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THE ORDWAY COLORADO EXPERIMENTAL BASE PROJECT

by

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THE ORDWAY COLORADO EXPERIMENTAL BASE PROJECT

Eight years ago a 2-1/2 mile test site was constructed by the Colorado Division of Highways in the southeastern part of the State to evaluate different thicknesses and different types of asphalt mixes placed directly on a clayey subgrade. The project is located at Ordway, Colorado, which is a small town about 50 miles east of Pueblo, Colorado. The construction details and our first evaluation reports were reported to this committee at the 1965 HRB Annual Meeting. The different sections have been evaluated seasonally since then by members of the research section of the Division of Highways and the Asphalt Institute, who was primarily responsible for establishing the research project.

The project consists of 11 sections of either 8", 9-1/2", or 11" thick asphalt mixes placed over an A-7-6(17) subgrade. Five sections were placed over an A-6(12) subgrade. In addition, there are four sections placed randomly consisting of what would have been the standard design for the project, i.e. 14" of sandy subbase, 4" of crushed gravel base, and 2-1/2" of AC surfacing. One-third of the deep strength pavement structures are composed of true asphaltic concrete with 5.6 asphalt content and 60 percent crushed particles. One-third are composed of a sand mix and 4% limestone dust with a Marshall stability value of over 700. One-third are composed of a sand mix with a Marshall stability of only 300. The average penetration of the asphalt was 67 and the sand mixes contained eight percent asphalt and three to six percent voids.

Each experimental section is 550 feet long with 50-foot transitions between test sections used for destructive testing. There is no cut or fill on the project. All sections were placed at grade on the old roadway, which had two-foot deep, gradually sloping ditches along each side, and was about two feet above the surrounding ground.

Cost per mile for the various test sections were determined to range from $36,000 for the Department Standard Section (14" subbase; 4" base course; and 2-1/2" Asphalt Concrete Mat) to a high of $75,000/mile for the section made of 11" thick Asphalt Concrete.

Two months after completion of the construction, the area was inundated by the flood of 1965. Since then the average annual precipitation has been 10 inches, and the subgrade appears to be gradually drying out from the shoulders inward toward the center of the roadway under the pavement. Approximately 1,500 vehicles a day travel this roadway through the Arkansas River Valley. Due to the presence of a large alfalfa dryer and other agricultural establishments along the roadway, the daily 18 kip equivalent wheel loading is approximately 50.

The tests for roadway performance the first 7 years showed little difference between the various sections. After approximately 150,000 equivalent 18 kip wheel loads, the deflection readings remained a function of the temperature, being about .050" in the summer and 0.020" in the winter. The Present Serviceability Index (PSI) averaged approximately 3.0 for the surface uncorrected for texture, and 3.6 for the surface corrected for texture. The surface of all the test sections gradually raveled out to the point that is could use a seal coat or slurry seal. However, there were really no base failures at the end of 7 years. The cracking that

did appear was a thin longitudinal type parallel to and about 9" from the edge of the pavement in the A-7-6(17) subgrade section. It seemed to be associated with a gradual drying out of the shoulders after the flood. They were only an inch or so deep, and did not warrant any type of maintenance.

In the last year, however, there has been a gradual increase in the cracking on the project. The longitudinal edge cracks are no worse, but transverse cracking has begun. The reason may be due to several sustained cold spells of sub-zero temperatures which the last two winters have brought. When the 1971 spring set of tests were made, transverse cracks were noted about every 30 feet, but often quite irregularly spaced. Now there are some sections with cracks every 15 feet, and these cracks are often as wide as 3/4". There is not complete agreement that these are temperature-induced cracks. Observers do agree, however, that after five or six years there must have been tensile stresses in the mat and that perhaps the cold weather provided the extra stress that finally brought on the cracking.

Five facts about the cracking seem particularly noteworthy:

1. The cracks do not close up very well during hot weather.
2. There is considerably more cracking in the transition sections between the different test sections than there is within the actual test sections themselves. In some cases the spacing of the transverse cracks in the transition sections is only 7 to 15 feet.
3. The large transverse cracks extend the entire depth of the asphalt.
4. The cracking is much more severe in the A-7-6(17) sections than in the A-6(12) subgrade sections.

5. The standard sections (2-1/2" mat and untreated base and subbase) are beginning to show alligator cracking. They have never been affected quite as bad by the transverse cracking as had the deep strength sections.

Just exactly what conclusions should follow an analysis of these facts is uncertain, but the cracks do not seem objectionable. They cannot be felt by the motorist, and at the present time the transverse cracks are not contributing to any significant progressive deterioration. If the surface of the entire project is provided with some type of seal in the summer of 1973, these cracks will get filled in the process. Very little increase in subgrade moisture is anticipated in this dry climate during the late winter and early spring of 1973.

(LIGHTS OUT TO SHOW SLIDES)

Recent observations and photographs of the test sections show that there is very little difference in the appearance of the different test sections except for the alligator cracking which shows signs of beginning in the standard central sections.

(SHOW SLIDES 1, 2, 3 and 4 of test sections with 2", 8", 9-1/2" and 11" thickness -- CALL ATTENTION TO TRANSVERSE CRACKS.)

The moisture distribution under the deep strength asphalt is different than the moisture distribution under the standard section which has the 2-1/2" mat over 18" of untreated gravel. The untreated gravel appears to provide a place for moisture to collect and be distributed to the subgrade.

(SHOW SLIDE #5 OF MOISTURE DISTRIBUTION UNDER THE 8" MAT AND SLIDE #6 OF MOISTURE UNDER THE 2-1/2" MAT AND UNTREATED SUBBASE.)

SLIDE #7 - STRUCTURAL NUMBERS FOR ORDWAY TEST SECTION

Required for 2.5 PSI = Design for 20 years
by Colorado Roadway Design..... 3.1

Provided by Std. Section consisting of 2½" AC,
(Coef = .44) 4" crushed gravel base (Coef = .14)
and 14" of sandy subbase (Coef = .11)..... 3.0

Provided by the following thickness of deep strength asphalt:

	8"	9½"	11"
Asphaltic Concrete (Coef = .44)..	3.5	4.2	4.8
Sand Asphalt Mix + 4% Limestone Dust (Coef = .3).....	2.8	3.2	3.6
Sand Asphalt Mix (Coef = .25)....	2.5	2.8	3.2

SUMMARY

To come up with any definite conclusions on this experimental project has been very difficult. My assistant and myself have walked over the project, either every year or every other year, and have attempted to make some sense out of all the data (Benkelman Beam, Radius of Curvature, and PSI values) collected by our field crews. We ask ourselves the question, "If you had to make the decision tomorrow as to what type of section you would recommend, what would your answer be?"

Normal maintenance in the summer of 1973 will probably fill all the cracks and provide this 2-1/2 mile section of highway with a good seal coat. At this point we would guess that all sections will last another five to eight years without any major maintenance. Hence, I suppose, our answer to the above question would be to use one of the more economical sections.

In 1967 the Colorado Division of Highways did build a second test project similar to the Ordway project. This project is located on U. S. 40 about 50 miles east of the Utah border near a town called Elk Springs. On this project test sections as thin as 4" of Asphaltic Concrete were placed directly on clayey subgrade. Other test sections were 6-1/2" and 9-1/2" thick. Some test sections were placed over a catalytically blown asphalt membrane, which extended up the ditch on either side of cuts. Already some of the 4" thick sections are beginning to show distress. In a few years we hope to be able to tie the data from these two test projects together and come up with some minimum recommended thickness of asphaltic concrete when placement is directly on top of clay subgrade.

Work Sheet No, (14-05)4
10-2-69

EXPERIMENTAL PROJECT
DATA SUMMARY

Project S 0016(28)

Location ORDWAY

Date APRIL 1972

	Section	PSI (CHLOE)	Benk. Beam Deflection (inches)	Radius of Curvature (feet)	Cracks & Patch. (--/1000 ft²) Lin. (ft)	Allig. (ft²)	Patch. (ft²)	Rut Depth (inches)	Texture* (inches)	Jan 1973 Notes
Std	1 EB	2.6 / 3.3*	.036	220					18	Alligator cracking progressir rapidly
	1 WB	2.6 / 3.4	.037	190	28	1	0		23	
SA 300 7"	2 EB	2.5 / 3.4	.045	210					24	Bad lon & some tran cracking
	2WB	2.8 / 3.6	.043	300	43	0	0		25	
8" SA 300	3 EB	3.0 / 3.7	.025	370					18	Bad tran crack ever 45' to 60'
	3 WB	2.5 / 3.2	.023	430	38	0	0		19	
8½" AC	4 EB	2.8 / 3.6	.021	1170					21	Some tran cracks - not bad
	4 WB	2.8 / 3.6	.028	860	29	0	0		22	
5½" SA 700	5 EB	2.8 / 3.6	.042	260					20	Bad tran and lon cracks every 30'
	5 WE	2.9 / 3.7	.047	220	76	0	0		20	
8½" SA 700	6 EB	2.9 / 3.7	.027	540					21	Thin and wide tran cracks every 60'
	6WB	2.9 / 3.6	.042	490	44	2	0		21	
5½" AC	7 EB	2.8 / 3.6	.027	320					19	Bad lon and tran cracks every 45'
	7 WB	2.6 / 3.4	.050	270	85	0	0		19	

* Lower number is PSI corrected for texture.

*15 PROBE

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EXPERIMENTAL PROJECT
DATA SUMMARY

Project S 0016(28)

Location ORDWAY

Date APRIL 1972

	Section	PSI (CHLOE)	Benk. Beam Deflection (inches)	Radius of Curvature (feet)	Cracks & Patch. (--/1000 ft²) Lin. (ft)	Allig. (ft²)	Patch. (ft²)	Rut Depth (inches)	Texture* (inches)	Notes
8½" AC	8 EB	2.9/3.6	.021	890					17	Thin tran cracks only
	8 WB	2.7/3.3	.034	580	56	0	0		16	
SA 700 7"	9 EB	3.1/4.0	.031	190					26	Wide tran cracks every 45' to 60'
	9 WB	2.6/3.4	.041	170	72	0	0		23	
SA 300	10 EB	2.7/3.5	.055	160					19	Wide tran cracks every 30' to 45'
	10 WB	2.7/3.4	.055	120	37	0	0		21	
Std	11 EB	2.7/3.4	.034	270					19	Alligator & random cracking but not very wide
	11 WB	2.9/3.6	.033	230	29	19	0		19	
7" AC	12 EB	2.8/3.7	.024	700					26	Only fine line crack visible
	12 WB	2.8/3.6	.043	1100	53	0	0		24	
SA 300 8½"	13 EB	2.7/3.5	.025	360					23	Tran cracks 60' to 75' apart
	13 WB	2.9/3.6	.035	400	38	0	0		21	
	14 EB	2.6/3.5	.025	210					27	Alligator cracks starting
	14 WB	2.9/3.8	.027	210	52	15	0		26	wide crack

End A-7-6(17) Subgrade CBR = 2.6. PI = 35

*15 PROBE

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Sheet 3 of 3

EXPERIMENTAL PROJECT
DATA SUMMARY

Project S 0016(28)

Location ORDWAY

Date APRIL 1972

Begin A-6(12)
CBR = 3.4 PI = 22

	Section	PSI (CHLOE)	Benk. Beam Deflection (inches)	Radius of Curvature (feet)	Cracks & Patch. (--/1000 ft²) Lin. (ft)	Allig. (ft²)	Patch. (ft²)	Rut Depth (inches)	Texture* (inches)	Notes
7" AC	15 EB	2.6/3.5	.032	510					27	Thin cracks only.
	15 WB	2.9/3.8	.035	420	4	0	0		28	Looks good
5½" AC	16 EB	2.8/3.8	.041	360					34	Thin cracks only.
	16 WB	2.6/3.6	.048	260	10	0	0		33	Looks good
- AC	17 EB	2.5/3.4	.029	370					30	Thin cracks only.
	17 WB	2.9/3.8	.041	1530	16	0	0		29	Looks good
5½" SA 300	18 EB	2.8/3.7	.038	130					28	Alligator cracks but not wide open.
	18 WB	2.7/3.6	.062	130	62	0	0		28	
7" SA 300	19 EB	2.7/3.7	.031	180					34	Some thin cracks. Patch due to utility line break
	19 WB	2.8/3.7	.049	170	40	0	6		29	
Std	20 EB	2.6/3.6	.022	180					35	Alligator cracking starting.
	20 WB	2.9/3.8	.027	190	21	31	0		32	Thin lines only.
	EB AVE.	2.7/3.6	.032	380					24	
	WB AVE.	2.8/3.6	.040	420					24	
	TOTAL AVERAGE	2.8/3.6	.036	400	42	3	1/2		24	

*15 PROBE