 was used. This is twice the manufacturer's recommended rate but consistent with the rate used in the first ultrathin project in Kentucky. Table 4 identifies the sections containing each type of fiber and those containing no fibers. This is a detailed list vs. the general variable list of sections in Figure 1.

Base Preparation

Three types of base preparation were utilized prior to the concrete and asphalt overlays. The project was divided approximately into thirds. The south one third of the project was patched and the surface milled to remove road surface oils and provide a rough bonding surface. Previous research conducted by the Iowa DOT indicated that bond is enhanced with this type of preparation. The middle portion of the project was patched and broom cleaned. The northern one third of the project base was prepared by cold-in-place recycling of the 75 mm asphalt surface.

Other Variables

A hot pour type joint sealant was employed where pavement thickness of greater than 100 mm were constructed. The 50 mm and 100 mm thick pavement sections did not have joint sealant placed in the joints, except for five sections.

Conventional concrete construction procedures (slipform) and paving mixtures were specified. Most ultrathin whitetopping projects built to date have utilized some form of early opening concrete, i.e. Fast Track. This project was specifically intended to evaluate ultrathin whitetopping performance where a conventional paving mixture was used. Therefore, the concrete mixture was not a variable. Table 5 lists the concrete proportions.

RESEARCH

Iowa State University conducted laboratory research, field test site development, and field evaluation prior to and during construction. Evaluation in terms of visual distress surveys and strain measurements will continue quarterly for the first five years. Deflection evaluations are conducted annually using a falling weight deflectometer (FWD) and a RoadRater to monitor bond strength, pavement structure, and load transfer. Table 6 presents the information from this testing. The structural number is a result of correlating the deflections measured, to a core thickness. An AASHTO value of 0.5/25 mm of PCC depth is assumed. Table 6 relates the values before overlay (4/28/94) to two measurements after paving. Iowa does not have a correlation value for composite depths. The table values do show increases after paving (potential bonding/composite action) and retention of this potential overtime.

CONSTRUCTION

This project was constructed in 1994, between June 24 and July 27. A construction report for this research, designated Project HR-559, is entitled "Ultra Thin PCC Overlays" and is available from the Iowa DOT.

One feature became a variable inadvertently. The contractor began the project by having water from the ready mix delivery trucks sprayed on the surface of the asphalt immediately ahead of the paver. This is not the recommended practice. Wetting the grade ahead of paving is required on new construction, but not on overlays. The practice was stopped when it was discovered, but this was not until Section 15 had been constructed. Therefore, approximately half of the sections with the base preparation type of patching and scarifying were constructed with a watered surface and half without.

INITIAL CONDITION

Project construction resulted in a defect free pavement with the exception of materials placed July 11 and 12. Sections 36 through 48 were constructed on those days. Of those, Sections 36, 39, 41, 43, and 45 experienced transverse cracking that was recorded in the first two condition surveys (8/6 & 10/29/94). Section 39 contained the most with 26 cracks found in the first survey. These cracks are classic examples of those which form due to late sawing. They begin near the transverse joint at one edge of the pavement and join the sawed transverse joint near the centerline. Another crack begins at the other edge and joins the transverse sawed joint about 1 m from that edge. This happens when one begins sawing about 1 m from the edge and as the saw passes the area just across the center line, enough pavement has been relieved to allow cracking to happen ahead of the saw and behind the saw. Therefore, the authors feel this cracking was construction related and is not an adverse effect of any of the research variables.

PERFORMANCE RELATED FACTORS

Additional factors which may affect the long term performance of the pavement are traffic loadings and environmental conditions. The following discusses each for the two and one half year period.

Traffic Loading

The traffic estimates for the research site have been verified by use of a weigh-in-motion device installed in each lane near the center of the project. The volumes closely approximate the estimated 1350 Average Daily Traffic (ADT). The number of Equivalent Single Axle Loads (ESAL's) has also matched projections. Currently an average of 40 ESAL's per day are recorded northbound and 20 ESAL's per day southbound. It is estimated that 28,000 ESAL's have been applied to the roadway as of February 1997.

Environmental Factors

Iowa experiences great variations in climatic conditions between seasons. Summer temperatures can exceed 40 °C and winter low temperatures can reach -30 °C. The weather in January 1996 brought an extremely large temperature swing. In Des Moines, Iowa, approximately 100 km from the project, the high temperature on January 13 was 16 °C. The low temperature on January 31 was -29 °C. It is possible that these conditions may have played a role in the cracking and distress that first became evident in 1996.

CONDITION AFTER TWO YEARS

Of the 41 test sections being studied, only minor surface distress has been noted. During the first one and one half years there was no change from the initial conditions for any of the test sections. Severe temperature changes during the second winter and spring resulted in the identification of new crack locations in concrete and asphalt sections.

Of the concrete sections exhibiting a small amount of distress, two have exhibited isolated areas of potential debonding and distress cracking, Sections 23 and 62.

Two other sections have a small amount of cracking but no debonding. The cracks have exhibited no adverse effect to date, Sections 10 and 39.

The three asphalt sections have exhibited transverse cracking.

The visual distresses listed below are as of the visual distress survey conducted in November 1996. It can be summarized in terms of distress type, slab depth and size, and percent of potential slabs that exhibit the distress. Those results are shown in Table 7. Fractured slabs are identified from other types of cracking by a slab containing four or more pieces due to multiple cracks.

Transverse Cracking

The only significant concrete distress has occurred in five test sections in the patch only base preparation area. They were all constructed on two consecutive days in July. The cracking became evident in the first two crack surveys. The cracks have not caused further distress and therefore show no advance effect to date on long term performance. The cause of the cracking can be attributed to the construction process, specifically late sawing of the joints. The three asphalt section also developed a total of 45 full width transverse cracks during the second winter season.

Longitudinal Cracking

Longitudinal cracking has been isolated to two sections in the milled surface area for the 0.6 m joint pattern and two sections with the 1.2 m joint pattern in the same base preparation area and a third section in the recycled area. The amount of longitudinal cracking to date is so small it is almost insignificant. No longitudinal cracks have been noted in the asphalt sections.

Corner Cracking

The cracks in the 50 mm x 1.2 sections have all occurred in three sections in the patch and broom and surface recycle areas of the project. Even though only one section has a significant amount of cracking, there may be more potential for this type of cracking where this thickness and panel size is used. Other cracks have occurred in a random fashion across all base preparation types.

Diagonal Cracking

This distress has been noted in one section of the milled area and one of the recycled base area. The amount is so small it is appropriate to summarize the diagonal cracking as virtually none.

Fractured Slabs

All fractured slabs are located in one test section, Section 62, within the recycled base preparation. They are predominately in one area which is noted in the construction diary as being the location of a paver malfunction. Significant grinding took place in this area. The number of fractured slabs is a very small portion of the total number of slabs in this section.

Potential Debonding

Potential debonding has been located by manual sound testing with a reinforcing bar in four areas within two test sections, Sections 23 and 62. In each case the depth of the concrete is 50 mm. In Section 23 the joints are spaced at 0.6 m and in Section 62 at 1.2 m. The first section involves a patch and broom base preparation and in the second section the deterioration is located over the recycled base. Each of these areas was identified in the August 1996 survey. The area of the four locations identified in Section 62 with cracking and distress is 2% of the area of the entire section. Partial debonding has been found at each of the areas. Steps were taken using epoxy to seal the joints around the debonded slabs. To date no slabs have left the surface of the asphalt.

SUMMARY OF THE CONDITION

- Distress to date has been found only in sections of 50 and 100 mm thicknesses.
- Only two of the eight sections constructed 50 mm in depth exhibit any debonding and distress cracking.
- The two 50 mm thick sections exhibiting debonding and distress cracking contain no fibers. Two 50 mm thick sections exhibiting some cracking but no debonding or distress contain fibers. The other four 50 mm thick sections do contain fibers and show no cracking or debonding.
- One section of the two sections showing some debonding and distress cracking had a significant construction problem occur in the exact location where the distress has become evident.
- Transverse cracking has occurred in all three asphalt sections. The cracking began in late fall of 1995 and winter of 1996, approximately a year and a half after construction.

CONCLUSIONS

It is too early in the life of the pavement sections to find wide spread distress which would differentiate good and poor performance related to the research variables. Since only two sections of the 41 test sections have exhibited any debonding and distress cracking, it can be concluded that after more than two years, the concrete overlay sections have all performed well.
Since the only distress has occurred in the 50 mm and 100 mm thick sections, there may be indications that 50 mm sections are more vulnerable to being adversely affected by construction practices or possible weaknesses in the base and old pavement below. It will be some time before this can be confirmed or invalidated.

The two sections showing some debonding and distress cracking have different sawing patterns. One is cut in 0.6 m squares and the other in 1.2 m squares. Joint spacing as it relates to thickness can not be evaluated at this time.

The milled surface preparation does appear to enhance bonding and reduce the potential for distress in each of the pavement depths.

The two 50 mm sections exhibiting some debonding and distress cracking are the only two 50 mm sections containing no fibers. It may be premature to draw conclusions about the benefits of fibers. But, after more than two years, the thinnest sections with fiber have shown better performance.

FIGURE 1: Test Section Layout

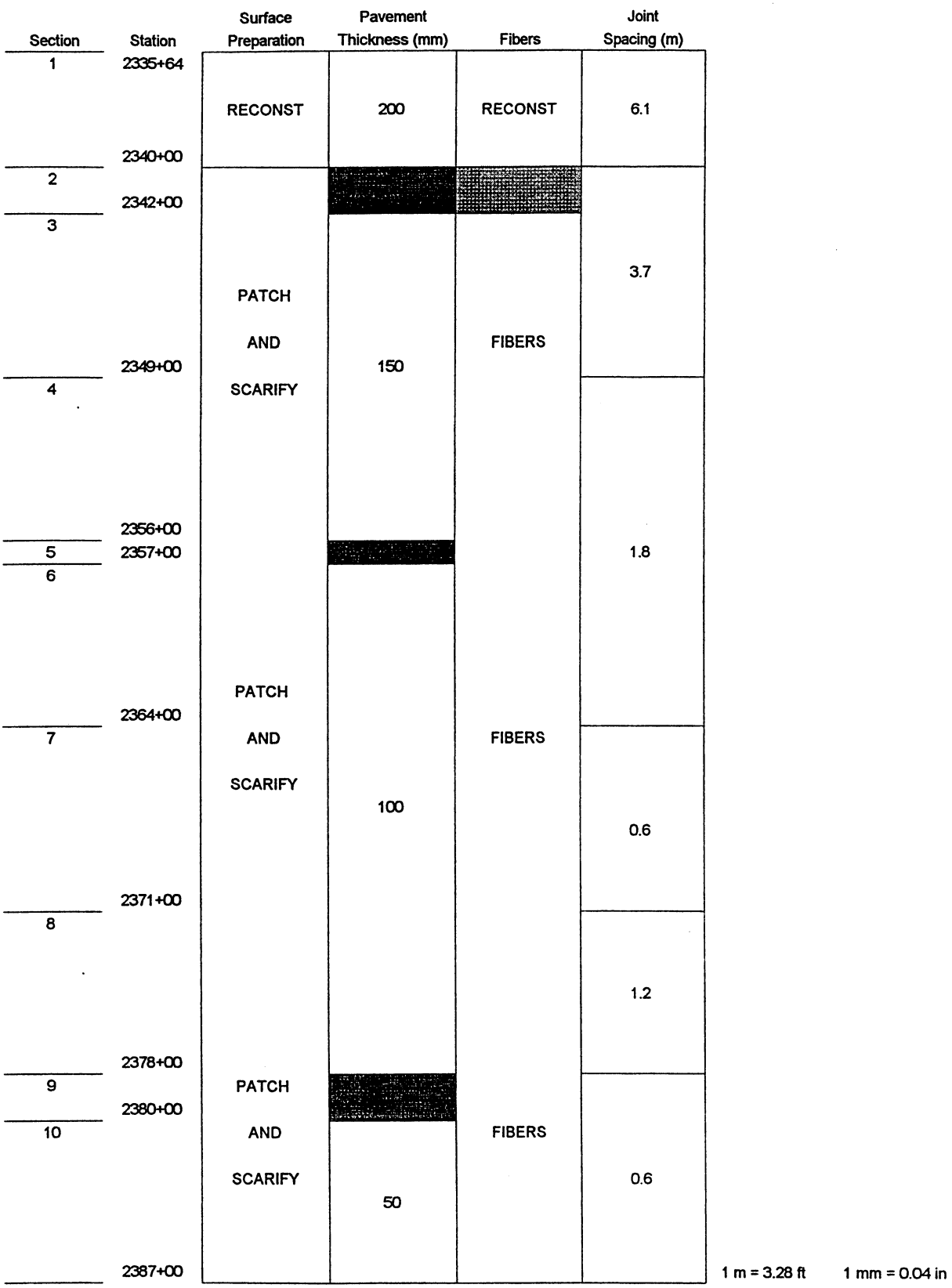


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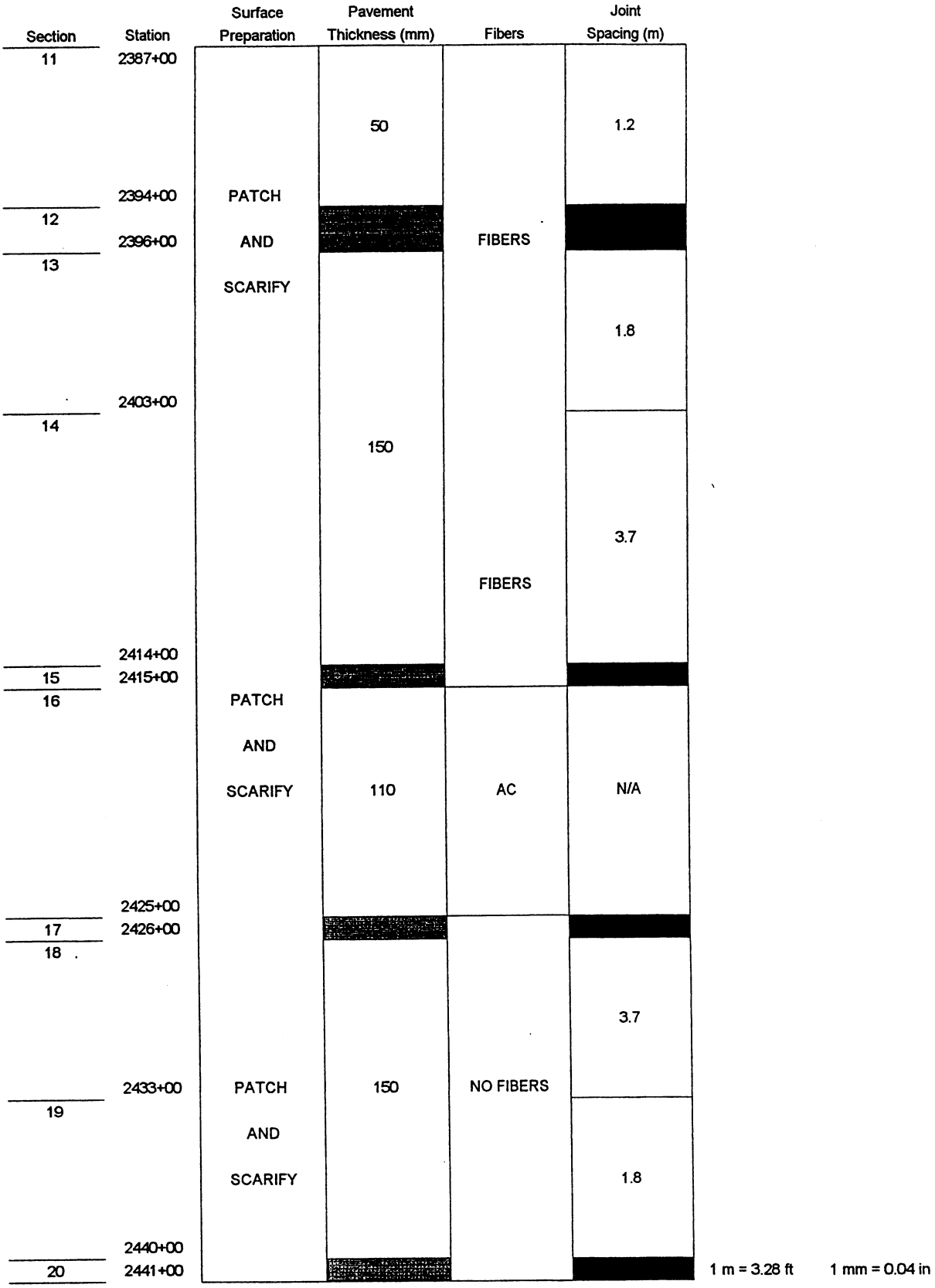
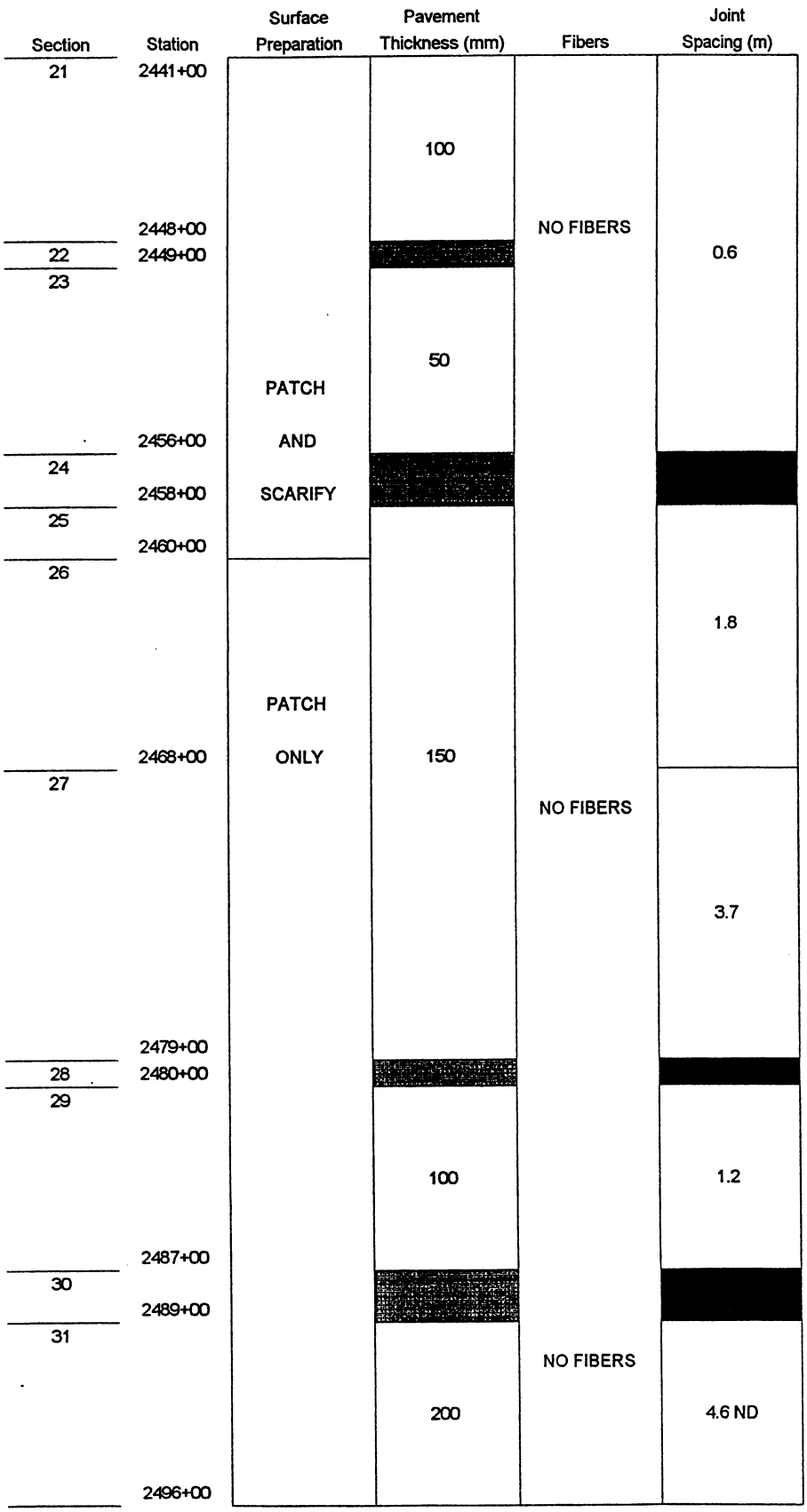


FIGURE 1: Test Section Layout



1 m = 3.28 ft 1 mm = 0.04 in

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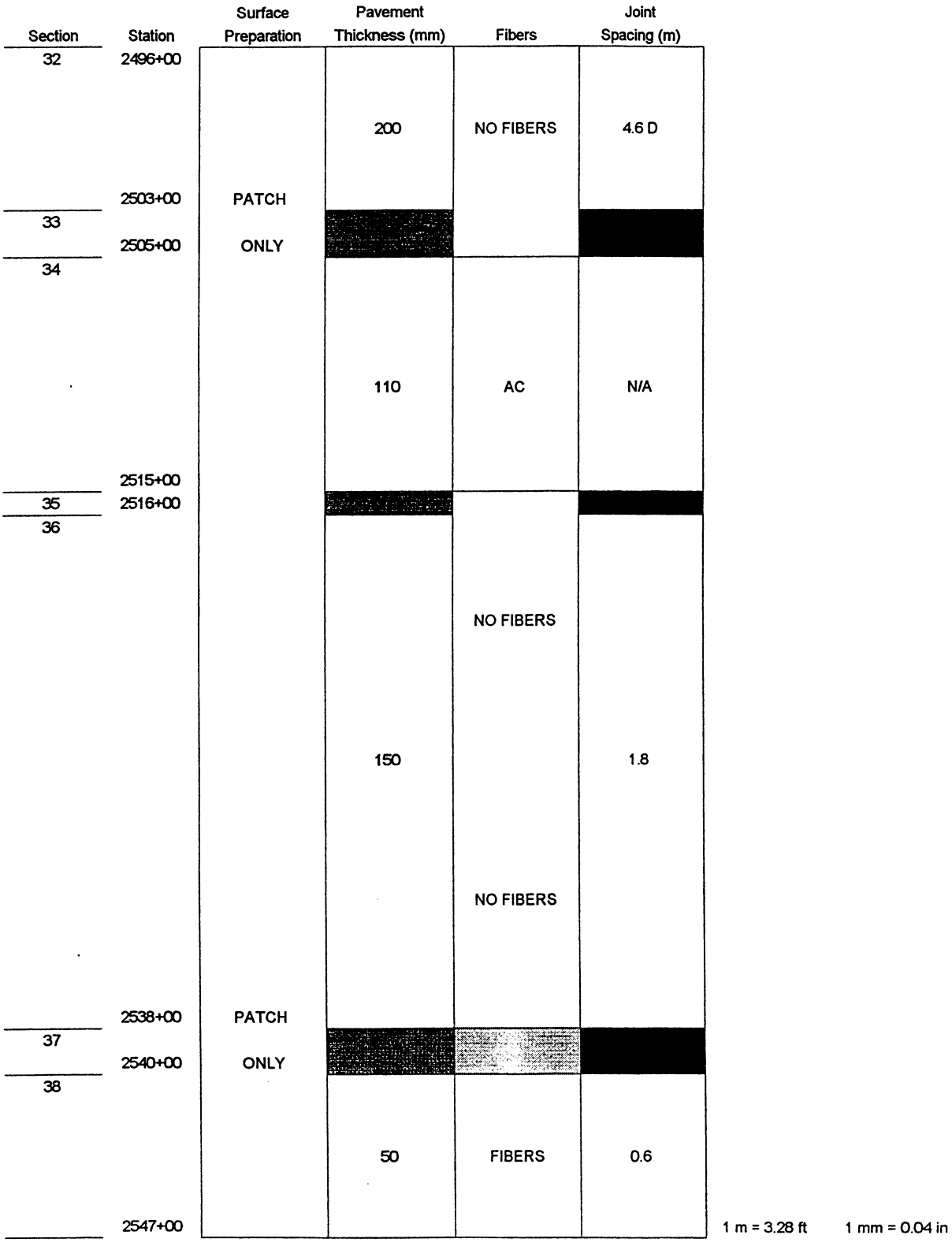


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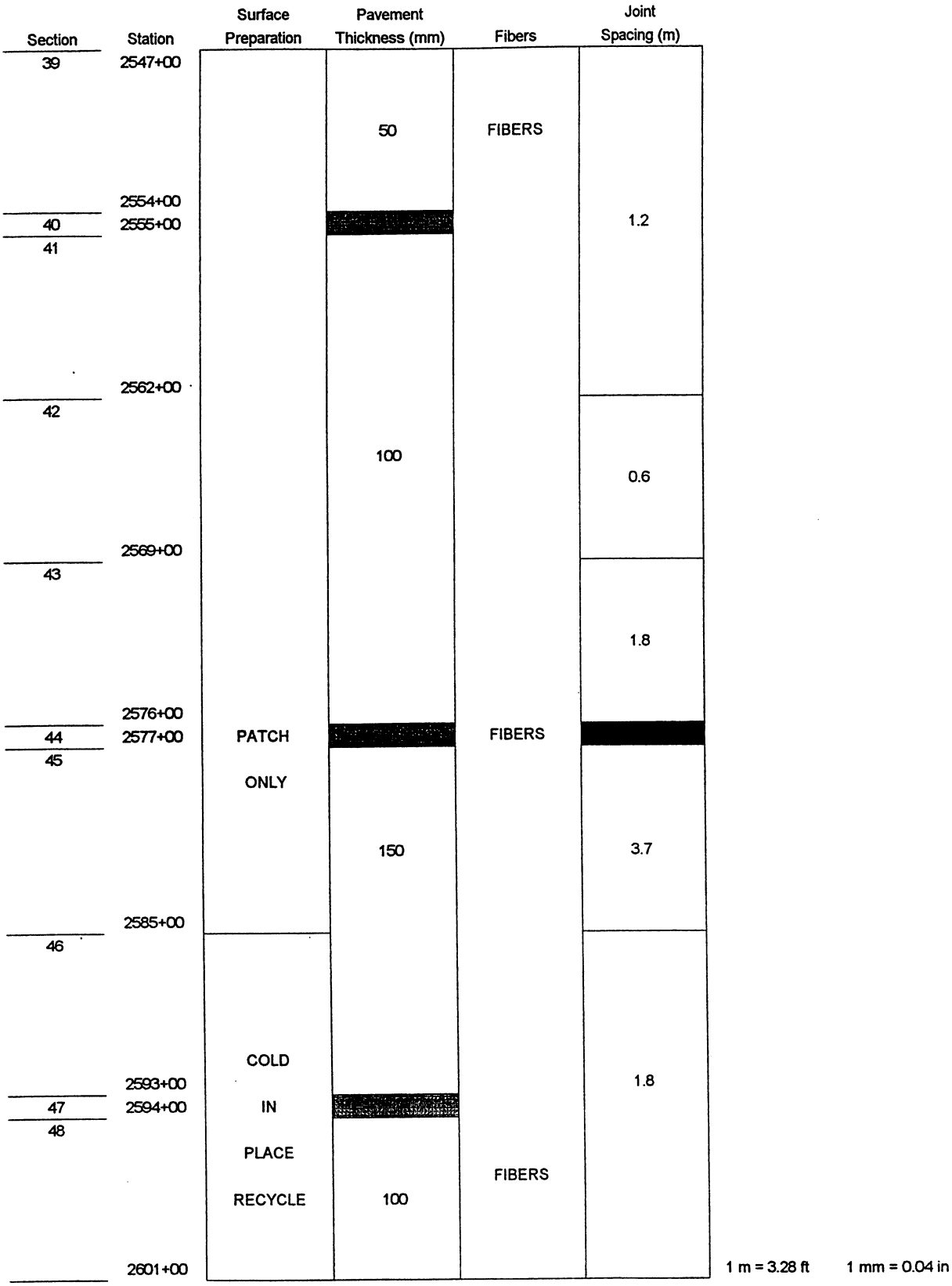


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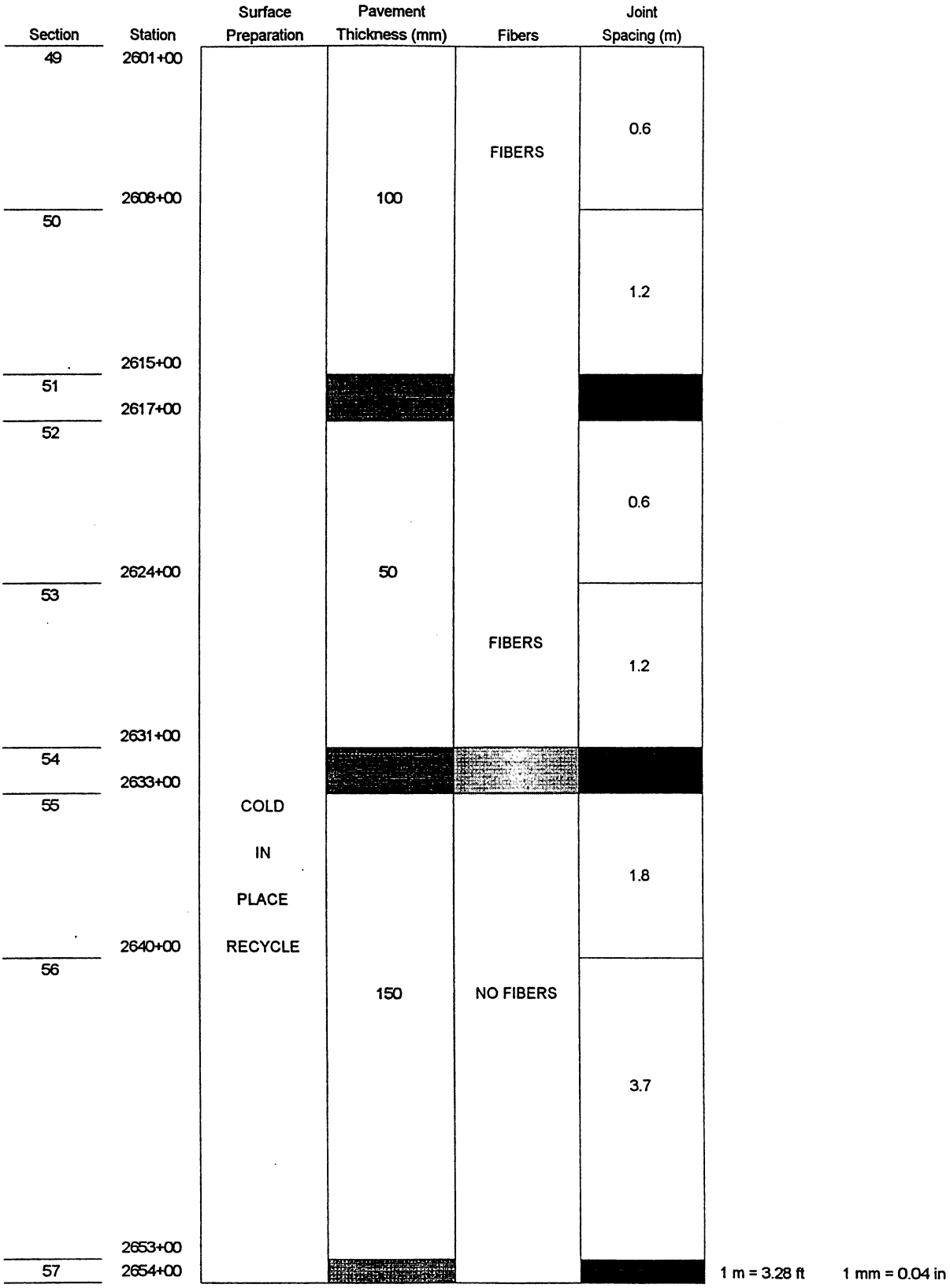
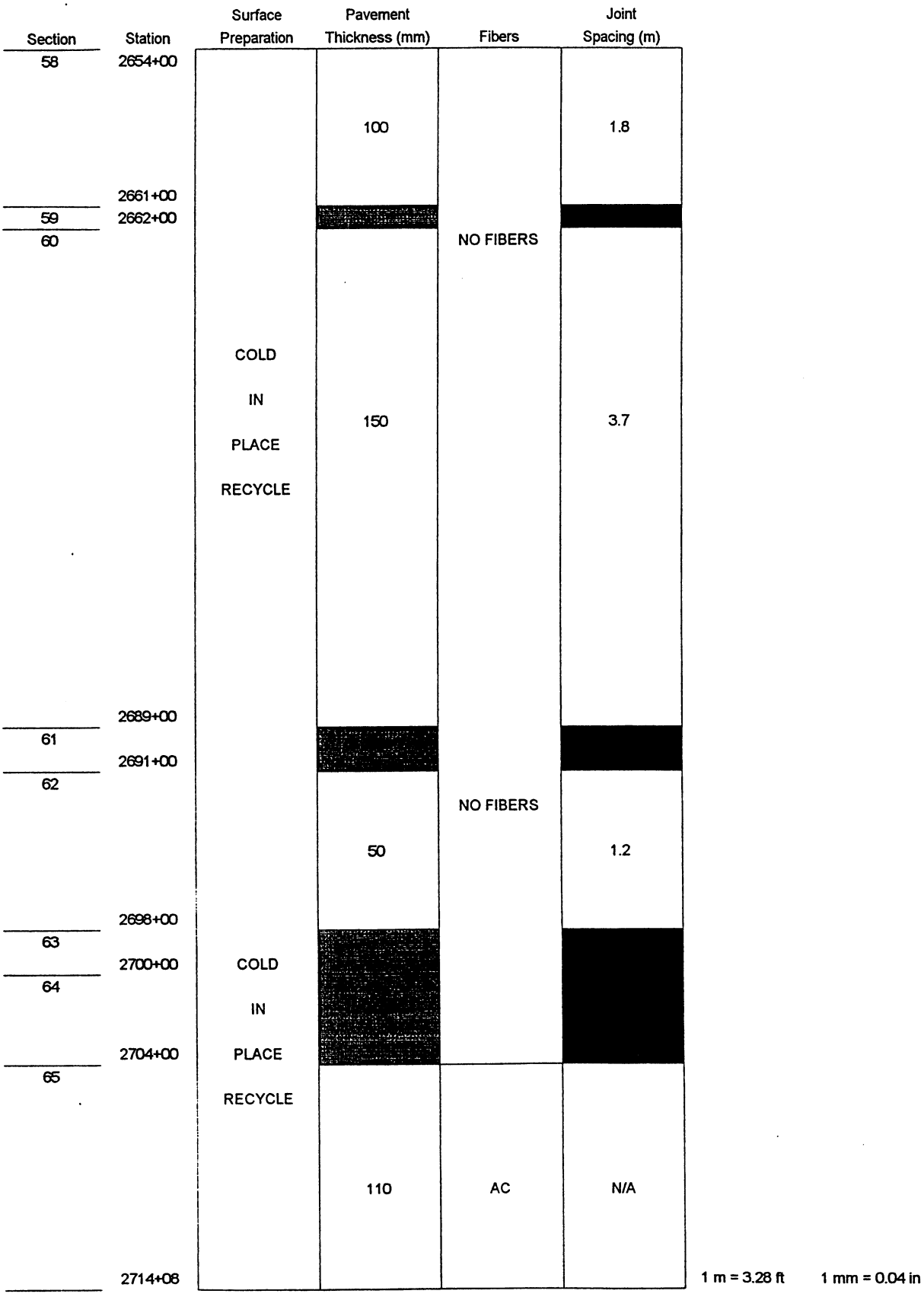


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1 m = 3.28 ft 1 mm = 0.04 in

TABLE TITLES

Table 1: Project Layout

Table 2: Project Research Study Section

Table 3: Actual Depth of Slab

Table 4: Mixtures

Table 5: Concrete Mixture Proportions Basic Absolute Volumes Per Unit Volumes

Table 6: Average Structural Ratings

Table 7: Concrete Distress

Table 1: Project Layout

Section Number	Begin Station	Ending Station	Thickness (mm)	Fiber F & NF	Joint Spacing (m)	Surface Preparation
1	2335+64	2340+00	200	RECONSTR	6.1	***
2	2340+00	2342+00	200-150	NF-F	3.7	P&S
3	2342+00	2349+00	150	F	3.7	P&S
4	2349+00	2356+00	150	F	1.8	P&S
5	2356+00	2357+00	150-100	F	1.8	P&S
6	2357+00	2364+00	100	F	1.8	P&S
7	2364+00	2371+00	100	F	0.6	P&S
8	2371+00	2378+00	100	F	1.2	P&S
9	2378+00	2380+00	100-50	F	0.6	P&S
10	2380+00	2387+00	50	F	0.6	P&S
11	2387+00	2394+00	50	F	1.2	P&S
12	2394+00	2396+00	50-150	F	1.2-1.8	P&S
13	2396+00	2403+00	150	F	1.8	P&S
14	2403+00	2414+00	150	F	3.7	P&S
15	2414+00	2415+00	150-110	F	3.7-1.8	P&S
16	2415+00	2425+00	110	ACC	ACC	P&S
17	2425+00	2426+00	110-150	NF	1.8-3.7	P&S
18	2426+00	2433+00	150	NF	3.7	P&S
19	2433+00	2440+00	150	NF	1.8	P&S
20	2440+00	2441+00	150-200	NF	1.8-0.6	P&S
21	2441+00	2448+00	100	NF	0.6	P&S
22	2448+00	2449+00	100-50	NF	0.6	P&S
23	2449+00	2456+00	50	NF	0.6	P&S
24	2456+00	2458+00	50-150	NF	0.6-1.8	P&S
25	2458+00	2460+00	150	NF	1.8	P&S
26	2460+00	2468+00	150	NF	1.8	P ONLY
27	2468+00	2479+00	150	NF	3.7	P ONLY
28	2479+00	2480+00	150-100	NF	3.7-1.2	P ONLY
29	2480+00	2487+00	100	NF	1.2	P ONLY
30	2487+00	2489+00	100-200	NF	1.2-4.6	P ONLY
31	2489+00	2496+00	200	NF	4.6 ND	P ONLY
32	2496+00	2503+00	200	NF	4.6 D	P ONLY
33	2503+00	2505+00	200-110	NF	4.6-1.8	P ONLY
34	2505+00	2515+00	110	ACC	ACC	P ONLY
35	2515+00	2516+00	110-150	NF	1.2-1.8	P ONLY
36	2516+00	2538+00	150	NF	1.8	P ONLY
37	2438+00	2540+00	150-50	NF-F	1.8-0.6	P ONLY
38	2540+00	2547+00	50	F	0.6	P ONLY
39	2547+00	2554+00	50	F	1.2	P ONLY
40	2554+00	2555+00	50-100	F	1.2	P ONLY
41	2555+00	2562+00	100	F	1.2	P ONLY
42	2562+00	2569+00	100	F	0.6	P ONLY
43	2569+00	2576+00	100	F	1.8	P ONLY

1 m = 0.305 ft

1 mm = 0.04 in

Table 1: Project Layout

Section Number	Begin Station	Ending Station	Thickness (mm)	Fiber F & NF	Joint Spacing (m)	Surface Preparation
44	2576+00	2577+00	100-150	F	1.8-3.7	P ONLY
45	2577+00	2585+00	150	F	3.7	P ONLY
46	2585+00	2593+00	150	F	1.8	CIP
47	2593+00	2594+00	150-100	F	1.8	CIP
48	2594+00	2601+00	100	F	1.8	CIP
49	2601+00	2608+00	100	F	0.6	CIP
50	2608+00	2615+00	100	F	1.2	CIP
51	2615+00	2616+00	100-50	F	1.2-0.6	CIP
52	2616+00	2624+00	50	F	0.6	CIP
53	2624+00	2631+00	50	F	1.2	CIP
54	2631+00	2633+00	50-150	F-NF	1.2-1.8	CIP
55	2633+00	2640+00	150	NF	1.8	CIP
56	2640+00	2653+00	150	NF	3.7	CIP
57	2653+00	2654+00	150-100	NF	3.7-1.8	CIP
58	2654+00	2661+0	100	NF	1.8	CIP
59	2661+00	2662+00	100-150	NF	1.8-3.7	CIP
60	2662+00	2689+00	150	NF	3.7	CIP
61	2689+00	2691+00	150-50	NF	3.7-1.2	CIP
62	2691+00	2698+00	50	NF	1.2	CIP
63	2698+00	2700+00	50-150	NF	1.2-3.7	CIP
64	2700+00	2704+00	150-110	NF	3.7-1.2	CIP
65	2704+00	2714+08	110	ACC	ACC	CIP

NOTE: ALL INFORMATION WAS TAKEN FROM PLANS
D: DOWELLED
ND: NON-DOWELLED
****: SPECIAL BACKFILL*
P&S: PATCH AND SCARIFY
P ONLY: PATCH ONLY
CIP: COLD-IN-PLACE RECYCLE

1 m = 0.305 ft

1 mm = 0.04 in

Table 2: Project Research Study Sections

Section Number	Begin Station	Ending Station	Thickness (mm)	Fiber F & NF	Joint Spacing (m)	Surface Preparation
1	2335+64	2340+00	200	RECONSTR	6.1	***
3	2342+00	2349+00	150	F	3.7	P&S
4	2349+00	2356+00	150	F	1.8	P&S
6	2357+00	2364+00	100	F	1.8	P&S
7	2364+00	2371+00	100	F	0.6	P&S
8	2371+00	2378+00	100	F	1.2	P&S
10	2380+00	2387+00	50	F	0.6	P&S
11	2387+00	2394+00	50	F	1.2	P&S
13	2396+00	2403+00	150	F	1.8	P&S
14	2403+00	2414+00	150	F	3.7	P&S
16	2415+00	2425+00	110	ACC	ACC	P&S
18	2426+00	2433+00	150	NF	3.7	P&S
19	2433+00	2440+00	150	NF	1.8	P&S
21	2441+00	2448+00	100	NF	0.6	P&S
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26	2460+00	2468+00	150	NF	1.8	P ONLY
27	2468+00	2479+00	150	NF	3.7	P ONLY
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32	2496+00	2503+00	200	NF	4.6 D	P ONLY
34	2505+00	2515+00	110	ACC	ACC	P ONLY
36	2516+00	2538+00	150	NF	1.8	P ONLY
38	2540+00	2547+00	50	F	0.6	P ONLY
39	2547+00	2554+00	50	F	1.2	P ONLY
41	2555+00	2562+00	100	F	1.2	P ONLY
42	2562+00	2569+00	100	F	0.6	P ONLY
43	2569+00	2576+00	100	F	1.8	P ONLY
45	2577+00	2585+00	150	F	3.7	P ONLY
46	2585+00	2593+00	150	F	1.8	CIP
48	2594+00	2601+00	100	F	1.8	CIP
49	2601+00	2608+00	100	F	0.6	CIP
50	2608+00	2615+00	100	F	1.2	CIP
52	2616+00	2624+00	50	F	0.6	CIP
53	2624+00	2631+00	50	F	1.2	CIP
55	2633+00	2640+00	150	NF	1.8	CIP
56	2640+00	2653+00	150	NF	3.7	CIP
58	2654+00	2661+0	100	NF	1.8	CIP
60	2662+00	2689+00	150	NF	3.7	CIP
62	2691+00	2698+00	50	NF	1.2	CIP
65	2704+00	2714+08	110	ACC	ACC	CIP

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P ONLY: PATCH ONLY
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1 m = 0.305 ft

1 mm = 0.04 in

Table 3: Actual Depth of Slab

SECTION NUMBER	MINIMUM			MAXIMUM			AVERAGE			SAMPLE SIZE
	LT	CL	RT	LT	CL	RT	LT	CL	RT	
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
2	T	T	T	T	T	T	T	T	T	-
3	200	200	200	200	200	200	200	200	200	1
4	150	160	130	220	220	180	180	190	150	5
5	T	T	T	T	T	T	T	T	T	-
6	100	100	100	130	160	160	120	130	130	3
7	110	110	80	110	120	130	110	110	100	2
8	110	100	150	170	140	180	140	120	170	5
9	T	T	T	T	T	T	T	T	T	-
10	100	80	40	100	90	60	100	80	50	2
11	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
12	T	T	T	T	T	T	T	T	T	-
13	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
14	130	140	150	190	190	190	160	170	170	6
15	T	T	T	T	T	T	T	T	T	-
16	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC
17	T	T	T	T	T	T	T	T	T	-
18	140	150	160	170	180	160	150	170	190	4
19	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
20	T	T	T	T	T	T	T	T	T	-
21	50	80	80	100	140	140	80	110	110	3
22	T	T	T	T	T	T	T	T	T	-
23	60	80	60	130	140	130	100	100	100	3
24	T	T	T	T	T	T	T	T	T	-
25	180	180	200	180	180	200	180	180	200	2
26	150	170	170	200	200	200	170	190	190	4
27	150	170	170	190	200	190	170	190	180	4
28	T	T	T	T	T	T	T	T	T	-
29	150	150	140	150	150	140	150	150	140	1
30	T	T	T	T	T	T	T	T	T	-
31	200	210	180	270	270	280	220	240	240	4
32	200	240	210	230	280	270	210	260	230	4
33	T	T	T	T	T	T	T	T	T	-
34	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC
35	T	T	T	T	T	T	T	T	T	-
36	100	150	170	190	220	180	150	190	170	8
37	T	T	T	T	T	T	T	T	T	-
38	40	80	80	80	100	100	60	90	90	3
39	50	80	70	100	90	110	70	80	80	3
40	T	T	T	T	T	T	T	T	T	-
41	90	110	110	130	130	130	110	120	110	4
42	110	130	110	140	140	130	120	140	120	3
43	70	100	100	120	150	110	100	120	100	3
44	T	T	T	T	T	T	T	T	T	-
45	150	150	150	170	200	170	160	170	160	3
46	160	150	130	170	160	160	160	150	140	3

Table 3: Actual Depth of Slab

SECTION NUMBER	MINIMUM			MAXIMUM			AVERAGE			SAMPLE SIZE
	LT	CL	RT	LT	CL	RT	LT	CL	RT	
47	T	T	T	T	T	T	T	T	T	-
48	110	100	100	140	220	130	130	160	110	3
49	130	150	140	150	220	150	140	180	140	4
50	80	120	120	180	200	120	130	160	120	2
51	T	T	T	T	T	T	T	T	T	-
52	50	80	50	50	80	50	50	80	50	1
53	60	60	40	60	60	40	60	60	40	1
54	T	T	T	T	T	T	T	T	T	-
55	130	150	110	210	220	170	160	180	140	4
56	150	130	130	210	220	200	190	190	170	5
57	T	T	T	T	T	T	T	T	T	-
58	110	110	110	150	150	130	130	130	120	2
59	T	T	T	T	T	T	T	T	T	-
60	120	140	140	200	180	170	150	160	150	9
61	T	T	T	T	T	T	T	T	T	-
62	40	80	80	60	110	120	50	90	100	2
63	T	T	T	T	T	T	T	T	T	-
64	T	T	T	T	T	T	T	T	T	-
65	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC

NOTE: T: TRANSITION SECTION
NA: NO INFORAMITON AVAILABLE FOR SECTION
ALL MEASUREMENTS IN mm

Table 4: Mixtures

Beginning Station	Ending Station	Mixture	Section Numbers
2335+64	2341+02	Standard	1-2
2341+02	2386+75	Fibrillated	2-10
2386+75	2412+75	Monofillament	10-14
2412+75	2415+00	Fibrillated	14-15
2415+00	2425+00	ACC	16
2425+00	2505+00	Standard	17-33
2505+00	2515+00	ACC	34
2515+00	2539+09	Standard	35-37
2539+09	2632+25	Fibrillated	37-54
2632+25	2703+95	Standard	54-64
2703+95	2714+00	ACC	65

Note: Information taken from plant reports

Table 5: Concrete Mixture Proportions Basic Absolute Volumes Per Unit Volumes

Concrete Mixture Class	Fine Aggregate	Coarse Aggregate	Cement Minimum	Water	Entrained Air	Flyash	Basic W/C	Maximum W/C
C-3WR-C	0.307	0.375	0.092	0.147	0.06	0.019	0.430	0.480
C-3WR	0.309	0.377	0.108	0.146	0.06	--	0.430	0.480

TABLE 6 Average Structual Ratings

Section Number	North Bound (4/28/94)	North Bound (10/13/94)	North Bound (6/06/95)	South Bound (4/28/94)	South Bound (10/13/94)	South Bound (6/06/95)	Combined (4/28/94)	Combined (10/13/94)	Combined (6/06/95)
1	2.76	4.82	4.20	2.73	5.53	4.32	2.75	5.18	4.26
2	2.14	5.14	4.25	2.24	4.99	4.02	2.19	5.07	4.13
3	1.78	5.04	5.66	1.99	5.31	4.96	1.89	5.18	5.31
4	1.93	3.98	2.82	1.97	5.60	3.90	1.95	4.79	3.36
5	2.20	4.73	3.91	1.76	3.89	2.92	1.98	4.31	3.41
6	1.82	3.95	3.54	1.75	3.17	2.80	1.78	3.56	3.17
7	1.83	2.50	1.83	1.81	3.00	2.16	1.82	2.75	2.00
8	2.07	4.83	3.93	2.23	3.60	3.65	2.15	4.22	3.79
9	1.89	3.35	2.62	2.61	3.04	2.84	2.25	3.20	2.73
10	2.15	2.23	1.66	2.18	2.86	1.94	2.17	2.55	1.80
11	-	2.30	1.86	2.14	2.23	1.51	-	2.27	1.69
12	2.20	3.61	2.63	1.89	4.37	3.15	2.05	3.99	2.89
13	1.50	7.02	5.20	2.35	5.12	5.10	1.93	6.07	5.15
14	2.14	4.66	4.03	2.02	4.65	4.23	2.08	4.66	4.13
15	2.33	4.51	3.59	2.07	3.74	2.93	2.20	4.13	3.26
16	1.60	2.59	3.77	2.13	2.45	3.95	1.87	2.52	3.86
17	1.43	4.56	3.08	2.19	4.56	3.32	1.81	4.56	3.20
18	1.83	5.63	4.57	3.61	4.79	4.22	2.72	5.21	4.39
19	2.59	5.86	4.76	2.94	5.02	3.98	2.77	5.44	4.37
20	2.85	4.70	3.14	2.04	3.81	3.00	2.45	4.26	3.07
21	1.62	4.43	3.19	2.08	4.16	2.99	1.85	4.30	3.09
22	2.60	3.16	2.12	2.23	2.62	1.85	2.42	2.89	1.98
23	2.64	3.02	2.06	2.23	2.40	2.00	2.44	2.71	2.03
24	2.83	4.42	3.47	2.47	4.47	3.33	2.65	4.45	3.40
25	2.47	5.98	5.32	1.91	5.69	5.51	2.19	5.84	5.41
26	1.47	6.21	5.32	2.12	4.80	4.36	1.79	5.51	4.84
27	1.89	5.51	4.58	2.38	5.24	4.37	2.14	5.38	4.47
28	2.08	4.45	2.88	2.35	4.26	3.04	2.21	4.36	2.96
29	2.77	6.17	3.68	2.29	4.53	3.59	2.53	5.35	3.63
30	2.07	6.64	4.73	2.18	5.07	4.70	2.13	5.86	4.71
31	1.78	7.74	6.81	2.34	6.74	5.71	2.06	7.24	6.26
32	2.27	7.31	6.43	2.28	7.58	6.12	2.28	7.45	6.27
33	2.37	6.13	5.33	2.91	6.35	5.98	2.64	6.24	5.65
34	2.37	3.93	4.92	2.30	2.44	4.26	2.34	3.18	4.59
35	2.44	5.79	4.23	2.57	5.02	4.51	2.51	5.41	4.37
36	2.18	6.47	-	2.87	6.40	5.04	2.53	6.44	2.52
37	2.21	5.25	3.72	2.47	4.61	4.09	2.34	4.93	3.90
38	3.23	4.45	3.34	3.35	3.79	3.13	3.29	4.12	3.23
39	1.97	2.41	2.13	2.39	2.63	2.29	2.18	2.52	2.21
40	2.52	3.99	2.94	2.42	3.45	2.73	2.47	3.72	2.83
41	2.63	4.26	3.12	2.21	4.71	3.21	2.42	4.49	3.16
42	1.98	3.42	2.34	1.75	3.57	2.97	1.86	3.50	2.66
43	1.65	3.52	2.53	2.86	4.10	3.11	2.26	3.81	2.82
44	2.16	3.72	2.25	2.26	3.96	3.07	2.21	3.84	2.66
45	2.42	4.35	3.59	2.51	5.28	4.41	2.47	4.82	4.00
46	2.87	4.33	3.47	2.49	4.56	3.54	2.68	4.45	3.50

TABLE 6 Average Structual Ratings

Section Number	North Bound (4/28/94)	North Bound (10/13/94)	North Bound (6/06/95)	South Bound (4/28/94)	South Bound (10/13/94)	South Bound (6/06/95)	Combined (4/28/94)	Combined (10/13/94)	Combined (6/06/95)
47	2.61	4.33	3.29	2.09	4.36	3.32	2.35	4.35	3.30
48	2.42	4.38	3.63	2.52	4.56	3.53	2.47	4.47	3.58
49	2.63	4.94	3.84	2.38	4.35	3.93	2.51	4.65	3.89
50	2.57	3.83	3.28	2.66	4.47	3.70	2.62	4.15	3.49
51	1.84	2.58	1.56	1.98	2.77	2.09	1.91	2.68	1.83
52	2.63	3.16	2.08	2.07	2.76	2.30	2.35	2.96	2.19
53	1.95	3.60	1.92	2.50	2.50	2.38	2.22	3.05	2.15
54	2.35	3.54	2.70	2.69	3.45	3.73	2.52	3.50	3.22
55	1.77	4.45	4.45	1.81	5.37	4.34	1.79	4.91	4.39
56	2.72	4.94	4.32	2.35	5.71	4.48	2.53	5.33	4.40
57	2.58	3.44	2.92	1.98	4.36	4.16	2.28	3.90	3.54
58	2.11	4.94	2.52	2.15	4.63	3.13	2.13	4.79	2.82
59	1.62	3.11	2.78	1.73	3.68	2.79	1.68	3.40	2.79
60	2.18	5.25	3.50	1.76	4.79	3.49	1.97	5.02	3.49
61	1.71	3.26	2.00	1.82	2.44	1.94	1.77	2.85	1.97
62	2.01	2.94	1.84	2.35	2.19	1.87	2.18	2.57	1.85
63	2.80	4.65	3.07	1.84	4.44	2.87	2.32	4.55	2.97
64	1.83	4.67	3.93	2.51	4.21	3.96	2.17	4.44	3.95
65	3.78	3.44	4.44	3.16	3.21	5.42	3.47	3.33	4.93

Table 7: Distress

	Depth (mm) / Slab Size (m)				
	50/0.6	50 / 1.2	100 / 0.6	100 / 1.2	100 / 1.8
Transverse Cracking					
Number Distressed Slabs	5	38	0	8	8
Percent Distressed Slabs	0.1	1.8	0.0	0.8	1.7
Longitudinal Cracking					
Number Distressed Slabs	36	28	0	0	0
Percent Distressed Slabs	0.9	1.3	0.0	0.0	0.0
Corner Cracking					
Number Distressed Slabs	4	54	0	2	0
Percent Distressed Slabs	0.1	2.6	0.0	0.2	0.0
Diagonal Cracking					
Number Distressed Slabs	2	0	0	1	0
Percent Distressed Slabs	0.0	0.0	0.0	0.0	0.0
Fractured Slabs					
Number Distressed Slabs	0	26	0	0	0
Percent Distressed Slabs	0.0	1.2	0.0	0.0	0.0