COMPARISON OF OREGON STATE HIGHWAY DIVISION TABLE-1 AND TABLE-2 ASPHALT

Final Report

OREGON STATE FUNDED RESEARCH PROJECT
OR-RD-92-09

Austin Avenue - Eastside Bypass Section
Klamath Falls - Lakeview Highway
Oregon Highway #20
Contract No. C10697

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December 1991

Technical Report Documentation Page

1. Report No. OR-RD-92-09	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle COMPARISON OF OREGON STATE HIGHWAY DIVISION TABLE-1 AND TABLE-2 ASPHALT, Final Report		5. Report Date December, 1991 6. Performing Organization Code
7. Author(s) Rusnak, J.S.; Selkirk, K.T.; Zhou, H.		8. Performing Organization Report No. OR-RD-92-09
9. Performing Organization Name and Address Oregon State Highway Division Materials and Research Section 800 Airport Road, S.E. Salem, OR 97310		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Oregon State Highway Division Materials and Research Section 800 Airport Road, S.E. Salem, OR 97310		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The objective of this study was to compare the effect of using the Oregon State Highway Division (OSHD) modified Table-1 asphalts and the OSHD modified Table-2 asphalts in asphalt concrete; the primary factors for comparison were reflective and thermal cracking. Crack information obtained prior to paving was compared to crack information obtained two years after paving.

In 1989, an overlay project was constructed in Southern Oregon. The project consisted of one control section and one test section. Witco AC-15 asphalt cement, representing TABLE-1, was used in the control section. Chevron AC-20 and Idaho AC-20 asphalt cements, representing TABLE-2, were used in the test section. After two years of service, the control section showed significantly more reflective cracking than the test section. This indicates the TABLE-2 asphalt was more effective than TABLE-1 asphalt in reducing reflective cracking. However, the effect of cold temperatures on the development of cracking in both the control and test sections was not clear. It may be expected that TABLE-2 asphalts would have a better thermal resistance than TABLE-1 asphalt because TABLE-2 asphalts are less temperature susceptible than TABLE-1 asphalts. The study conclusions were based on limited information. Further verification, if necessary, should be conducted on a wider scale.

17. Key Words PAVEMENTASPHALT, CEMENTS		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

ACKNOWLEDGEMENT

The authors wish to thank the many Oregon State Highway Division (OSHD) employees who had key roles in supplying construction information and follow up field inspections during the evaluation. In addition, the authors thank the following OSHD employees for reviewing this report: Dale Allen (Region 4 Engineer), Tony George (Roadway Materials Engineer), Jeff Gower (Acting Pavement Design Engineer), Jim Huddleston (Acting Paving Quality Engineer), Richard Steyskal (Project Manager), and Pat Turpen (Petroleum Crew Leader). Furthermore, the authors thank Stephanie Swetland and Jo Anne Robison for typing this report.

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1.0 INTRODUCTION

1.1 Background

The American Association of State Highway Officials (AASHO) initially developed the Standard Specification for viscosity graded asphalt cement (M226, TABLE-1). This specification[1] covers asphalt cement grade by viscosity at 60°C (140°F) for use in pavement construction. In the past, the Oregon State Highway Division (OSHD) had been using a modified version of the TABLE-1 specifications[2] for specifying asphalt cements.

In 1974, AASHO developed a modified asphalt grade specification (M226, TABLE-2). This specification[3] requires that the asphalt be more viscous at higher temperatures and softer at lower temperatures. In 1989, OSHD modified the TABLE-2 and used it in areas where a less temperature susceptible asphalt was called for.

Tables 1.1 and 1.2 present the OSHD modified asphalt cement specifications. To compare the effect of specifying asphalts using OSHD TABLE-1 or TABLE-2, a single-lane test section was constructed in 1989. The test section was included as a part of Austin Avenue - Eastside Bypass, Klamath Falls paving project.

Chevron AC-20 and Idaho AC-20 asphalts were chosen to represent the OSHD TABLE-2 specification. Witco AC-15 asphalt was chosen to represent the OSHD TABLE-1 specification. The reason for choosing AC-15 for TABLE-1 was in consideration that Witco AC-20 asphalt was too viscous to resist thermal cracking in the Klamath Falls climate. The AC-20 asphalt was used for TABLE-2 because AC-15 asphalt for TABLE-2 was not readily available.

1.2 Objective

The objective of this study was to compare the effect of using TABLE-2 versus TABLE-1 asphalts in delaying reflective and thermal cracking on the test section. Crack information obtained prior to paving was compared to crack information obtained after two years of pavement service. This comparison was an attempt to identify any difference in using asphalts specified by each specification.

Table 1.1: OSHD Modified AASHTO M226 (TABLE-1)

The following specification shall be used for furnishing asphalt cements to the Division based on viscosity graded asphalt cement at 140°F (60°C) on original asphalt.

Characteristics	AASHTO Test	Viscosity Grades (Based on Original Asphalt)					
Tests on Original Asphalt		**AC-2.5**	**AC-5**	**AC-10**	**AC-15**	**AC-20**	**AC-30**
Viscosity, 60°C (140°F), poises	T 202	200-300	400-600	800-1200	1200-1800	1600-2400	2400-3600
Penetration, 25°C (77°F), Min.	T 49	200	120	70	55	40	35
Penetration, 4°C (39.2°F), 200g., 60 sec., percent of Pen. at 25°C (Minimum)		25	25	25	25	25	25
Viscosity, 135°C (275°F), Cs-min.	T 201	80	110	150	175	210	230
Flash Point, COC, °F, Min.	T 48	325	350	425	435	450	450
Solubility in Trichloroethylene, % Min.	T 44	99.0	99.0	99.0	99.0	99.0	99.0
Tests on Residue From Rolling Thin-Film Oven	T 240						
Loss on Heating, Percent-Maximum*		2.00	1.30	1.10	1.00	1.00	1.00
Viscosity, 60°C (140°F) poises - maximum	T 202	1000	2000	4000	6000	8000	12000
Ductility, 25°C (77°F) 5 cm per min., cm-minimum	T 51	100[1]	100	75	75	50	40

*Corrected January 1989

[1]If ductility is less than 100, material will be accepted if ductility at 15.6°C (60°F) is 100 minimum.

Table 1.2: OSHD Modified AASHTO M226 (TABLE-2)

Requirements for Asphalt Cement Graded by Viscosity at 60°C (140°F)
(Grading based on original asphalt)

	VISCOSITY GRADING						
	AC-2.5	**AC-5**	**AC-10**	**AC-15**	**AC-20**	**AC-30**	**AC-40**
Viscosity, 60°C (140°F), poises	250±50	500±100	1000±200	1500±300	2000±400	3000±600	4000±800
Viscosity, 135°C (275°F), Cs-min.	125	175	250	275	300	350	400
Penetration, 25°C (77°F), 100 g. 5 sec. - minimum	220	140	80	70	60	50	40
Flash Point, COC, C (F) -minimum	163(325)	177(350)	219(425)	232(450)	232(450)	232(450)	232(450)
Solubility in trichloroethylene, percent-minimum	99.0	99.0	99.0	99.0	99.0	99.0	99.0
Tests on Residue from Rolling Thin-Film Oven Test							
Loss on heating percent-maximum		1.0	1.0	1.0	1.0	1.0	1.0
Viscosity, 60°C (140°F), poises - maximum	1000	2000	4000	6000	8000	12000	16000
Ductility 25°C (77°F), 5 cm per minute, cm-minimum	100	100	75	60	50	40	25

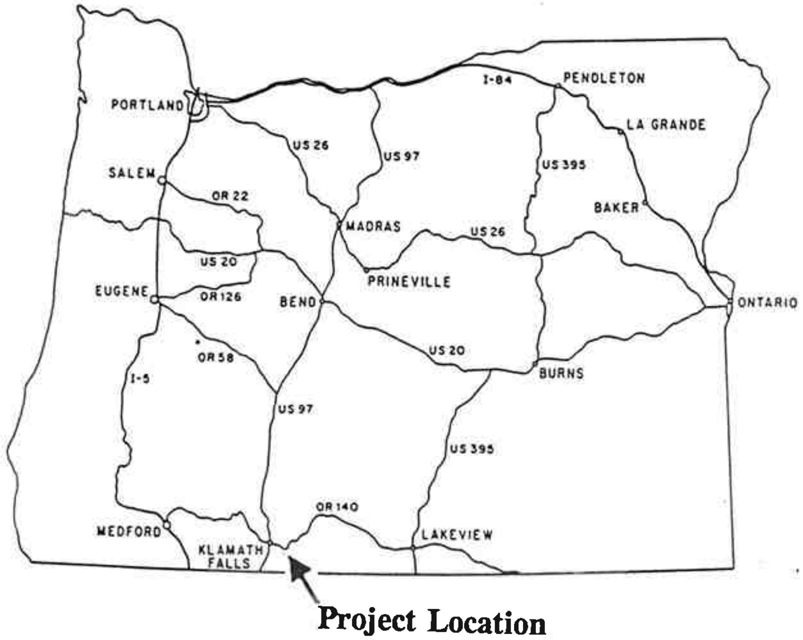
2.0 PROJECT DATA

2.1 Project Location

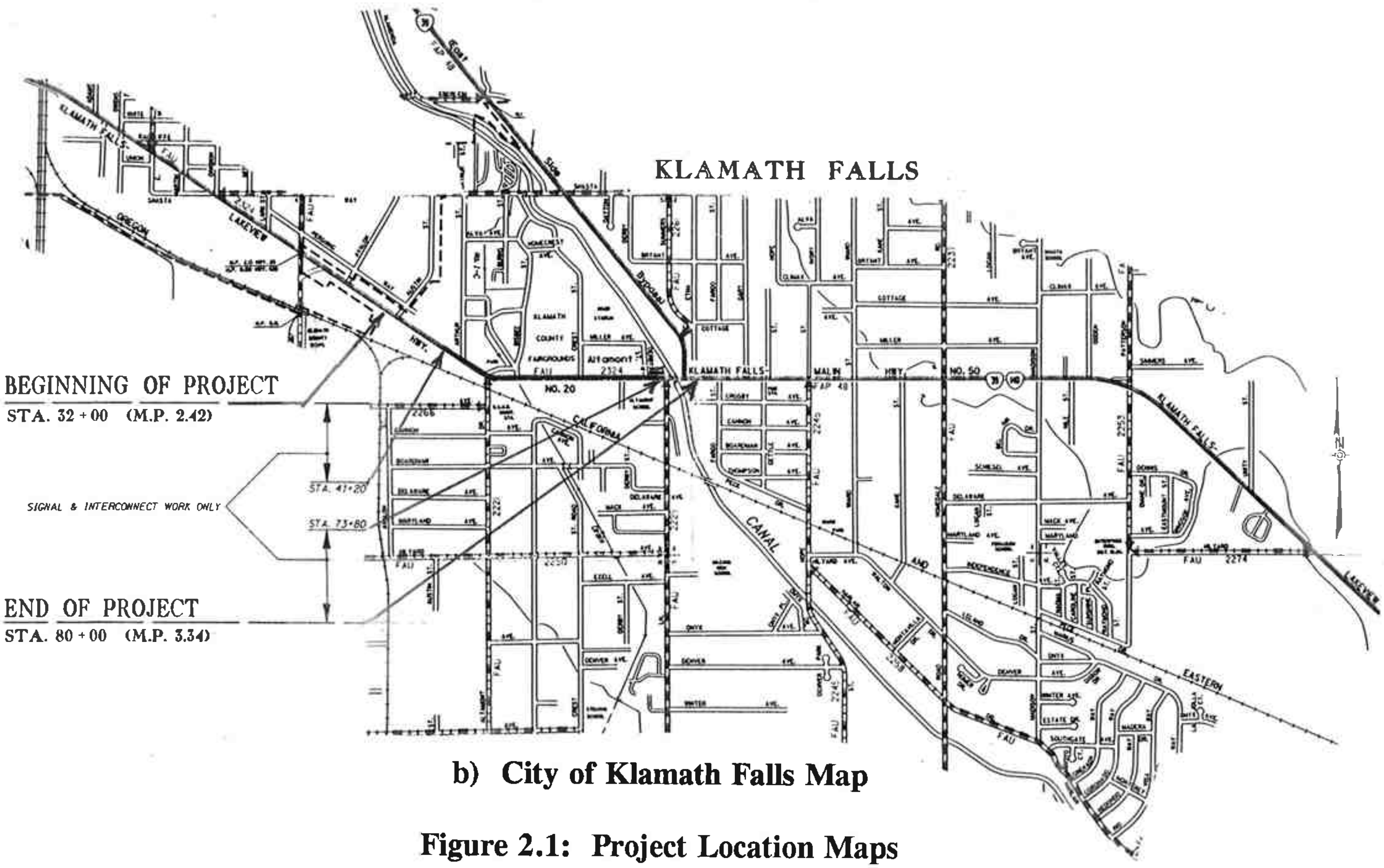
The Austin Ave. - East Side Bypass project (South 6th Street) is located between Milepoints 2.40 and 3.40 of the Klamath Falls - Lakeview Highway (Highway 20, Oregon Route 140) as shown in Figure 2.1. In this section, Oregon Route 140 is a 5-lane roadway with a center left turn lane. The project is within the city limits of Klamath Falls at an elevation of approximately 4,000 feet. The terrain is high-desert with predominantly sage brush vegetation. Low annual rain fall, high summer temperatures, and low winter temperatures are common to the area.

2.2 Pavement Construction

A typical pavement cross section is shown in Figure 2.2. The pavement structure consists of an AC wearing course and a base course. There is a portion of Portland Cement Concrete (PCC) slab located approximately 8" below the pavement surface. This concrete slab was probably the original pavement, constructed many years ago.



a) Project Location Vicinity Map



b) City of Klamath Falls Map

Figure 2.1: Project Location Maps

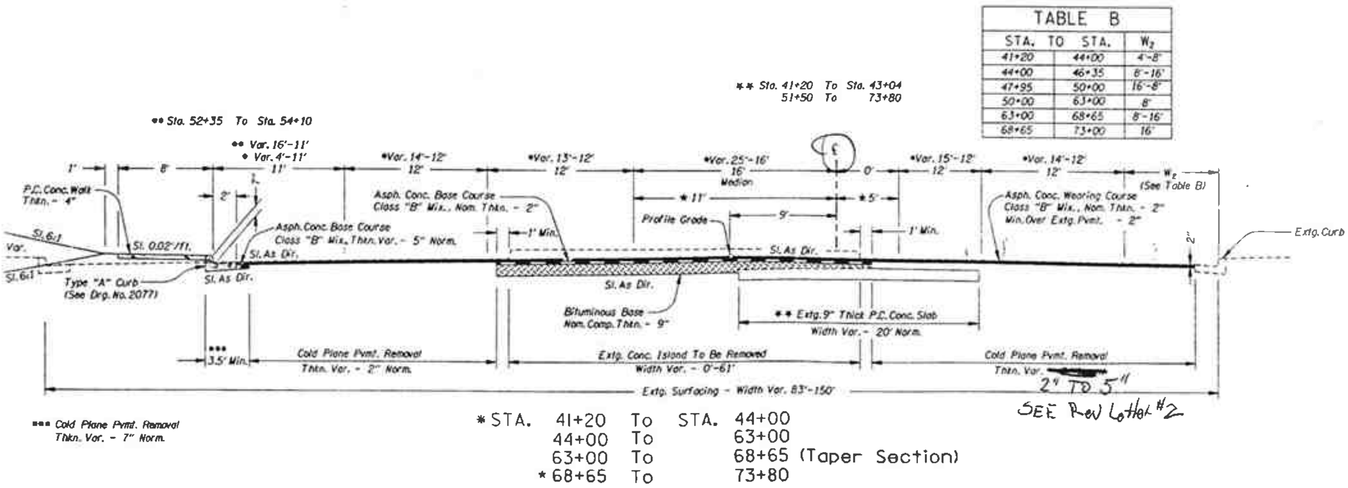


Figure 2.2: Typical Cross-Section

2.3 Project Mix Design

The AC used for the project was a standard Oregon Class "B" asphalt mixture. The Class "B" mix is a dense graded, 3/4" maximum size aggregate. Witco AC-15 (representing OSHD TABLE 1) asphalt was used in the base course of both the control section and the test section. Witco AC-15 asphalt was also used in the wearing course of the control section. A typical profile is shown in Figure 2.3. Chevron AC-20 and Idaho AC-20 (representing OSHD TABLE-2) asphalts were used in the wearing course of the test section. A 5.8% asphalt content was recommended for use on this project. Aggregate for all job mix formulas was lime treated per the project specifications. The mix design data can be found in the appendix.

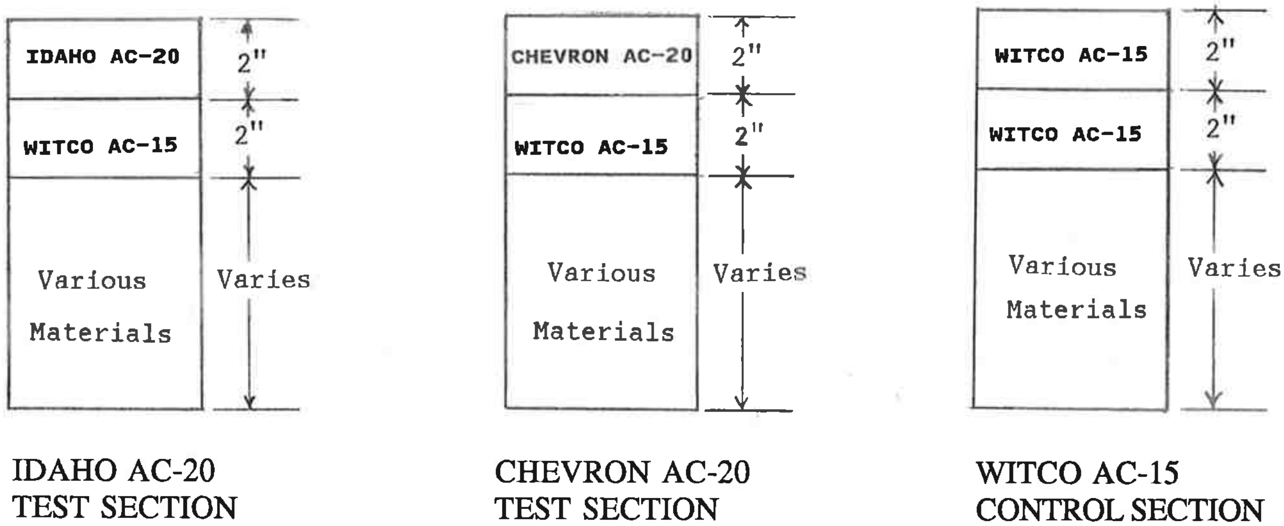


Figure 2.3: Profile of the Test and Control Sections

2.4 Average Test Results for Asphalts

The 1989 yearly average test results of the three asphalts used are presented here for the purpose of comparison. These results were provided by the Highway Materials Laboratory of the Oregon State Highway Division. Tables 2.1, 2.2, and 2.3 show the mean, standard deviation, and number of tests that were performed during the 1989 paving season using each type of asphalt. Actual asphalt test results for this particular project are not available, due to some miscommunication as to when the contractor was switching asphalts during construction.

The average test results are illustrated in Figure 2.4. The figure clearly shows the relationship between original and residue asphalt properties as well as the difference of asphalt properties between the TABLE-1 and TABLE-2 asphalts. The penetration for residue asphalt may be extrapolated from the viscosities and penetration at 77°F., as shown in the figure by dotted line. The predicted field asphalt properties may also be interpolated from the same figure.

Table 2.1: Average Test Results for Witco AC-15

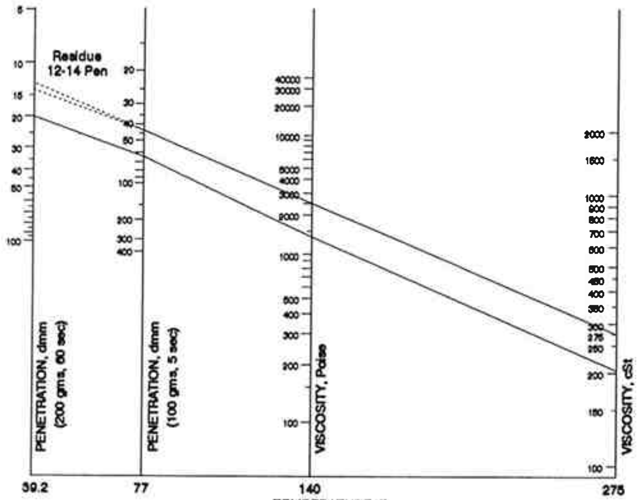
Variable	Mean	Standard Deviation	No. of Tests
Penetration 77	62	6	28
Penetration 39	20	3	27
Penetration Ratio	31	4	27
Kinematic Viscosity	212	15	9
Residue Kinematic Viscosity	268	19	9
Absolute Viscosity	1,420	112	27
Residue Absolute Viscosity	2,500	349	14
Residue Penetration 77	42	4	9
Percent Original Penetration	68	7	9
Ring Ball Softening Point	126	2	4

Table 2.2: Average Test Results for Chevron AC-20

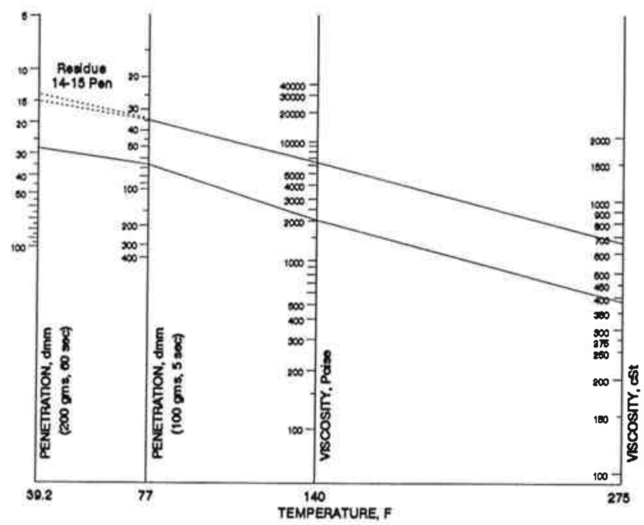
Variable	Mean	Standard Deviation	No. of Tests
Penetration 77	67	4	157
Penetration 39	27	2	157
Penetration Ratio	40	3	157
Kinematic Viscosity	384	21	44
Residue Kinematic Viscosity	630	45	44
Absolute Viscosity	2,040	109	158
Residue Absolute Viscosity	6,688	766	51
Residue Penetration 77	35	2	44
Percent Original Penetration	52	3	44
Ring Ball Softening Point	131	5	11

Table 2.3: Average Test Results for Idaho AC-20

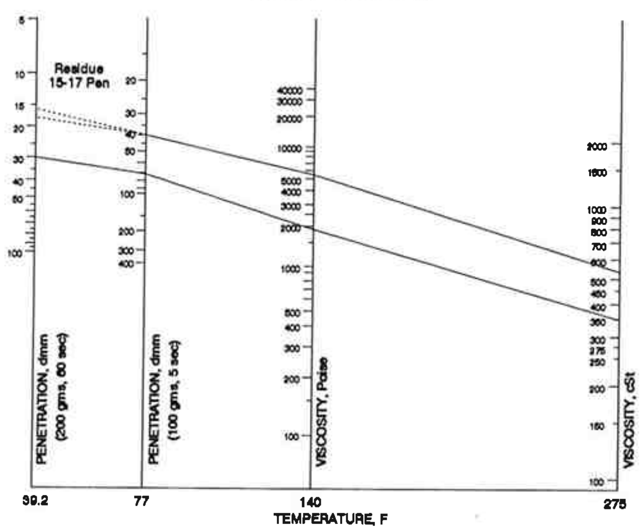
Variable	Mean	Standard Deviation	No. of Tests
Penetration 77	71	4	24
Penetration 39	30	2	24
Penetration Ratio	42	3	24
Kinematic Viscosity	360	18	10
Residue Kinematic Viscosity	562	22	10
Absolute Viscosity	1,894	150	25
Residue Absolute Viscosity	5,823	377	15
Residue Penetration 77	38	2	10
Percent Original Penetration	53	4	10
Ring Ball Softening Point	132	3	2



a) Witco AC-15



b) Chevron AC-20



c) Idaho AC-20

Figure 2.4: Average Test Results for Asphalts Used

3.0 TEST SECTION

3.1 Construction

The existing pavement was milled to a two inch depth and inlaid with a two inch Class "B" base course. A two inch Class "B" wearing course was placed on the top of the inlay. Witco AC-15 asphalt was used in the base course and in the wearing course of the control section. Idaho AC-20 and Chevron AC-20 asphalts were used in the wearing course of the test section. The typical profile can be seen in Figure 2.3.

The existing pavement had extensive cracking, and during the construction this cracking was not totally eliminated by the milling. This allowed the existing cracking to reflect through the inlay as well as the overlay.

3.2 Test Section Layout

Figure 3.1 gives a detailed layout of the test sections. Idaho AC-20 asphalt was used between station 41+20 and 59+00 in the westbound outside lane. Chevron AC-20 was used between station 59+00 and 73+80 in the westbound outside lane.

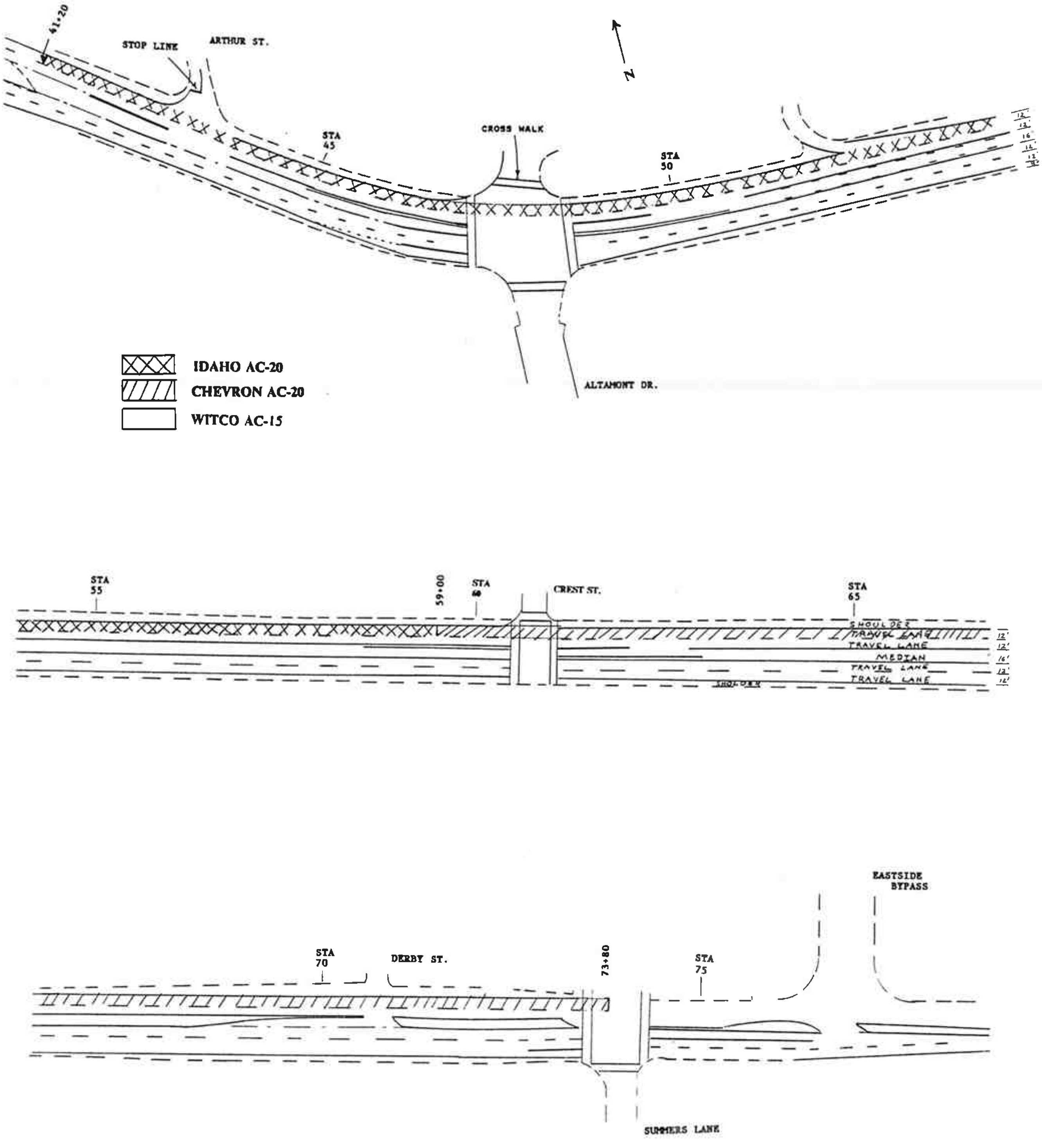


Figure 3.1: Layout of Test Sections

4.0 PAVEMENT EVALUATION

4.1 Preconstruction Crack Survey

Preconstruction crack information was obtained for the Chevron AC-20 asphalt test section. Only a portion of crack information was obtained for the Idaho AC-20 asphalt test section. The crack pattern on these sections is illustrated in Figures 4.1 and 4.2.

A crack survey was performed prior to rotomilling. In July 1989 after the rotomilling occurred, the same thermal cracks were still visible. This cracking occurred full depth of the pavement. It is also interesting to note that many of these cracks corresponded to the joints in the old concrete panel underlying portions of the pavement. These cracks extended across both lanes of the outside and inside westbound lanes. Referring to Figure 4.2, no crack information was obtained in the westbound lanes station 41+20 to 53+20 due to the fact that this area was excavated to subgrade and pavement removed due to realignment of centerline to the south.

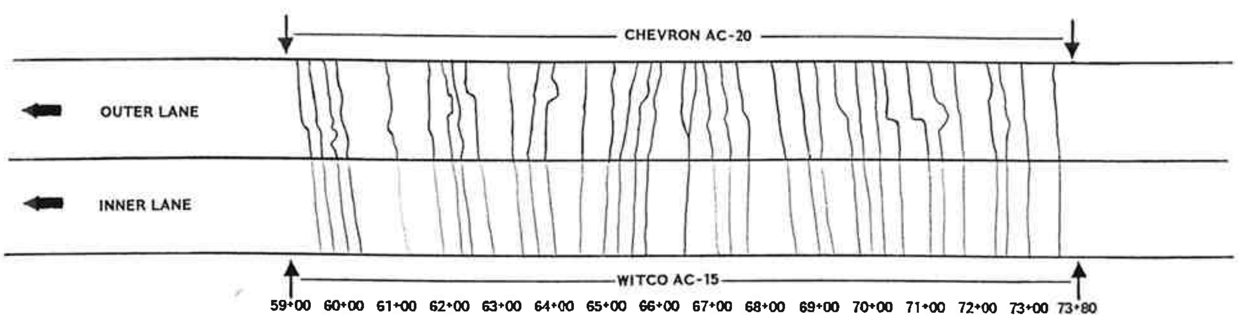


Figure 4.1: Crack Map Before Overlay (Chevron AC-20)

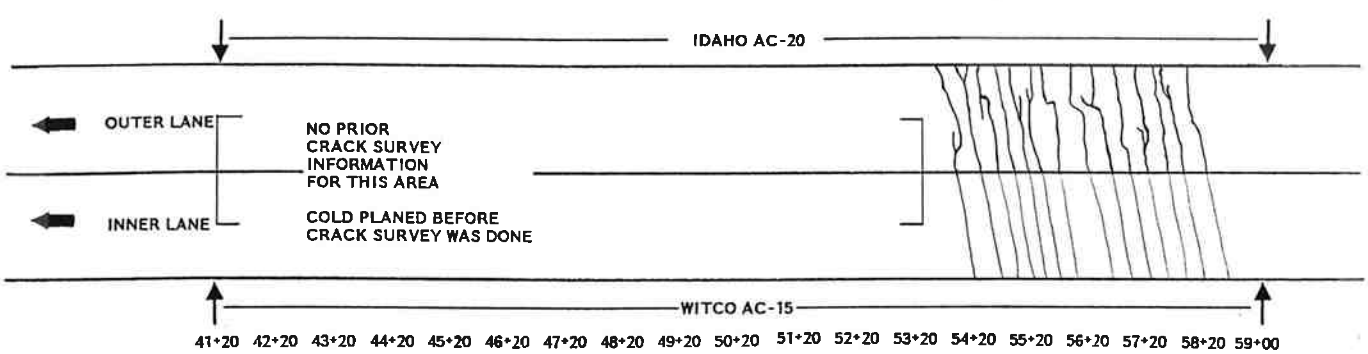


Figure 4.2: Crack Map Before Overlay (Idaho AC-20)

4.2 Post Construction Crack Survey

In June 1991, two years after project completion, a post-construction crack survey was conducted. The crack survey results are illustrated in Figures 4.3 and 4.4.

The preconstruction crack survey recorded 14 cracks on the Idaho AC-20 test section. After two years of service, six of these cracks had reflected. This results in 43% of the cracks reflecting through the new wearing course (see Table 4.1). In the control section where Witco AC-15 was used, there were 14 cracks before placing the wearing course. During the 1991 inspection, an actual crack count showed that all 14 cracks (100%) had reflected through.

In the Chevron AC-20 test section, 35 cracks were recorded during the preconstruction crack survey. After two years of service, 17 of these had reflected. This results in 48% of the cracks reflecting through. In the control section where Witco AC-15 was used, the same number of cracks as in the Chevron AC-20 test section were observed before placing the wearing course. The cracks extended across both westbound lanes. During the 1991 inspection, an actual crack count showed that 29 cracks (83%) had reflected through.

Table 4.1: Summary of Crack Survey Results

Section	No. of Cracks Preconstruction	No. of Cracks Postconstruction	Percent of Cracks That Came Through
IDAHO AC-20(Test)	14	6	43%
WITCO AC-15(Control)	14	14	100%
CHEVRON AC-20(Test)	35	17	48%
WITCO AC-15(Control)	35	29	83%

The crack survey results in Table 4.1 indicate that both Chevron and Idaho AC-20 asphalts (representing TABLE-2) have a better cracking resistance than Witco AC-15 asphalt (representing TABLE-1).

4.3 Effect of Temperature

The coldest temperature to which the pavement was subjected during the two-year evaluation is given in Table 4.2.

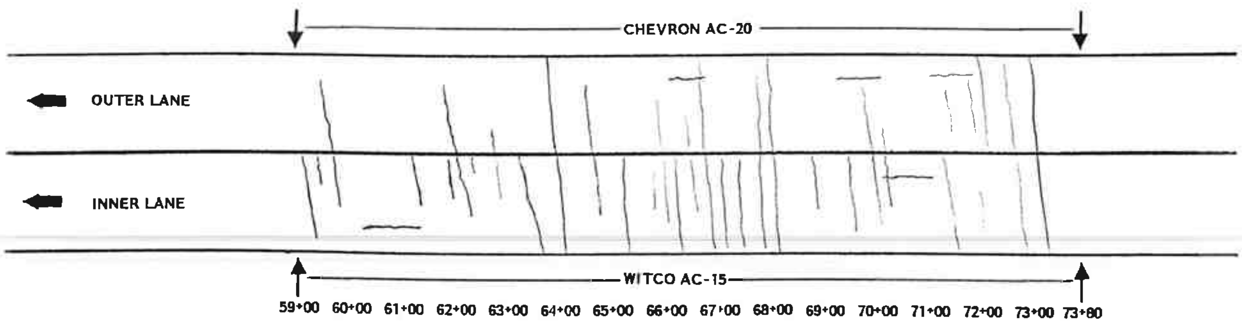


Figure 4.3: Crack Map Two Years After Overlay (Chevron AC-20)

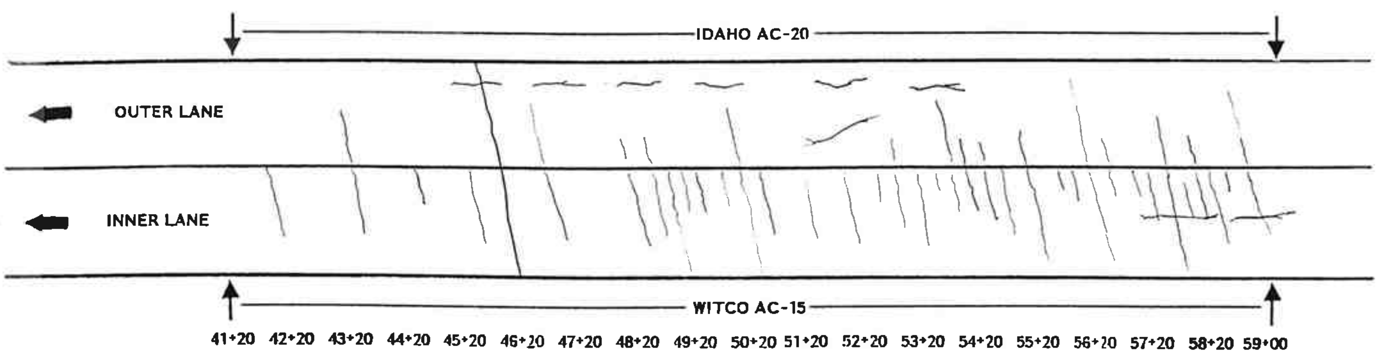


Figure 4.4: Crack Map Two Years After Overlay (Idaho AC-20)

Table 4.2: Temperature Data During the Two-Year Evaluation

1989 - 1990 Winter
Lowest Monthly Temperature

Date	Temperature in Degrees F
November 28	+ 9
December 25	+12
January 3	+ 9
February 19	- 7

1990 - 1991 Winter
Lowest Monthly Temperature

Date	Temperature in Degrees F
November 24	+18
December 22	- 16
January 4	+ 4
February 26	+23

The lowest recorded temperature was a minus sixteen degrees (-16) recorded on December 22, 1990. After experiencing this cold temperature, the test section has substantially less cracks than the control section. This may indicate that the TABLE-2 asphalts have a better resistance to thermal cracking than TABLE-1 asphalt. However, it is not known how much effect the cold temperature had on the test and the control sections. Based on asphalt test results in Section 2.4 of this report, it would appear that Chevron AC-20 and Idaho AC-20 asphalts, because of their slightly higher penetration at low temperature, would have a better thermal cracking resistance than Witco AC-15. The reflective cracking in both sections would be largely due to the existing pavement cracking, while the cold temperature might have accelerated the development of cracks. In addition, the TABLE-2 asphalts are expected to perform better in all-weather conditions because of their relative flatness (less temperature susceptible) in asphalt properties, as can be seen in Figure 2.4.

4.4 Effect of Traffic

In general, traffic loadings have a significant effect on the development of cracks; the number and severity of cracks in the pavement increases with higher volumes of traffic and weights of vehicles. In this study, the distribution of traffic on both lanes was not clear. However, it may be noticed that the test section is in the outer lane and the control section is in the inner lane. The outer lane generally experiences more traffic than the inner lane.

5.0 CONCLUSIONS AND COMMENTS

This study has attempted to compare the effect of asphalts specified by either OSHD modified TABLE-1 or OSHD modified TABLE-2. Based on limited laboratory and field information, it appears that the following conclusions are warranted.

1. TABLE-2 asphalt was more effective than TABLE-1 asphalt in reducing reflective cracking. This conclusion is reached based on the two-year evaluation. The number of cracks in the TABLE-2 test section is less than that of the TABLE-1 control section.

2. The effect of cold temperatures on the development of cracking in both test and control sections was not known. However, it may be expected that TABLE-2 asphalts would have a better thermal resistance than TABLE-1 asphalt because TABLE-2 asphalts were less temperature susceptible than TABLE-1 asphalt.

The following are some comments pertinent to this study:

1. The same grade of asphalts should have been used for the purpose of comparison.

2. Actual asphalt test properties for projects in evaluation should have been determined.

3. More project sites should have been selected for this research investigation.

4. Additional field observation on both sections may be necessary to evaluate any long-term performance differences.

6.0 REFERENCES

1. The American Association of State Highway Officials, "Standard Specifications for Highway Materials and Methods of Sampling and Testing," 10th Edition, AASHO, Washington, D.C., 1970.

2. Oregon State Highway Division, "1989 Specifications for Asphalt Materials," OSHD, Oregon Department of Transportation, Salem, Oregon, 1989.

3. The American Association of State Highway Officials, "Standard Specifications for Highway Materials and Methods of Sampling and Testing," 11th Edition, AASHO, Washington, D.C., 1974.

APPENDIX

Mix Design Data

PRELIMINARY BITUMINOUS MIXTURE DESIGN

Highway Division
Materials Section

Laboratory No. 07 04927
Data Sheet No. * Transfer
Prefix C10 697
Amount Charge #134—
Date Received 5/24/89
Date Reported 6-2-89

Project— Austin Ave- Eastside Bypass (Klamath Falls)
Contractor: Prime— Roy L. Houck Construction Co. Mix Type Class— Class "B" A/C
Paving— / Contract No.— C10697 Fed. Aid No.— STA-MOD
Engineer: Region— Steve Macwab Resident— Richard Steyskal (8033)

AGGREGATE GRADATION: Source— Long Lake Rd Quarry # 18-48-4 Type— Quarry

Aggregate Size	3/4 - 1/4	1/4 - 10	10 - 0				Combined Dry Sieve	Agg. Grad. Extracted
% Comb.	44	26	30					
1"	100 100						100	100
3/4	98 98						99	99
1/2	73 73						88	88
3/8	44.6	100 100					76	76
1/4	13 13	92 92	100 100				60	60
10	1 1	6 6	90 90				29	30
40	1 1	1 1	42 42				13	14
200 (Dry)	0.7	0.3	14.7				4.8	6.5
200 (Wet)	1.0	1.0	16.0					
No. Ave.	7	5	4				P200/ac = 1.3	

TEST DATA: Asphalt Brand/Grade— Witco AR4000 #87-4013 Additive—

Percent Asphalt (total mix)	4.5	5.0	5.5	6.0	6.5
Asphalt Film	Dry	Dry-Suff	Suff.	Suff-Th	Thick
Sp. Gr. @ 1st Comp. (T-246)	2.42	2.44	2.46	2.48	2.49
Percent Voids @ 1st Comp.	6.7	5.0	3.6	2.5	1.7
Stability @ 1st Comp. (T-247)	32	33	34	24	22
Sp. Gr. @ 2nd Comp.	2.47	2.49	2.51	2.53	2.53
Percent Voids @ 2nd Comp.	4.7	3.1	1.6	0.5	0.2
Stability @ 2nd Comp.	34	43	44	9	8
Max. Sp. Gr. (T-209)	2.593	2.569	2.551	2.543	2.534
Index Ret. Str. (T-165) Witco AR4000	100+		100+		100+
Index Ret. Str. (T-165) Witco AC15 + 0.5% Unichem	65	75	100		
Index Ret. Str. (T-165) 8160					

~~RECOMMENDATIONS~~: Job Mix Formula:

Aggregate Gradation		Asphalt Content:	Sp. Gr. @ 100% Comp	T-209	Design Voids 100% Comp	@ 1st
1"	100	Wearing course— 5.0	2.49	2569	3.1	5.0
3/4	99	Base course— 5.0	2.49	2569	3.1	5.0
1/2	87	Shoulder course—				
3/8	76	PMBB—				
1/4	60	Asphalt:			VMA = —	
10	30	Brand— Witco	Mix Placement Temp.— 280°F			
40	14	Grade— AC15	Mixing Temp— —			
200	5.5	Additive— 0.5% Unichem 8160				

Comments: aggregate produced for The Dalles/Cal Hy – Washburn Way C10171
Qualifying: 87-7473-CA-LAR = 15.0%; NA_2SO_4 = 6.0%; Deg. = 15.4% 0.3" Friable = 0.2%
87-7474-FA- ——— ; " = 0.8%; " = 11.3% 0.3" " = 0.3%
87-7475-FA- ——— ; " = 0.8%; " = 11.3% 0.3" " – 0.4%
87-6491

x Const.
x FHWA
Reg. Engr.
x Res. Engr. John Stucky
~~Dist. Engr.~~ RAs 4
x Region Geo. RJ Vancleave
2x Files
x Roy L. Houck Construction

* Transfer from C10171 with additional IRS to verify the use of carbonized aggregate surface and liquid additive.

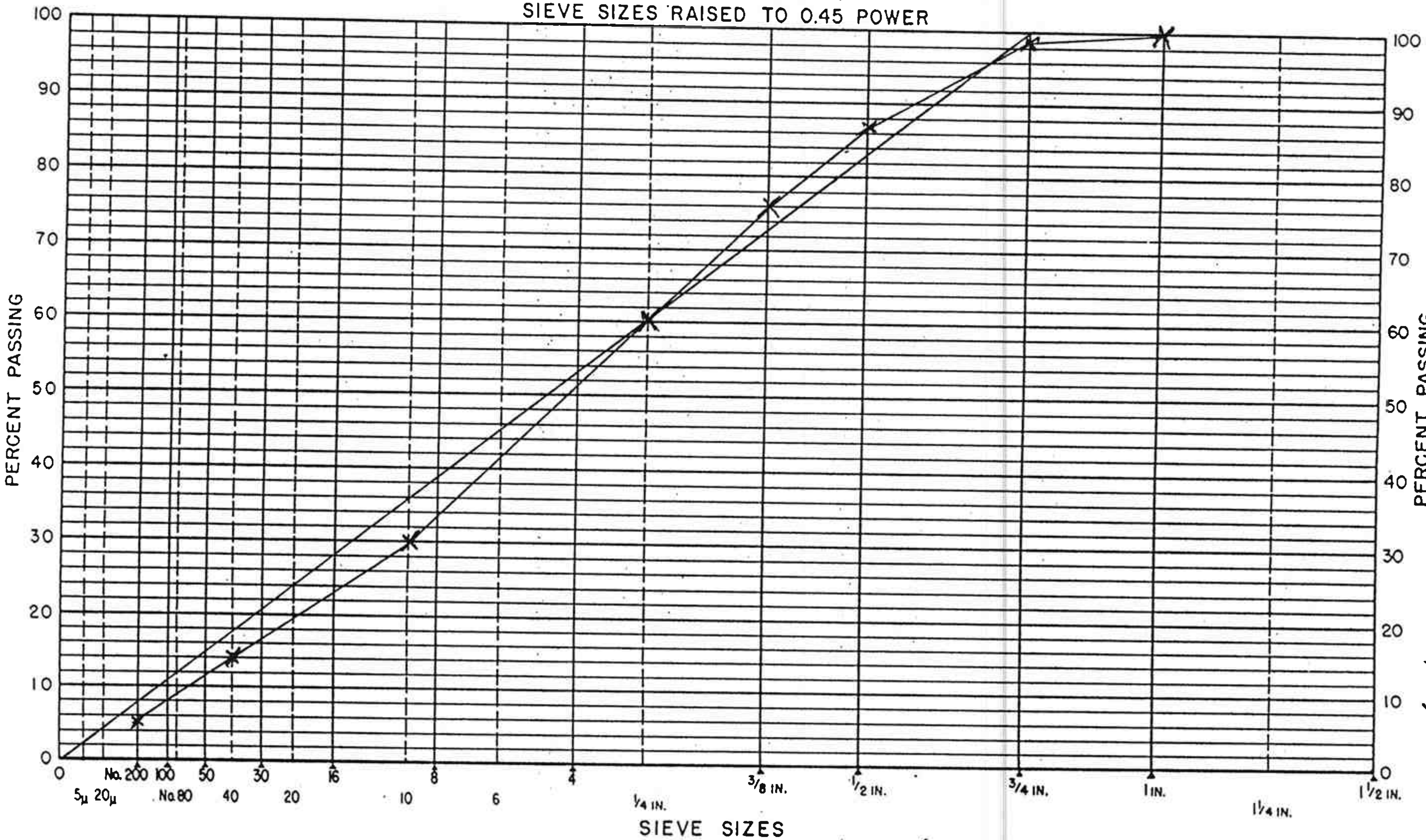
NOTED
Tony George

W. J. Quinn [signature]
Engineer of Materials

734-1887 (11-81)

GRADATION CHART

SIEVE SIZES RAISED TO 0.45 POWER



Class "B" A/C

▲ THIS SYMBOL IDENTIFIES SIMPLIFIED PRACTICE AND COMPATIBLE SIEVE SIZES

Idenification of gradations:

Austin Ave – Eastside By Pass (Klamath Falls) C10697

Sheet No.
Date

HWY FORM 350-564
10/70

04927