EVALUATION OF ASPHALT STABILIZING ADDITIVES

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EVALUATION OF ASPHALT STABILIZING ADDITIVES

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8. ABSTRACT

Efforts are constantly being put forth by researchers, highway related industries and product suppliers to improve the life and performance of asphalt pavements. As a result of those efforts, a variety of asphalt modifiers have been developed and evaluated in experimental sections over the years. Evaluations of the polymer asphalt modifiers have been done and results were usually compared with conventional sections within each respective project. The research presented in this report is also a comparison of asphalt modifiers with each other as well as a comparison of a modifier with its respective conventional section, when they exist. Several of the modifiers showed some improvements in performance while others did not.

9. KEY WORDS	10. NO. OF PAGES
Polymer Modifiers Asphadur Asphalt Ralumac Chem-Crete UltraPave Ductilad	106

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DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute any standard, specification or regulation.

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INTRODUCTION

Various asphalt additives have been used at several Iowa locations over the years. Unfortunately, the analysis and comparison of performance between the sites has not always been thoroughly documented. This project was initiated to evaluate and summarize the experiences to date of approximately 15 different Iowa sites where various asphalt additives have been used. In many cases, the projects used in this research were completed before this research was initiated. Project correspondence and agreement are in Appendix A.

OBJECTIVE

The objective of the research is to compare performance results of various asphalt modifiers as used in various Iowa test sections.

PROJECT DESCRIPTION

The research project consists of a combination of various projects and test sections with asphalt additives which have been used or are under study in recent years.

Eight different types of asphalt additives were evaluated in the project. The additives were applied in a total of 15 specific Iowa sites. Four products were applied at more than one site. In some cases, a conventional section within the project was not available for comparison to the test additive. Data collected, as well as results found from each site, were unique for each application. Applications were often very different from each other. The various projects consisted of seal coats, microsurfacing treatments and sometimes one or more courses of asphalt on a highway or at a specific area near a signalized intersection. Evaluations were done mainly through visual inspections and rut depth measurements. Core densities and percent air were also obtained, where applicable. See Appendix C.

PROJECT LOCATIONS

A list of the locations of the projects and the asphalt additives used is as follows:

	SITE	ASPHALT MODIFIER
1.	Jasper County, in the city of Newton	PAC 40 Styrene Butadiene Styrene (SBS)
2.	Clinton County in the city of Clinton on US 67	PAC 40 Styrene Butadiene Neoprene (SBN)
3.	O'Brien County in the city of Sheldon on US 18	PAC 40 Styrene Butadiene Rubber (SBR)
4.	Pottawattamie County in the city of Council Bluffs on I-480 (1979)	Asphadur
5.	Woodbury County in the city of Sioux City on IA 12, Gordon Drive	AC-13 (Styrelf-13)
6.	Story County, south of Napier on county road E57	Chem-Crete
7.	Polk County, south of Madrid on IA 415	Ductilad D1002
8.	Polk County, north of Ankeny on US 69	Ralumac
9.	Story County, north of Nevada on county road E29	UltraPave
10.	Pottawattamie County in the city of Council Bluffs on I-480 (1988 resurfacing of site 4)	3M additive 5990 (Asphadur)
11.	Webster County, south of Ft. Dodge on US 169	Ralumac
12.	Polk County in the city of Des Moines on Fleur Drive	PAC 30 Styrene Butadiene Styrene (SBS)
13.	Story County in the city of Ames on US 69, Duff Avenue	PAC 30 Styrene Butadiene Styrene (SBS)
14.	O'Brien County in the city of Sheldon on IA 60	PAC 40 Styrene Butadiene Rubber (SBR)
15.	Polk County in the city of Des Moines on Fleur Drive	PAC 30 Styrene Butadiene Styrene (SBS)

PAC 30, PAC 40, SITES 1, 2, 3, 12, 13, 14 and 15

Seven different sites were selected to evaluate polymer modified asphalt cements, PAC 30s and PAC 40s. The seven sites were selected from different areas of the state and with different average daily traffic counts. All the sites were in areas of city traffic and often at street intersections with a high number of traffic stops and starts.

Location, Date, Evaluation and Conclusion

Details for site No.:

1. Jasper County, in the city of Newton on US 6, project FN-6-4(85)--21-50. The project extends from West 15th Place north to West 3rd Street and from East 2nd Street to East 28th Street.

   The PAC 40 Styrene Butadiene Styrene (SBS) treatment is in both the 38.1 mm (1½ in.) thick binder and surface course from 30.5 m (100 ft.) east to 30.5 m (100 ft.) west of signalized intersections.

   The Average Daily Traffic (ADT) was 10,000 with 3.3% trucks. The project was constructed in September 1987.

   Evaluations for this project were near the intersection of East 23rd Street for both the test and conventional sections. Visual evaluations and rut depth measurements were recorded.

Visual evaluation showed no major amount of stripping, raveling or cracking and no significant difference when comparing the PAC 40 to the conventional section.

Rut depth average measurements in mm (in.) were:

	1991	1993
PAC 40	2.54 mm (0.10 in.)	4.1 mm (0.16 in.)
Conventional	5.08 mm (0.20 in.)	5.08 mm (0.20 in.)

The contract prices quoted did not show an extra cost for the polymerized (PAC 40) asphalt. The conventional and PAC 40 asphalt cement concretes were both quoted at $0.02 per kg ($11.73 per ton), so no cost comparisons is available.

In conclusion, the polymerized (PAC 40) asphalt cement concrete performed slightly better than the conventional asphalt cement concrete even when placed near a signalized intersection. The rut depth measurement showed slightly less rutting in the PAC 40 test section.

See Appendix B - 1 for Materials Data.

2. Clinton County, in the city of Clinton on US 67, project FN-67-2(42)--21-23. The project extends from 7th Avenue South, north 1.3 km (0.8 miles) to 7th Avenue North and from North 2nd Street, west to North 3rd Street.

The PAC 40 Styrene Butadiene Neoprene (SBN) modified asphalt was applied in the center 12.2 m (40 ft.) from Sta. 17+69.90 (MP 38.11) to Sta. 39+82.90 and center 9.8 m (32 ft.) on Main Street from 2nd Street to 3rd Street. The ADT was 13,400 on US 67 and 6,380 on Main Street. The project was constructed in May 1987.

Evaluations for this project were on US 67 between 2nd and 3rd Street South, between 4th and 5th Street North and on Main Street between N. 2nd Street and N. 3rd Street. Visual evaluations and rut depth measurements were recorded.

Visual evaluations showed no stripping or raveling. Some cracking was evident, but it appeared to be reflective or related to city utility lines. It appeared to be similar in the PAC 40 and conventional sections.

Rut depth averages in mm (in.) were:

	1990	1993
PAC 40	0.25 mm (0.01 in.)	2.0 mm (0.08 in.)
Conventional	1.27 mm (0.05 in.)	2.3 mm (0.09 in.)

The contract prices quoted were the same for the polymerized (PAC 40) asphalt cement concrete and the conventional asphalt cement concrete. The price for each was quoted at $0.03 per kg ($23.00 per ton) so no cost comparison is available.

The conclusion from evaluations at this site would be similar to site 1. Raveling and stripping were not evident. Some cracks were observed but appeared to be reflective or related to underground utilities. The rut depth measurements show that the modified asphalt (PAC 40) cement concrete had slightly less rutting with a difference which is relatively insignificant.

In this case, performance of the asphalt modifier would not justify any increase in product cost.

See Appendix B - 2 for Materials Data.

3. O'Brien County, in the city of Sheldon on US 18 from the railroad tracks east to the east city limit of the city of Sanborn at the junction of US 69. The project is FN-18-2(50)--21-71.

The section of modified asphalt (PAC 40 Styrene Butadiene Rubber (SBR)) cement extends from the intersection of US 18 and IA 60, eastward from Sta. 29+73 to Sta. 35+50.

The ADT is 5,300 with 14% trucks. The project was constructed in June 1987.

Evaluation of the modified asphalt (PAC 40) cement concrete section was of the westbound inside lane and results were compared with the conventional section. Visual evaluations showed that there was no significant stripping or raveling and that some cracking did exist, however, it was similar to the conventional section.

Rut depth measurements in mm (in.) were:

	1989	1991	1993
PAC 40	2.29 mm (0.09 in.)	2.29 mm (0.09 in.)	3.30 mm (0.13 in.)
Conventional	1.27 mm (0.05 in.)	2.54 mm (0.10 in.)	2.80 mm (0.11 in.)

The contract price for PAC 40 is not quoted as it was substituted in the place of Asphadur in this project.

Based on visual evaluations and on rut depth measurements, the conclusions from this test site are that the PAC 40 performed similar to the conventional asphalt cement concrete. A significant extra cost for the PAC 40 would not have been recovered through extra or exceptional performance. The conventional section performed as well as the PAC 40 section.

See Appendix B - 3 for Materials Data.

12. Polk County, in the city of Des Moines, on Fleur Drive from McKinley Avenue, north approximately 2.4 km (1.5 miles) to the railroad viaduct. The project is WO 0206-85-009 constructed in 1986.

A modified asphalt PAC 30 cement concrete was used in two 38.1 mm (1½ in.) lifts.

The ADT was 30,000 with 5% trucks.

Visual evaluations and rut depth measurements were mainly in the southbound driving lane south of the intersection with Wakonda View Drive. There was no conventional section in this project. There was no evidence of stripping or raveling. Some reflective cracking did exist.

Rut depth measurement averages in mm (in.) were:

1990	1991	1993
3.30 mm (0.13 in.)	2.79 mm (0.11 in.)	5.59 mm (0.22 in.)

The contract quoted price for asphalt cement, polymerized, was $0.33 per kg ($296.06 per ton). The average price for regular asphalt cement in 1986 was $0.23 per kg ($204.00 per ton).

The polymerized asphalt cement concrete, PAC 30, put down in 1986 was still performing fairly well in 1993. The most evident and increasing problem was wheelpath rutting which measured 5.59 mm (0.22 in.) in 1993. Without a conventional section for comparison, it can only be concluded that the polymerized asphalt performed in a satisfactory manner under the heavy traffic conditions and the long period of time.

See Appendix B - 12 for Materials Data.

13. Story County, in the city of Ames on Us 69, Duff Avenue, from the Squaw Creek Bridge north to South Third Street. The test section for evaluation of the PAC 30 extends from the centerline of South 5th Street 42.98 m (141 ft.) southerly. The remainder of the project southward was the conventional section.

    The PAC 30 treatment was applied in both the 38.1 mm (1½ in.) thick binder and surface courses.

    The ADT was 19,000 with 3% trucks. The project was constructed in August 1988.

    Evaluations for this project were between South 5th Street and the Squaw Creek Bridge. Visual evaluations and rut depth measurements were recorded for the PAC 30 section and for the conventional section.

There was no evidence of stripping or raveling in either section. Cracking was observed, but was minimal in both sections.

Rut depth average measurements in mm (in.) were:

	1990	1991	1994
PAC 30	1.27 mm (0.05 in.)	2.03 mm (0.08 in.)	2.79 mm (0.11 in.)
Conventional	2.29 mm (0.09 in.)	2.54 mm (0.10 in.)	3.30 mm (0.13 in.)

The contract quoted price was $0.17/kg ($148.00/ton) for the conventional asphalt cement and $0.31/kg ($275.00/ton) for the polymerized (PAC 30) asphalt cement.

The conclusion from field evaluations of the polymer modified asphalt cement concrete is that it is performing in a satisfactory manner. Considering that the PAC 30 section was placed at a signalized intersection where it was exposed to the extra stresses from stopping, starting and turning traffic, it still performed better than the conventional asphalt mix. Rut depth measurements were also lower in the PAC 30 section. Considering the high volume of traffic and the location of the PAC 30 test section, it can be concluded that the PAC 30 modified asphalt cement is, under these conditions, performing better than the conventional asphalt and it's performance would support some additional expenditure on PAC 30 modifier.

See Appendix B - 13 for Materials Data.

14. O'Brien County, on IA 60 from US 18 in Sheldon north to the C&NW RR in Sibley.

A modified asphalt cement, PAC 40, was applied north of the signalized intersection with US 18. The PAC 40 was used in both the 38.1 mm (1½ in.) thick binder and surface courses from Sta. 1750+15 north to Sta. 1763+07. The project number was FN-60-3(11)--21-71.

The ADT was 8,400 with 14% trucks and the project was constructed in 1987.

Visual evaluations for this test site and the adjoining conventional section identified no significant stripping or raveling in either section. Some cracks were evident but they appeared to be reflective. Rut depth measurements in mm (in.) were:

	1989	1991	1993
PAC 40	2.54 mm (0.10 in.)	3.81 mm (0.15 in.)	1.78 mm (0.07 in.)
Conventional	1.27 mm (0.05 in.)	0.76 mm (0.03 in.)	0.76 mm (0.03 in.)

The contract quoted prices for the asphalt cement concrete mixes were: Conventional - $0.02 per kg ($13.75 per ton)
Polymer modified (PAC 40) - $0.03 per kg ($23.00 per ton)

Conclusions, based upon field performance and product cost only at this site, may be misleading. The polymerized asphalt mix did cost more. From visual evaluations, it did not perform better than the conventional mix. Rut depth measurements would imply that the polymerized mix did not perform quite as well as the conventional mix. However, the polymerized mix was placed in a location of vehicle braking, accelerating or turning which clearly puts additional stresses on the pavement. The conventional mix was placed in the main line away from the signalized intersection. Under these conditions of extra stress, the polymerized asphalt, PAC 40 mix, did perform in a very acceptable manner considering its location.

See Appendix B - 14 for Materials Data.

15. Polk County, in the city of Des Moines on Fleur Drive, from McKinley Avenue south to Army Post Road. The project number is 020687003.

A polymer modified asphalt cement (PAC 30) was used in the mix for two 38.1 mm (1½ in.) thick lifts constructed in 1989.

The ADT was 30,000 with 5% trucks.

Performance evaluations were mainly of the southbound lanes just south of Hackley Avenue. Visual evaluations showed no stripping or raveling. There was minimal transverse cracking which appeared to be reflective.

Rut depth measurement averages in mm (in.) were:

1989	1990	1991	1993
2.03 mm (0.08 in.)	2.03 mm (0.08 in.)	4.32 mm (0.17 in.)	3.56 mm (0.14 in.)

There was no conventional section within this project for comparison of asphalt performance and material cost.

A conclusion, based upon the evaluation of field performance of the modified asphalt cement PAC 30, is that it has performed in an acceptable manner. There are indications of wheelpath rutting problems and this is a point of concern. Considering the length of time in service and the volume of traffic, the polymerized asphalt cement, PAC 30, concrete mix has performed at least as well or better than would be expected from a conventional asphalt cement concrete mix.

See Appendix B - 15 for Materials Data.

CONCLUSIONS

PAC 30, PAC 40, Sites 1, 2, 3, 12, 13, 14 and 15

At some project sites, the polymerized asphalt cement PAC 30 and

PAC 40 concretes were applied at the stop, start and turn areas near signalized intersections. These areas of asphalt pavement are known to be highly stressed from vehicle tires. In most cases, the modified asphalt at those sites performed at least as good as the conventional asphalt even though the stresses were abnormally high. This performance indicates that the polymer modified asphalts are more durable than the conventional asphalts in the areas of normal stress.

ASPHADUR, SITES 4 and 10

Two different sites were selected for the experimental application of the polymer modified asphalt cement concrete containing Asphadur. They were both applied at the same location on I-480 in Pottawattamie County in different projects, in 1979 and in 1988. For details on the polymer asphalt modifier, Asphadur, see Ref. 1.

Location, Date, Evaluation and Conclusion

Details for site No.:

4. Pottawattamie County, in the city of Council Bluffs on I-480 over North 41st Street. The project number is I-IR-480-1(114)0--14-78.

   The polymer modified asphalt cement concrete containing 6% Asphadur was applied in this project as a 50.8 mm (2 in.) thick surface course constructed in 1979.

Project estimates called for 865 tons of the modified asphalt cement concrete. The estimated cost was $0.04 per kg of mix ($35.00 per ton of mix). The 1980 ADT was 40,300 with 6% trucks.

Visual evaluations and rut depth measurements were not made in the project as it was resurfaced in 1988 soon after the start of this research project with another polymer modified asphalt cement containing Asphadur.

No conclusion will be made on the performance of Asphadur at this site due to its being resurfaced.

See Appendix B - 4 for Materials Data.

10. Pottawattamie County, in the city of Council Bluffs on I-480 from the Missouri River Bridge to I-29. The project number is IR-480-1(1117)0--12-78.

The Asphadur modified asphalt cement concrete was applied in two lifts for a total of 101.6 mm (4 in.) thickness in June 1988.

The ADT was 44,000 with 5% trucks.

Evaluations were approximately 100.58 m (330 ft.) west of the bridge over North 41st Street. There was no conventional section for comparison.

Visual evaluations showed no stripping. Some transverse cracks were visible. The surface showed many small map cracks and substantial raveling. The asphalt gave an appearance of being very hard, brittle and aged.

Rut depth average measurements in mm (in.) were:

1989	1991	1993
0.76 mm (0.03 in.)	2.54 mm (0.10 in.)	2.03 mm (0.08 in.)

Considering the high volume of traffic, rut depths were considered minimal.

The additional cost of the Asphadur for this project was only $2,572.80. The Asphadur was provided from the Iowa DOT owned stock which was valued at $0.36/kg ($0.16/lb.) for 7,293.89 kg (8.04 tons) used. The percent of Asphadur in the mix was 6%. In this case, no cost comparisons were made.

Conclusions made from this site on the use of the asphalt polymer modifier, Asphadur, would be that the asphalt mix appears to be quite resistant to wheelpath rutting. However, the appearance of early aging, brittleness and major raveling

on the surface does give cause for concern as to possibly some adverse effect such as accelerated aging from the addition of a modifier. Asphadur is not currently available. Asphadur additive was also marketed as 3M Additive 5990.

See Appendix B - 10 for Materials Data.

AC-13, SITE 5

Location, Date, Evaluation, Conclusion

A polymer modified asphalt cement AC-13 (Styrelf-13) has been developed to exhibit characteristics of very high stability in asphalt mixes. It is intended to prolong good performance of asphalt pavement life in areas of heavy traffic stopping, starting and turning maneuvers. Use of AC-13 should reduce the distortions of asphalt rutting and shoving. It should also reduce the need for maintenance cold milling or heater planing operations to maintain a smooth roadway.

The AC-13 modified asphalt research site was located in Woodbury County, on Sioux City Iowa Primary Road 12 (Gordon Drive). The project extends from near US 75 east, southeast for 4.18 km (2.6 miles). This is a limited access 4-lane facility with turning lanes at service roads and intersections. Traffic volumes range from 6,000 ADT with 10% trucks near the east end and 17,000 ADT with 5% trucks near the west end.

The AC-13 modified asphalt was applied at 5 specific sites within the project. Four sites were at signalized intersections and one site was at a 4° circular curve that was not super elevated.

Construction of the project was done in July, 1984.

For a final report on this project, see Ref. 2.

The field performance of the AC-13 asphalt concrete cement was evaluated in several ways. Cores were taken and analyzed for density and air voids at the time of construction. Each year for the 3 years which followed, cores were taken to determine the change in the absolute viscosity, penetration and ductility of the recovered AC-13. Rut depth, reflective cracking and surface raveling data was also recorded over a three-year period.

Project operations included first removal of the old asphalt cement concrete from the portland cement concrete base. Base repair work was also done. Two 38.1 mm (1½ in.) lifts of recycled asphalt concrete cement were applied throughout the project except for in the research areas. Virgin aggregate asphalt concrete cement containing AC-13 was placed in the five research areas.

Some conclusions on the performance of AC-13 from experience in this project are:

- Test results from the surface lift cores show a hardening or aging of the recovered AC-13 each year and the rate accelerated during the third year to an absolute viscosity of 34, 994 poise. The higher viscosity did not appear to be detrimental in the pavement performance.

- AC-13 did not stop all rutting from occurring. Rutting was increasing each year but appeared to stabilize by the third year at less than 6.35 mm (1/4 in.).

- The polymer modified asphalt cement was not effective in controlling transverse joint reflection cracks.

- There were no signs of raveling after 3 years.

- With 5 years of extended evaluations beyond the 3 years covered in the final report no significant changes had occurred. Over the total of 8 years, rutting remained less than 6.35 mm (0.25 in.) with most values being around 2.54 mm (0.10 in.). Raveling and stripping were not significant. Most cracks appeared to be reflective.

- Eight years after construction the AC-13 polymer modified asphalt pavement appears to be performing well, for its age.

See Appendix B - 5 for Materials Data.

CHEM-CRETE, SITE 6

Location, Date, Evaluation and Conclusion

Chem-Crete Bitumen is an asphalt modifier specifically designed to upgrade the performance of asphalt mixes which use deficient aggregates. It is promoted as a product which increases stability, durability and fatigue response at all temperatures.

Chem-Crete was used in two asphalt mixes, one containing a poorly graded sand and the other, a Type B, Class 2 asphalt concrete mix. The mixes were blended 1:9 with an AC 10 asphalt. Both of these mixes were also used with unmodified asphalt cement. Two 38.1 mm (1½ in.) lifts were placed for a total thickness of 76.2 mm (3 in.).

The location of the Chem-Crete application was on Story County road E57. The application covered 1.68 km (1.046 miles) from the Boone County line eastward. The ADT of this roadway in 1980 was 160 with 20% trucks.

The application of the Chem-Crete on county road E57 began on September 15, 1980.

Visual evaluations showed that the Chem-Crete additive did not improve asphalt performance, in fact, in this case it was detrimental to long-term performance. In comparison, the Chem-Crete sections began showing extensive cracking with many full length transverse cracks very early. Within six months, the ratio of feet of cracks in the two Chem-Crete sections compared to the conventional section was 16 to 1 and 40 to 1.

Road Rater tests were also done. In the Type B mix, strength values of the Chem-Crete were lower than the conventional sections.

For a final report on this project, see Ref. 3.

Based upon results from field tests of the use of Chem-Crete and the comparison of its transverse cracking with a conventional test section, it was concluded that Chem-Crete did not perform well. Maintenance against major cracking problems was required

within two years in the Chem-Crete test section. Further testing or use of Chem-Crete is not recommended.

See Appendix B - 6 for Materials Data.

DUCTILAD D1002, SITE 7

Location, Date, Evaluation and Conclusion

A polymer modified asphalt was used at site number 7 in a seal coat treatment over an old asphalt surface. The polymer additive, Ductilad D1002, was added to the asphalt cement at a rate of 3% by weight.

The location of the project was in Polk County on IA 415 from near the north city limit of Polk City north 9.82 km (6.1 miles) to near the junction with IA 17. The research section containing Ductilad D1002 is in the southbound lane, starting near IA 17. The section extends 4.22 km (2.62 miles) from Station 1074+80 to Station 936+47. The adjacent opposing lane, containing a regular CRS-2 binder, was used as the conventional section.

The seal coat was applied July 13, 1987.

The evaluation of Ductilad D1002 was done by comparing the loss of aggregate chips over a 5 year period between the Ductilad section and the conventional section.

Samples of the seal coat were removed from the conventional and the test sections of the project. The weight of aggregate chips recovered was determined and the rate of loss over the years was compared. For a final report on this project, see Ref. 4.

By the comparison of weight of aggregate chips retained, it is shown that the overall amount retained was slightly higher in the Ductilad section. However, it should be noted that test results from chips varied widely from year to year and that by visual evaluations, no difference could be determined between the performance of the conventional and test sections. See Appendix B-7 for Materials Data and for Grams of Aggregate Chips Recovered.

The results show that any appreciable increase in cost for the polymerized asphalt and processing operations, estimated to be $0.06/L ($0.21/gal.) would most likely not be recovered.

RALUMAC, SITES 8 AND 11

Two different sites were selected to evaluate a latex modified asphalt microsurfacing treatment called Ralumac. Both treatments were applied as a slurry seal coat. The treatment at site 8 was applied over an old roadway after an estimated 250.83 sq. m (300 sq. yds.) of full depth ACC repairs were made. The old pavement consisted of 203.2 mm (8 in.) of PCC overlaid with 171.45 mm (6.75 in.) of ACC.

A second Ralumac latex modified asphalt microsurfacing treatment was applied at site 11 mainly to fill in wheelpath ruts, but also to provide a new microsurface and to seal the old asphalt pavement.

Location, Date, Evaluation and Conclusion

Details for site No.

8. A Ralumac microsurfacing treatment in Polk County on US 69 constructed in July 1982 extends from just north of 1st Street in Ankeny north 8.10 km (5.035 miles) to 1.61 km (1 mile) north of IA 87.

   The project number is MP-1700-69-77. The ADT in 1982 was 8,160 with 3% trucks.

   Visual evaluations, friction tests and rut depth readings were taken in the test area.

   Visual evaluations confirmed that the Ralumac performed in a satisfactory manner at this site. It appeared very stable. Longitudinal marks left during construction in 1982 were still visible in the wheelpaths in 1988. Ralumac material removed with a screwdriver in 1986 was approximately 9.53 mm (3/8 in.) thick but did not appear to be flexible and resilient.

Friction test result averages were increasing slightly over the years from 1983 to 1988. The overall average value was 36.

Rut depth values taken in 1986 averaged 1.27 mm (0.05 in.).

Reflective cracks were occurring but they were being sealed.

A conclusion from this evaluation is that Ralumac can provide a good sealing and wearing surface on old asphalt roadways. Ralumac performance and success is highly dependent upon careful and correct control of product mixing and application.

In this test application, the Ralumac treatment performed very well and would be competitive to conventional slurry seals.

A limited amount of information is available on this test site as it was constructed some time before this research project was initiated.

See Appendix B - 8 for Materials Data

11. The location of the project was in Webster County on US 169 near the south edge of Ft. Dodge. The project extends north

for about 0.80 km (1/2 mile) from the county road P51. The Ralumac was applied from Station 1150+00 to Station 1180+00. There was no conventional section on this project constructed as project FN-6-4(185)--21-50 on June 16, 1988.

The evaluation of the Ralumac section was done mainly through visual evaluations and by rut depth measurements. Evidence of wheelpath rutting was seen soon after traffic was allowed on the new Ralumac surface. Within 60 days after construction, rut depth averages were already approximately 6.35 mm (0.25 in.) deep.

For a final report on this project, see Ref. 5.

During the process of applying the Ralumac, it was evident that there were difficulties in getting the proper ratios of materials in the mix. In some areas, the emulsion was very slow to break. The application of the Ralumac treatment was done by an experienced crew provided by the product supplier.

From observations made during the application of the Ralumac treatment, and from the development of ruts soon after, product mixing and application may be quite critical and somewhat difficult to control.

Due to a poorly controlled mix ratio and the resulting slow breaking of the emulsion, some of the Ralumac was eroded away by a rainfall 18 hours after application. With evidence of early rutting and continued rutting, it can be concluded that the Ralumac treatment was not successful in this test.

There were no charges for the Ralumac material and application under this demonstration project so no cost comparisons are available. If there were charges for the Ralumac additive or treatment, the result would have been, in this case, that it was not a cost effective treatment. The long-term performance of the product was not good.

See Appendix B - 11 for Materials Data.

ULTRAPAVE, SITE 9

Location, Date, Evaluation and Conclusion

UltraPave, a latex modifier added to an AC 10 asphalt cement, was used for resurfacing at site number 9. The UltraPave was used in the top 44.45 mm (1¾ in.) lift of a 88.9 mm (3½ in.) resurfacing project. The purpose of UltraPave is to "waterproof," add flexibility, retain aggregate better and longer and extend the life of the road.

The project was located in Story County on county road E29. The UltraPave was applied in the westbound lane beginning

approximately 3.62 km (2.25 miles) east of Story County road S14. The test section west from Station 114+60 to Station 126+00. The eastbound lane of the project was a conventional Type B asphalt cement. The resurfacing project was constructed on July 19, 1983.

The long-term evaluation of UltraPave was done visually in comparing results from UltraPave in the westbound lane with results of the conventional asphalt cement in the eastbound lane.

A preliminary evaluation at the time of construction showed that the UltraPave mix was very sticky and difficult to work with. A later evaluation, February 12, 1986, showed no significant difference in cracking between the UltraPave and the conventional sections.

A long-term evaluation showed that slightly less rutting and more cracks were observed in the UltraPave section. The final evaluation results were:

May 12, 1993 - Across two 30.5 m (100 ft.) sections

	CRACKS (AVG.)	RUTS (AVG.)
UltraPave	12 cracks/30.5 m (100 ft.)	3.8 mm (0.15 in.)
Conventional	9 cracks/30.5 m (100 ft.)	4.8 mm (0.19 in.)

The UltraPave latex additive was added into the pugmill after the asphalt and aggregate were heated to at least 148.9°C (300°F). The mix became extremely sticky. It was difficult to remove from the trucks and caused problems in passing through the paver. Severe tearing of the mat was observed behind the paver.

The UltraPave latex provided by Seal Lock of Iowa Incorporated was a product promotion and, therefore, no product costs are available.

From the experimental use of the latex polymer additive UltraPave, we can conclude that it does not give overall superior performance and that, in this case, it would not be cost effective. It was more difficult to work with during construction. Follow-up visual evaluations indicated more cracks existed in the UltraPave section but rutting was slightly less. In general, cracking was severe. The UltraPave section had 12 cracks per 30.5 m (100 ft.) while the control section had 9 cracks per 30.5 m (100 ft.). See Appendix B - 9 for Materials Data.

GENERAL CONCLUSIONS

Of all the different polymer modifiers for asphalt evaluated over the 15 different sites in this research project, it has been determined that some of the products did not perform well in spite of supplier support, or approved installation. In other

cases, other products did perform better than their conventional counter part in the same roadways.

In many cases, the products tested were applied in relatively short sections of a complete project. Under that condition, there is commonly a problem of a poorer mix or quality control in the "start up" phase of a new mix. By the time mix adjustments are brought under control, the test section is completed. The Ralumac, applied at site 11 may have failed as a result of that situation.

Evaluations have shown that the polymer modifiers PAC 40 SBS, PAC 40 SBN, PAC 40 SBR and PAC 30 SBS performed well in their special applications. Those products, combined with today's state-of-the-art crushed aggregate gradations should provide a very durable asphalt cement concrete roadway and would be cost effective for high stress or critical areas such as at signalized intersections with heavy traffic.

Chem-Crete resulted in very poor performance. Ductilad and UltraPave were not deemed cost effective.

GENERAL RECOMMENDATIONS

Based upon the evaluations and results from the various polymer modified asphalts used in the 15 sites in the state of Iowa, the recommendations are as follows:

Some modified asphalts have shown to perform better in the high stress areas, such as near signalized intersections, than the conventional asphalt applied in the lower stress areas of the same roadway away from signalized intersections. Under those conditions, it would be recommended that some amount of additional investment could be justified for an asphalt modifier and it would be cost effective. The modifiers in this case are those applied as follows:

Site 1	PAC 40	Styrene Butadiene Styrene
Site 2	PAC 40	Styrene Butadiene Neoprene
Site 3	PAC 40	Styrene Butadiene Rubber
Site 5	AC-13	Styrelf-13
Site 12	PAC 30	Styrene Butadiene Styrene
Site 13	PAC 30	Styrene Butadiene Styrene
Site 14	PAC 40	Styrene Butadiene Rubber
Site 15	PAC 30	Styrene Butadiene Styrene

The performance of the remaining asphalt modifiers used in this project, did not perform as proposed, expected or in a satisfactory manner for one or more reasons. They are as follows:

Site 4	Asphadur
Site 6	Chem-Crete
Site 7	Ductilad D1002
Site 8	Ralumac
Site 9	UltraPave

Site 10 Asphadur (3M-5990)

Site 11 Ralumac

Some of these reasons could be improper product preparation or application. No recommendations are being made for further tests, evaluations or use of products used in those sites.

REFERENCES

1. L. J. Zearley and R. Shelquist, MLR-78-2, "A Laboratory Evaluation of Asphaltic Concrete Containing Asphadur." Iowa Department of Transportation, Office of Materials, Ames, Iowa, Dec. 1978.

2. C. E. Leonard, HR-522, "Asphalt Cement Containing AC-13," Iowa DOT Project FR-12-1(8)--2G-97 Final Report, District 3, Sioux City, Iowa, Feb. 1988.

3. D. Jespersen, P.E., K. Jones, P.E., HR-226, "Iowa Research With Chem-Crete Bitumen," Iowa Research Board, Final Report, Iowa Department of Transportation, Office of Materials, Ames, Iowa.

4. R. F. Steffes, V. J. Marks, R. DeBok, HR-2035, "Polymer Additive Ductilad D1002 in a Bituminous Seal Coat," Final Report, Iowa Department of Transportation, Project Development Division, Ames, Iowa, May 1994.

5. R. Steffes, HR-2041, "Ralumac Latex Modified Asphalt," Final Report, Iowa Department of Transportation, Project Development Division, Ames, Iowa, May 1994.

Appendix A
Project Correspondence and Agreement

U.S. Department
of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

OCT 5 1988

Reply to: HHO-41

Mr. Robert L. Humphrey
Director, Iowa Department
of Transportation
800 Lincoln Way
Ames, Iowa 50010

Through:
Mr. Hubert A. Willard
Division Administrator
Ames, Iowa

Dear Mr. Humphrey:

Enclosed are two copies of a Work Order for evaluating and reporting on the performance of asphalt additives under Experimental Project No. 3. This Work Order is issued under our Cooperative Agreement dated March 24, 1982, and amendment No. 1 dated September 26, 1983.

Please execute both copies of the Work Order, enter the name, address and telephone number of the principal investigator under ARTICLE IV - KEY PERSONNEL of the Work Order and return one copy with original signatures to the office.

Any questions concerning this Work Order may be directed to Mr. Tommy L. Beatty at (202) 366-4667.

Sincerely yours,

Douglas A. Bernard
Chief, Demonstration
Projects Division

Enclosures

cc: RFHWA, Mr. E. Dean Carlson, Region 7, Kansas City, MO, HST-07

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
DEMONSTRATION PROJECTS PROGRAM
COOPERATIVE AGREEMENT WORK ORDER

WORK ORDER NO.: DTFH71-88-503-IA-28	EFFECTIVE DATE: SEP 16 1988

ISSUED BY:	COOPERATING AGENCY:
U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION 400 7TH ST. S.W. WASHINGTON, D.C. 20590	IOWA DEPARTMENT OF TRANSPORTATION 800 LINCOLN WAY AMES, IOWA 50010

EXPERIMENTAL PROJECT NO. 3, ASPHALT ADDITIVES

ACCOUNTING AND APPROPRIATION DATA: 248-15-73-1C-1060-8503

FUNDS AVAILABLE: $9,900

THE COOPERATING AGENCY AGREES TO PERFORM ALL THE SERVICES SET FORTH IN THE ATTACHED SCHEDULE FOR THE CONSIDERATION STATED HEREIN. THE RIGHTS AND OBLIGATIONS OF THE PARTIES TO THIS WORK ORDER SHALL BE SUBJECT TO AND GOVERNED BY THE SCHEDULE AND THE COOPERATIVE AGREEMENT DATED MARCH 24, 1982 , AND AMENDMENT NO. 1 DATED SEPTEMBER 26, 1983

COOPERATING AGENCY:	ISSUING OFFICE:
IOWA DEPARTMENT OF TRANSPORTATION 800 LINCOLN WAY AMES IOWA 50010	U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION 400 7TH ST. S.W. WASHINGTON, D.C. 20590
BY(AUTHORIZED SIGNATURE)	BY(AUTHORIZED SIGNATURE)
TYPED NAME: R.L. Humphrey DATE: October 18, 1988	TYPED NAME: GARY L. KLINEDINST DATE: SEP 16 1988
TITLE: Highway Division Director Chief Engineer	TITLE: DIVISION ENGINEER

ARTICLE I - STATEMENT OF WORK

The Cooperating Agency shall provide for the reporting on the performance of nine asphalt additives on projects that are completed. These additives and their locations are listed in Exhibit C. The Cooperating Agency will also evaluate and report on the performance of six undetermined asphalt additives on future projects.

ARTICLE II - WORK PLAN

The work plan, attached as Exhibit A, is approved subject to the modifications shown in Exhibit B.

ARTICLE III PERIOD OF PERFORMANCE

The final report for Phase I of the project shall be submitted no later than November 1, 1991.

ARTICLE IV - KEY PERSONNEL

The Cooperating Agency shall assign the following individual(s) as principal investigator(s):

Robert Steffes (Name)

Materials Research Assistant

Iowa Department of Transportation
800 Lincoln Way (Address)

Ames, IA 50010

511-239-1392 (Telephone Number)

ARTICLE V - CONSIDERATION AND PAYMENT

The Federal Highway Administration's Demonstration Projects Division (FHWA-DPD) agrees to reimburse the Cooperating Agency up to $9,900 for allowable costs in evaluating the performance of the Asphalt Additives listed as stated in the work plan.

Following acceptance of each interim report by FHWA-DPD, the Cooperating Agency may submit vouchers for partial payment not to exceed 70 percent of the amount being provided for the work item. After acceptance of the final report by FHWA-DPD, the Cooperating Agency may submit a voucher for reimbursement of all remaining allowable cost. Each voucher must itemize the costs incurred by the Cooperating Agency.

The Demonstration Projects Division funds provided by this Work Order shall not be used by the Cooperating Agency as matching funds for federally funded programs.

Iowa DOT Work Plan
Evaluation of Asphalt Stablizing Additives
April 1988

INTRODUCTION

Many asphalt pavements built in the past which were considered to be properly designed and constructed began to show some early signs of distress and poor performance. The distress signs occurred in the form of rutting, shoving and cracking.

Suppliers of asphalt additives claim they have products which will improve asphalt performance, stabilize pavements and reduce rutting and cracking.

Some of these products for stabilizing asphalts have been used in various locations in Iowa. However, documentation and follow-up on these applications were not extensive and conclusions were not formulated or reported as to the success and cost effectiveness of the additives used.

This research proposes to study the performance of asphalt stabilizing additives at approximately 15 project sites and to develop a conclusion concerning the additives effectiveness based on results from field applications.

OBJECTIVE

The objective of this project is to determine the performance and cost effectiveness of asphalt stabilizing additives used to minimize rutting, shoving and cracking in asphalt pavements.

Additive applications to be evaluated would include rubber, chemical or natural products. Chemical antistrip agents and mineral fillers would not be included in the project.

A summary of results from this study of field applications of various additives could be used as a guide to help improve asphalt pavement mix designs and pavement performance on future projects.

STARTING DATE

The proposed starting date for the project will be July 1, 1988.

PROPOSED RESEARCH

The project will study approximately nine sites of previous applications of asphalt additives and an estimated six sites of future applications planned to be constructed before December 31, 1988. Phase 1 evaluation will cover a minimum of three years from the contract date. Phase II evaluation will continue with periodic reviews.

WORK PLAN

1. Experimental Features

There are currently nine locations in Iowa which are considered as candidates for evaluation of existing applications of asphalt stabilizing additives. In addition, new applications, estimated to be 6 before the end of 1988, will be considered for evaluation.

The performance evaluation will cover:

a. Detailed information on the design, construction, and performance of experimental sections and on control sections when available.

2. Design and Preconstruction Testing Details

Available information will be documented for both the test section (s) covering:

a. Structural design data and assumptions (ADT, percentage of trucks, etc.).

b. Subgrade, subbase, and base data

c. Materials data (asphalt grade, asphalt source, additive type, aggregate types and gradation, etc.,)

d. Mix design

e. Results of materials and design testing, and

f. Special design of materials, concerns, or features

3. Construction Procedures

Information will be provided on:

a. Plant Operations

1) Plant type and needed modifications

2) Mix temperatures

b. Mix control testing results (Gradations, extractions, stabilities, VMA, VTM, etc.)

c. Laydown temperature and densities

d. Weather conditions

e. Laydown and compaction equipment used

f. Toxic emissions during construction

g. Special construction concerns or features

4. Performance Measurements

Field measurements, tests or surveys will be done by the Iowa DOT as follows:

Test	Const. Yr.	One Yr.	Two Yrs.	Three Yrs.
a. Rutting	X	X	X	X
b. Raveling	X	X	X	X
c. Cracking	X	X	X	X
d. Stripping	X	X	X	X
e. Densities, void contents	X	X	X	X

5. Cost

An analysis will be made on a comparison of the costs (dollars per ton) of the material with the asphalt additive versus the material without the asphalt additive.

6. Performance Reporting

The first phase will be a detailed and frequent investigation that lasts a minimum of three years. The second phase will be a long-term evaluation that would involve selective investigations at periodic intervals throughout the life of the project.

a. Phase I Reporting:

1) Initial Report: This report will be prepared within 90 days of completion of an agreement to perform this evaluation or within 90 days of completion of construction of the project, as appropriate. It will contain all information as required under Items 1 through 5.

2) Interim Reports: Information obtained from Item 4, will be reported annually, presented in a form easily understood, and summarized. If appropriate, it will include any discussions useful in assessment of the asphalt additives.

3) Final Report: This will include a comprehensive summary of all data collected, an overall evaluation of the cost-effectiveness of the asphalt additive and con-

clusions and recommendation based on the information collected.

b. Phase II Reporting:

1) Periodic Progress Reports: After completing Phase I of the evaluation, monitoring of the project will continue through six years. Data on information included under Item 4 will be reported every 2 years or as appropriate.

2) These periodic progress reports will be similar to the interim reports described above.

7. Estimated Evaluation Cost

Project costs are estimated to be $9900.00 to cover performance evaluation and report writing (see Appendix A).

8. Principal Investigator

The Principal Investigator for the project will be:

Robert Steffes
Materials Research Assistant
Iowa Department of Transportation
Phone: 515-239-1392

Appendix A

Estimated Evaluation Cost, Dollars (for 15 sites)

TEST	'88 CONST YR	'89 ONE YR	'90 TWO YRS	'91 THREE YRS	FOUR YRS
Rutting	1000	1000	1000	1000	
Raveling					
Cracking					
Stripping					
Densities	475	475	475	475	
Initial Rpt	2000				
Interim Rpt		400	400	400	
Final Rpt					800
Sub Total	3475	1875	1875	1875	800
Total					$9900.00

Exhibit B

Work Plan Modification

The work plan is modified as follows:

A draft final report will be submitted to the FHWA for review and comment following completion of Phase I of the study. The FHWA review is to be completed and comments furnished to the Cooperating Agency within 60 days. A reproducible copy of the final report shall be furnished to the FHWA within 60 days of the return of the draft to the Cooperating Agency.

The six additives and their locations will be identified prior to construction.

HR-542 - Evaluation of Asphalt Stabilizing Additives

	Asphalt Stabilizing Additive		Location
1.	PAC 40 Styrene Butadiene Styrene (SBS) Asphaltic cement concrete	Hot mix	Jasper Co. Newton, W. 15th St. E. to E. City Limit
2.	PAC 40 Neoprene Asphaltic cement concrete	Hot Mix (SBN)	Clinton Co. Clinton, 7th Ave. So./No. to W. Jct. of IA 136
3.	PAC 40 Styrene Butadiene Rubber (SBR) Asphaltic cement concrete	Hot Mix	O'Brien Co. Sheldon, Hwy. 18/60 Intersection, E. and N.
4.	Asphadur Asphaltic cement concrete	Hot Mix	Pottawattamie Co. Council Bluffs, I-480 EB from Mo. R. Br. to N. 41st St.
5.	Asphadur Asphaltic cement concrete	Hot Mix	Woodbury Co. Sioux City, Intersections IA 12 So. Fairmont, So. Martha, Stone and So. Palmetto St.
6.	Chemcrete Manganese modified Asphaltic cement concrete	Hot Mix	Story Co. So. of Napier on E-57, near R-38, 1 mi.
7.	Ductilad ~~2001~~ 1002 Polymer modified emulsion Chip seal	Cold Mix	Polk Co. So. of Madrid on Hwy. 415, near Hwy. 17, EBL, 2.6 mi.
8.	Ralumac Latex modified emulsion Slurry	Cold Mix	Polk Co. Hwy. 69, from Ankeny N, 5 miles
9.	Ultra Pave Latex modified Asphaltic cement concrete	Hot Mix	Story Co. on E-29, WBL, from 2.25 mi. E. of S-14 (Sta. 114+60 to 126+00) 1/4 mi.

IOWA DEPARTMENT OF TRANSPORTATION

TO OFFICE: Federal Highway Administration DATE: August 2, 1989

ATTENTION: H. A. Willard REF. NO.: 436/HR-542

FROM: R. L. Humphrey

OFFICE: Chief Engineer

SUBJECT: Iowa Experimental Project No. 3 Work Plan Evaluation of Asphalt Stabilizing Additives

Thank you for your assistance on this evaluation of asphalt additives.

The experimental project DTFH71-88-503-IA-28, Asphalt Additives, work plan calls for the evaluation of 15 sites. Nine sites were designated from previously completed projects and are already listed in the project work plan, Exhibit C. The remaining 6 sites were to be selected later from projects compleded by December 31, 1988. Due to a lack of 6 suitable projects by that date, we made five selections and one more in the spring of 1989. You will find the list of 6 additional projects for the Asphalt Additives study attached.

by B. C. Brown
Materials Engineer

RLH:BCB/VJM/kmd
cc: J. Bergren
V. Marks

HR-542 - Evaluation of Asphalt Stabilizing Additives

	Asphalt Stabilizing Additive		Location
10.	Asphadur Asphaltic Cement	Hot Mix Concrete	Pottawattamie County Council Bluffs, I-480, EB Mo. R Br to I-29 1988
11.	Ralumac Latex modified emulsion	Cold Mix	Webster Co. So. of Ft. Dodge on Hwy. 169 MP 155 1988
12.	Pac 30 (Elf) Asphaltic Cement	Hot Mix Concrete	Polk County Des Moines, Army Post Road/SE 5th Street 1988
13.	Asphadur Asphaltic Cement	Hot Mix Concrete	Story County Hwy. 69, Ames 1988
14.	Pac 40 Asphaltic Cement	Hot Mix Concrete	O'Brien County IA 60, From US 18 to Sibley 1987
15.	Pac 30 Asphaltic Cement	Hot Mix Concrete	Polk County Des Moines, Fleur Dr., McKinley Ave. to Army Post Road 1989

Appendix B
Materials Data

B-1	1) Conventional	Surface
	2) Conventional	Binder
	3) PAC-40	

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A RECYCLED LAB NO. ABD7-200

INTENDED USE: SURFACE

SIZE 1/2 SPEC. NO. 1043 DATE REPORTED 9-15-87

COUNTY JASPER PROJECT FN-6-4(85)--21-50

CONTRACTOR DES MOINES ASPHALT

PROJ. LOCATION FROM W. 15TH PLACE TO E. 28TH ST. N. IN NEWTON

AGG. SOURCES MILLED @ 5.5%-PROJECT; CR. LST & CHIPS- KASER, SULLY QRY, JASPER CO; SAND- VAN DUSSELDORP, COLFAX, JASPER CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 30% ABC7-310; 15% AAT7-111; 27.5% AAT7-1 27.5% AAT7-1002

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	97	86	59	43	34	23	11	6.5	5.3

TOLERANCE: 98/100 7 7 7 5 4 2*

% ASPHALT ADDED	3.10	4.10
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 965 POISES	
PLASTICITY INDEX		
% ASPH. IN MIX	4.75	5.75
NUMBER OF MARSHALL BLOWS	50	50
MARSHALL STABILITY - LBS.	2477	2363
FLOW - 0.01 IN.	7	8
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.315	2.348
BULK SP. GR. COMB. DRY AGG.	2.640	2.640
SP. GR. ASPH. @ 77 F.	1.032	1.032
CALC. SOLID SP.GR.	2.508	2.471
% VOIDS - CALC.	7.69	4.97
RICE SP. GR.	2.456	2.426
% VOIDS - RICE	5.74	3.22
% WATER ABSORPTION - AGGREGATE	1.75	1.75
% VOIDS IN THE MINERAL AGGREGATE	16.48	16.17
% V.M.A. FILLED WITH ASPHALT	53.32	69.20
CALCULATED ASPH.FILM THICKNESS(MICRONS)	7.47	9.50
FILLER/BITUMEN RATIO		0.98

A CONTENT OF 5.4% ASPHALT IS RECOMMENDED TO START THE JOB.
THIS IS AN ADD. 3.75% AC 10. *ALSO CONTROLLED BY FILLER/BIT. RATIO.
NUC. CAL: TEMP= 185; WT= 7200; SLOPE= 5.34; I'CEPT= (-6.30)
COPIES:
ASPHALT MIX DESIGN
FN-6-4(85)--21-50, JASPER
R. MUMM
J. PETERS
R. MONROE
J. SMYTHE
D. HEINS
DES MOINES ASPHALT
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A RECYCLED LAB NO. ABD7-201

INTENDED USE: BINDER

SIZE 3/4" SPEC. NO. 1043 DATE REPORTED 9/15/87

COUNTY JASPER PROJECT FN-6-4(85)--21-50

CONTRACTOR DES MOINES ASPHALT

PROJ. LOCATION FROM W. 15TH PLACE TO E. 28TH ST. N IN NEWTON

AGG. SOURCES MILLED @ 5.51% PROJECT; CR. LST. & CHIPS - KASER, SULLY WRY, JASPER CO.; SAND - VAN DUSSELDORP, COLFAX, JASPER CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 30% ABC7-310; 17.5% AAT7-1080; 25% AAT7-1081; 27.5% AAT7-1082

	JOB MIX FORMULA - COMBINED GRADATION										
1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	87	73	54	44	35	23	11	7.0	5.5

TOLERANCE: 98/100 7 7 7 5 4 2		
% ASPHALT ADDED	3.10	4.10
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 965 POISES	
PLASTICITY INDEX		
% ASPH. IN MIX	4.75	5.75
NUMBER OF MARSHALL BLOWS	50	50
MARSHALL STABILITY - LBS.	2408	2278
FLOW - 0.01 IN.	8	10
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.332	2.366
BULK SP. GR. COMB. DRY AGG.	2.648	2.648
SP. GR. ASPH. @ 77 F.	1.032	1.032
CALC. SOLID SP.GR.	2.511	2.473
% VOIDS - CALC.	7.12	4.34
RICE SP. GR.	2.463	2.419
% VOIDS - RICE	5.32	2.19
% WATER ABSORPTION - AGGREGATE	1.61	1.61
% VOIDS IN THE MINERAL AGGREGATE	16.12	15.79
% V.M.A. FILLED WITH ASPHALT	55.85	72.48
CALCULATED ASPH.FILM THICKNESS(MICRONS)	7.43	9.41
FILLER/BITUMEN RATIO	1.08	

A CONTENT OF 5.1% ASPHALT IS RECOMMENDED TO START THE JOB.
THIS IS AN ADD. 3.45 AC 10. ALSO CONTROLLED BY FILLER/BIT RATIO.
NUC. CAL.: TEMP = 200; WT = 7200; SLOPE = 4.60; I'CEPT = (-4.75)
COPIES:
ASPHALT MIX DESIGN
~~FN-6-4~~(85)--21-50, JASPER
R. MUMM
J. PETERS
R. MONROE
J. SMYTHE
D. HEINS
DES MOINES ASPHALT
W. OFFEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - MISCELLANEOUS MATERIALS
LAB LOCATION DISTRICT 1

MATERIAL PAC-40 LAB NO. 1DBA7-908 & 909

INTENDED USE

COUNTY JASPER PROJ NO. FN-6-4(85)--21-50

DESIGN CONTRACT NO. 27515

PRODUCER BITUCOTE CONTRACTOR DES MOINES ASPHALT

SOURCE DES MOINES

UNIT OF MATERIAL

SAMPLED BY G. SCHIPPERS SENDER'S NO. SEE BELOW

DATE SAMPLED 9-29-87 REC'D 10-1-87 REPORTED 10-5-87

1DBA7-908 (PAC-3)
ABSOLUTE VISCOSITY AT 140 F., 30 CM. HG. VACUUM = 2620 POISES

1DBA7-909 (PAC-4)
ABSOLUTE VISCOSITY AT 140 F., 30 CM. HG. VACUUM = 2540 POISES

COPIES:
MATERIALS
R. MUMM
J. PETERS
DES MOINES ASPHALT
DISTRICT 1 LAB

DISPOSITION: DOES NOT COMPLY

SIGNED: DISTRICT 1 MATERIALS

B-2	1) PAC-40	Binder/Surface
	2) Conventional	Binder/Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD7-23

INTENDED USE: BINDER/SURFACE

SIZE 1/2" SPEC. NO. 1030 DATE REPORTED
SS-1034
COUNTY CLINTON PROJECT FN-67-2(42)--21-23

CONTRACTOR DETERMANN

PROJ. LOCATION IN CLINTON FROM 7TH AVE. S. TO 7TH AVE. N. & N. 2ND TO N. 3RD ST

AGG. SOURCES 1/2" CR. LST. & 3/8" CHIPS-AGGRECON, SHAFTON, CLINTON CO.;
SAND - AGGRECON, DOYLE, CLINTON CO.
JOB MIX FORMUL52.5%RAAT7-65;020%TAAT7-66; 27.5% ATT7-67

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	98	90	63	41	31	20	10	6.1	4.8
TOLERANCE:			92/100	7	7	5		4			2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - PAC 40 - 3990 POISES	
PLASTICITY INDEX		
% ASPH. IN MIX	5.5	6.5
NUMBER OF MARSHALL BLOWS	75	75
MARSHALL STABILITY - LBS.	2893	2608
FLOW - 0.01 IN.	9	11
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.330	2.359
BULK SP. GR. COMB. DRY AGG.	2.621	2.621
SP. GR. ASPH. @ 77 F.	1.024	1.024
CALC. SOLID SP.GR.	2.477	2.440
% VOIDS - CALC.	5.94	3.34
RICE SP. GR.	2.432	2.403
% VOIDS - RICE	4.19	1.83
% WATER ABSORPTION - AGGREGATE	2.29	2.29
% VOIDS IN THE MINERAL AGGREGATE	15.99	15.85
% V.M.A. FILLED WITH ASPHALT	62.86	78.93
CALCULATED ASPH.FILM THICKNESS(MICRONS)	9.15	11.38
FILLER/BITUMEN RATIO	0.86	

A CONTENT OF 5.6% ASPHALT IS RECOMMENDED TO START THE JOB.
* ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
NUC. CAL: TEMP. = 210; WT. = 7300; SLOPE = 3.86; INTER = (-3.31)
COPIES:
ASPHALT MIX DESIGN
FN-67-2(42)--21-23, CLINTON
R. MERRITT
B. KUEHL
R. MONROE
J. SMYTHE
D. HEINS
DETERMANN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD7-14

INTENDED USE: BINDER/SURFACE

SIZE 1/2" SPEC. NO. 1030, SS-1034 DATE REPORTED 4-23-87

COUNTY CLINTON PROJECT FN-67-2(42)--21-23

CONTRACTOR DETERMANN

PROJ. LOCATION IN CLINTON FROM 7TH AVE S. TO 7TH AVE. N & N. 2ND ST. TO N 3RD. S

AGG. SOURCES 1/2" CR. LST. & 3/8" CHIPS-AGGRECON, SHAFFTON, CLINTON CO.;
SAND-AGGRECON, DOYLE, CLINTON CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 52.5% AAT7-65; 20% AAT7-66; 27.5% AAT7-67

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	98	90	63	41	31	20	10	6.1	4.8
TOLERANCE:			98/100	7	7	5		4			2

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 2220 POISES		
PLASTICITY INDEX			
% ASPH. IN MIX	4.5	5.5	6.5
NUMBER OF MARSHALL BLOWS	75	75	75
MARSHALL STABILITY - LBS.	3373	3158	3140
FLOW - 0.01 IN.	8	9	9
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.313	2.331	2.354
BULK SP. GR. COMB. DRY AGG.	2.621	2.621	2.621
SP. GR. ASPH. @ 77 F.	1.035	1.035	1.035
CALC. SOLID SP.GR.	2.517	2.480	2.444
% VOIDS - CALC.	8.11	6.01	3.68
RICE SP. GR.	2.491	2.447	2.424
% VOIDS - RICE	7.15	4.74	2.89
% WATER ABSORPTION - AGGREGATE	2.29	2.29	2.29
% VOIDS IN THE MINERAL AGGREGATE	15.72	15.96	16.02
% V.M.A. FILLED WITH ASPHALT	48.42	62.36	77.06
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.98	9.15	11.38
FILLER/BITUMEN RATIO		0.83	

A CONTENT OF 5.8% ASPHALT IS RECOMMENDED TO START THE JOB.
NUC. CAL: TEMP = 215; WT. = 7300; SLOPE = 4.22; INTER = -4.06

COPIES:
ASPHALT MIX DESIGN
~~FN-~~67-2(42)--21-23, CLINTON
R. MERRITT
B. KUEHL
R. MONROE
J. SMYTHE
D. HEINS
DTERMANN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

B-3	1) Conventional	Base/Binder
	2) Conventional	Surface
	3) PAC-40	Some as site 14
	4) PAC-40	Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS I (RECYCLED)AB NO. ABD7-34

INTENDED USE: BASE, BINDER

SIZE 3/4" SPEC. NO. 1024 DATE REPORTED 5/14/87

COUNTY O'BRIEN PROJECT FN-18-2(50)--21-71

CONTRACTOR ROHLIN

PROJ. LOCATION FROM RR IN SHELDON THROUGH SANBORN
MILLED @ 5.2% - PROJECT;
AGG. SOURCES CR. GRAVEL & WASHED GRAVEL - JOE'S READY MIX, O'BRIEN CO.;
PIT RUN GRAVEL - ROHLIN, 28-98-42 OSCEOLA CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 20% ABC7-34; 17% AAT7-177; 38% AAT7-179;
25% AAT7-178

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	95	86	68	52	37	25	12	6.4	5.0

TOLERANCE: 98/100	7 7 6	5	3
% ASPHALT ADDED	3.96	4.96	5.96
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 471 POISES		
PLASTICITY INDEX	NOT TESTED		
% ASPH. IN MIX	5.0	6.0	7.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	1762	1783	1723
FLOW - 0.01 IN.	7	8	10
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.281	2.325	2.339
BULK SP. GR. COMB. DRY AGG.	2.631	2.631	2.631
SP. GR. ASPH. @ 77 F.	1.019	1.019	1.019
CALC. SOLID SP.GR.	2.478	2.441	2.406
% VOIDS - CALC.	7.96	4.77	2.77
RICE SP. GR.	2.475	2.434	2.409
% VOIDS - RICE	7.84	4.48	2.91
% WATER ABSORPTION - AGGREGATE	1.42	1.42	1.42
% VOIDS IN THE MINERAL AGGREGATE	17.64	16.93	17.32
% V.M.A. FILLED WITH ASPHALT	54.90	71.86	84.01
CALCULATED ASPH.FILM THICKNESS(MICRONS)	8.04	10.04	12.05
FILLER/BITUMEN RATIO		0.81	

A CONTENT OF 6.2% ASPHALT IS RECOMMENDED TO START THE JOB.
THIS IA AN ADDITIONAL 5.16% ASPHALT.
NUC. CAL.: TEMP = 220; WT. = 7300; SLOPE = 4.75; INTER.= (-5.14)
COPIES:
ASPH. MIX DESIGN
FN-18-2(50)--21-71, O'BRIEN
C. LEONARD
W. BENNETT
R. MONROE
J. SMYTHE
D. HEINS
ROHLIN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A (RECYCLED) LAB NO. ABD7-43

INTENDED USE: SURFACE

SIZE 1/2" SPEC. NO. 1024 DATE REPORTED 5/21/87
1026
COUNTY O'BRIEN PROJECT FN-18-2(50)--21-71

CONTRACTOR ROHLIN

PROJ. LOCATION FROM RR IN SHELDON THROUGH SANBORN

AGG. SOURCES MILLED @ 5.2% PROJECT; 1/2" CHIPS & 1/4" CR. LST. - MIDWEST LST., GILMORE CITY, POCAHONTAS CO.; SAND-HALLETTS, 28-98-42, OSCEOLA CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 22% ABC7-34; 26% AAT7-235; 20% AAT7-236; 32% AAT7-237

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	91	67	53	40	28	15	8.4	5.5	

TOLERANCE:	98/100	7	7	5	4	2*
% ASPHALT ADDED				3.86	4.86	5.86
ASPHALT SOURCE AND APPROXIMATE VISCOSITY				KOCH - 471 POISES		
PLASTICITY INDEX						
% ASPH. IN MIX				5.0	6.0	7.0
NUMBER OF MARSHALL BLOWS				50	50	50
MARSHALL STABILITY - LBS.				2425	2517	1808
FLOW - 0.01 IN.				7	9	13
SP.GR. BY DISPLACEMENT(LAB DENS.)				2.319	2.358	2.352
BULK SP. GR. COMB. DRY AGG.				2.608	2.608	2.608
SP. GR. ASPH. @ 77 F.				1.019	1.019	1.019
CALC. SOLID SP.GR.				2.462	2.426	2.391
% VOIDS - CALC.				5.80	2.79	1.61
RICE SP. GR.				2.467	2.431	2.399
% VOIDS - RICE				6.00	3.00	1.96
% WATER ABSORPTION - AGGREGATE				1.53	1.53	1.53
% VOIDS IN THE MINERAL AGGREGATE				15.53	15.01	16.31
% V.M.A. FILLED WITH ASPHALT				62.63	81.41	89.99
CALCULATED ASPH.FILM THICKNESS(MICRONS)				7.02	8.77	10.56
FILLER/BITUMEN RATIO					0.98	

A CONTENT OF 5.6% ASPHALT IS RECOMMENDED TO START THE JOB. THIS IS AN ADD. 4.46%; *ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
NUC. CAL.: TEMP = 220; WT = 7300; SLOPE = 4.32; INTER = (-3.95)
COPIES:
ASPHALT MIX DESIGN
~~FN-18~~-2(50)--21-71, O'BRIEN
C. LEONARD
W. BENNETT
R. MONROE
J. SMYTHE
D. HEINS
ROHLIN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

Iowa Department of Transportation

CHANGE OR EXTRA WORK ORDER

☒ Non-Substantial
☐ Substantial

No. 1

FHWA Concurrence _____

Contract No. 25956

County O'Brien

Group 1
(Only one group can be covered by one work order)

Project FN-18-2(50)--21-71

Kind of Work A.C.C. Resurfacing

Date Prepared June 11, 1987

To Rohlin Construction Co., Inc., Estherville Contractor:

You are hereby ordered to make the following changes from the plans or do the following extra work on your contract dated 7/17/86.

A - Description of change to be made or extra work to be done:

Delete Item #5 - Asphalt cement concrete, asphadur modified, recycled--810 tons

Add Item 8002 - Asphalt cement concrete, Type A surface, polymerized (PAC-40), 1/2 inch mixture, recycled

B - Reason for ordering change or extra work:

Contractor has requested permission to combine work required at the intersection of US #18 and IA #60 on this project and near the intersection on project FN-60-3(11)--21-71, to eliminate duplication of traffic control and inconvenience to the traveling public on IA #60. This requires using the same polymerization material and the same aggregate gradations on both projects. Item #5 will be deleted to eliminate reference to asphadur. Item 8002 will be added to make polymerization material and gradation requirements the same on both projects.

(Continued on reverse side)

Approved 7-2, 1987
T. E. DeWitte, Dist. Engr. (Const.)

William R Bennett
Wm. R. Bennett, Dist. Engr. (Const.)

JUN 17 1987, 19

Receipt is acknowledged of this change or extra work and terms of settlement are hereby agreed to

Approved contingent upon funds being available under the existing project agreement or upon additional Federal-aid funds being made available by a modified project agreement

ROHLIN CONSTRUCTION CO., INC.
Contractor

By Keith W. Godfrey 6-15-87
Keith W. Godfrey 6/15/87, 19

Date

For the Division Administrator
Federal Highway Administration

Approved _____, 19____
Construction Engineer

DISTRIBUTION 1. White Copy - Iowa Department of Transportation Main Office, 2. Canary Copy - Federal Highway Administration, 3. Pink Copy - Resident Engineer, 4. Green Copy - Contractor, 5. Blue Copy - Office of Construction or Maintenance, 6. Buff Copy - District Engineer.

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD7-204

INTENDED USE: SURFACE

SIZE 3/4 SPEC. NO. 1036 DATE REPORTED 9-16-87

COUNTY O'BRIEN PROJECT FN-60-3(11)--21-71

CONTRACTOR ROHLIN

PROJ. LOCATION FROM U.S. 18 TO RR IN SIBLEY

AGG. SOURCES CR. GRAVEL & GRAVEL- ROHLIN, 32-98-37, DICKINSON CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT7-1120; 35% AAT7-1121

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	76	62	46	36	27	19	10	6.7	5.4

TOLERANCE: 98/100 7 7 7 5 4 2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY JEBRO - 3350 POISES

PLASTICITY INDEX			
% ASPH. IN MIX	4.75	5.75	6.75
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	3250	2952	2583
FLOW - 0.01 IN.	12	18	20
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.369	2.403	2.395
BULK SP. GR. COMB. DRY AGG.	2.674	2.674	2.674
SP. GR. ASPH. @ 77 F.	1.034	1.034	1.034
CALC. SOLID SP.GR.	2.516	2.489	2.444
% VOIDS - CALC.	5.91	3.12	2.01
RICE SP. GR.	2.500	2.449	2.415
% VOIDS - RICE	5.24	1.88	0.83
% WATER ABSORPTION - AGGREGATE	1.09	1.08	1.08
% VOIDS IN THE MINERAL AGGREGATE	15.45	15.30	16.48
% V.M.A. FILLED WITH ASPHALT	62.19	79.60	87.80
CALCULATED ASPH.FILM THICKNESS(MICRONS)	9.67	10.84	13.06
FILLER/BITUMEN RATIO		1.08	

A CONTENT OF 5.0% ASPHALT IS RECOMMENDED TO START THE JOB.
*ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
NUC. CAL.: NONE
COPIES:
ASPHALT MIX DESIGN
FN 60-3(11)--21-71, O'BRIEN
C. LEONARD
W. BENNETT
R. MONROE
J. SMYTHE
D. HEINS
ROHLIN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

B-4 1) Asphadur Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A SURFACE LAB NO. ABD9-191

INTENDED USE: ASPHADUR - 6% BY WT. OF ASPHALT

SIZE 1/2" SPEC. NO. DATE REPORTED 10/23/79

COUNTY POTTAWATTAMIE PROJECT I-IR-480-1(114)0--14-78

CONTRACTOR DELTA

PROJ. LOCATION IN COUNCIL BLUFFS OVER 41ST STREET

AGG. SOURCES 1/2" CR. GRAVEL - AVOCA PIT - POTTAW. CO.; SAND - VALLEY, NEBR.;
1/2" COVER AGG. - AVOCA PIT - POTTAW. CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT9-713, 30% AAT9-715, 5% AAT9-714

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	94	66	50	37	26	15	8.2	5.9

TOLERANCE:

75 BLOW MARSHALL DENSITY		2.38	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY		PHILLIPS - 2020 POISES	
PLASTICITY INDEX			
% ASPH. IN MIX	4.0	5.0	6.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	3372	3262	3020
FLOW - 0.01 IN.	8	9	12
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.31	2.36	2.38
BULK SP. GR. COMB. DRY AGG.	2.702	2.702	2.702
SP. GR. ASPH. @ 77 F.	1.017	1.017	1.017
CALC. SOLID SP.GR.	2.55	2.51	2.47
% VOILS - CALC.	9.3	5.9	3.6
RICE SP. GR.	2.50	2.45	2.41
% VOIDS - RICE	7.4	3.7	1.4
% WATER ABSORPTION - AGGREGATE	0.44	0.44	0.44
% VOIDS IN THE MINERAL AGGREGATE	17.9	17.0	17.2
% V.M.A. FILLED WITH ASPHALT	48.0	65.3	78.8
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.2	8.0	9.7

THIS MIXTURE CONTAINS ASPHADUR IN THE AMOUNT OF 6.0% BY WT. OF ASPHALT (SEE ABD9-190). MIXED AT 400 F. - 4 MIN.; MOLDED AT 300 F.

COPIES:
ASPH. MIX DESIGN
I-IR-480-1(114)0--14-78, POTTAW.
V. R. SNYDER
R. SHELQUIST
D. JORDISON
L. ZEARLEY
DELTA
C. JONES
D. HINES

SIGNED: BERNARD C. BROWN

B-5	1) AC-13	Surface/Binder

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

-24-

MIX. TYPE AND CLASS: TYPE A SURFACE - BINDER LAB NO. ABD4-163

INTENDED USE:

SIZE 1/2" SPEC. NO. 941. 951 DATE REPORTED 3/3/84
942
COUNTY WOODBURY PROJECT FR-12-1(8)--2G-97

CONTRACTOR BROWER

PROJ. LOCATION FROM SOUTH LINN STREET TO E.C.L. IN SIOUX CITY
AGG. SOURCES AGG. LIME - HALLETT, GILMORE CITY - POCAHONTAS CO.: 3/16". 5/8"X4, 3/8"X8 QTZ. - L. G. EVERIST, MINNEHAHA CO., S. DAK.: SAND - L. G. EVERIST, 15-95-48 - SIOUX CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 15% AAT4-408; 15% AAT4-352; 30% AAT4-351; 10% AAT4-372; 30% AAT4-353

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	99	90	68	57	46	32	17	9.0	5.4
TOLERANCE:		98/100	7	7	5		4				2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	BITUCOTE-3240 POISES (STYRELF 13)		
PLASTICITY INDEX			
% ASPH. IN MIX	4.50	5.50	6.50
NUMBER OF MARSHALL BLOWS	75	75	75
MARSHALL STABILITY - LBS.	3443	3227	3130
FLOW - 0.01 IN.	7	8	12
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.32	2.34	2.36
BULK SP. GR. COMB. DRY AGG.	2.651	2.651	2.651
SP. GR. ASPH. @ 77 F.	1.028	1.028	1.028
CALC. SOLID SP.GR.	2.486	2.449	2.414
% VOIDS - CALC.	6.67	4.46	2.24
ACE SP. GR.	2.476	2.441	2.398
% VOIDS - RICE	6.30	4.14	1.58
% WATER ABSORPTION - AGGREGATE	0.37	0.37	0.37
% VOIDS IN THE MINERAL AGGREGATE	16.42	16.59	16.67
% V.M.A. FILLED WITH ASPHALT	59.41	73.08	86.65
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.68	8.32	9.99
FILLER/BITUMEN RATIO		1.05	

A CONTENT OF 5.15% ASPHALT IS RECOMMENDED TO START THE JOB.
* ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
COPIES:
ASPH. MIX DESIGN
FR-12-1(8)--2G-97, WOODBURY
J. BUMP
R. BOLTON
R. SHELQUIST
D. JORDISON
D. HEINS
BROWER
W. OPPEDAL

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

B-6

1) Type B Class 2 - Chem-Crete
2) Type B Class 2
3) Special Sand - Chem-Crete
4) Special Sand
5) Asphalt Chem-Crete

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS 2 (CHEM-CRETE) NO. ABD0-141

INTENDED USE:

SIZE 3/4 SPEC. NO. 852-857 DATE REPORTED 8-28-80
861
COUNTY STORY PROJECT L-WA-180--73-85

CONTRACTOR IA. RD. BUILDERS

PROJ. LOCATION ON E57 ON N. LINE SEC. 31-83-24

AGG. SOURCES 3/4" GRAVEL-PETERSON PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-472

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	91	83	68	56	44	30	16	8.7	6.7

TOLERANCE: 98/100 7 7 6 5 3

75 BLOW MARSHALL DENSITY 2.35

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	SUGAR CREEK & CHEM-CRETE - 605 POISES		
PLASTICITY INDEX	N.P.		
% ASPH. IN MIX	5.0	6.0	7.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	2175	1975	1762
FLOW - 0.01 IN.	8	9	11
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.29	2.33	2.34
BULK SP. GR. COMB. DRY AGG.	2.670	2.670	2.670
SP. GR. ASPH. @ 77 F.	1.028	1.028	1.028
CALC. SOLID SP.GR.	2.49	2.46	2.42
% VOIDS - CALC.	8.2	5.2	3.3
RICE SP. GR.	2.47	2.42	2.38
% VOIDS - RICE	7.2	3.5	1.9
% WATER ABSORPTION - AGGREGATE	0.73	0.73	0.73
% VOIDS IN THE MINERAL AGGREGATE	18.5	18.0	18.5
% V.M.A. FILLED WITH ASPHALT	56.0	71.4	82.0
CALCULATED ASPH.FILM THICKNESS(MICRONS)	7.0	8.6	10.2
FILLER/BITUMEN RATIO		1.1	

A CONTENT OF 6.25% ASPHALT - CHEM CRETE IS RECOMMENDED TO START THE JOB.

COPIES:
ASPH. MIX DESIGN
L-WA-180--73-85, STORY
JESPERSON
R. HUMPHREY
D. JORDISON
R. SHELQUIST
L. ZEARLEY
IA. RD. BLDRS.
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS 2 LAB NO. ABD0-140

INTENDED USE:

SIZE 3/4" SPEC. NO. 852-857-DATE REPORTED 8/28/80
BOONE 861 3-80
COUNTY STORY PROJECT L-N-180--73-85
STORY L-WA-180--73-85
CONTRACTOR IOWA ROAD BUILDERS

PROJ. LOCATION

AGG. SOURCES 3/4" GRAVEL - PETERSON PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-472

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	91	83	68	56	44	30	16	8.7	6.7

TOLERANCE:	98/100	7	7	6	5	3
75 BLOW MARSHALL DENSITY				2.36		
ASPHALT SOURCE AND APPROXIMATE VISCOSITY			SUGAR CREEK - 914 POISES			
PLASTICITY INDEX			N. P.			
% ASPH. IN MIX			5.0	6.0	7.0	
NUMBER OF MARSHALL BLOWS			50	50	50	
MARSHALL STABILITY - LBS.			1758	1737	1550	
FLOW - 0.01 IN.			7	8	10	
SP.GR. BY DISPLACEMENT(LAB DENS.)			2.29	2.34	2.35	
BULK SP. GR. COMB. DRY AGG.			2.670	2.670	2.670	
SP. GR. ASPH. @ 77 F.			1.029	1.029	1.029	
CALC. SOLID SP.GR.			2.49	2.46	2.42	
% VOIDS - CALC.			8.2	4.8	2.9	
CE SP. GR.			2.48	2.43	2.40	
% VOIDS - RICE			7.8	3.9	2.0	
% WATER ABSORPTION - AGGREGATE			0.73	0.73	0.73	
% VOIDS IN THE MINERAL AGGREGATE			18.5	17.6	18.2	
% V.M.A. FILLED WITH ASPHALT			55.9	73.0	83.8	
CALCULATED ASPH.FILM THICKNESS(MICRONS)			7.0	8.6	10.2	
FILLER/BITUMEN RATIO				1.1		

A CONTENT OF 6.25% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:
ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
R. HUMPHREY
D. JESPERSEN
C. SCHNOOR
D. JORDISON
R. SHELQUIST
L. ZEARLEY
IOWA ROAD BUILDERS
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: SPECIAL SAND-CHEMCRETE LAB NO. ABD0-144

INTENDED USE:

SIZE SPEC. NO. 852-857-DATE REPORTED 9/2/80
861
COUNTY STORY PROJECT L-WA-180--73-85
L-F-180--73-85

CONTRACTOR IOWA ROAD BUILDERS
PROJ. LOCATION ON E57 ON THE N. LINE SEC. 31-83-24, 1 MI.; FROM W 1/4 COR. 20-84-24 SOUTH 2.4 MI. TO C.&N.W. RAILROAD

AGG. SOURCES SAND - WILLIAMS PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-469

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	96	87	72	53	35	18	6.5	4.3

TOLERANCE:

75 BLOW MARSHALL DENSITY		2.26	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	SUGAR CREEK & CHEMCRETE-605 POISES		
PLASTICITY INDEX	N. P.		
% ASPH. IN MIX	6.0	7.0	8.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	1260	1705	1642
FLOW - 0.01 IN.	8	8	9
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.23	2.25	2.27
BULK SP. GR. COMB. DRY AGG.	2.658	2.658	2.658
SP. GR. ASPH. @ 77 F.	1.028	1.028	1.028
CALC. SOLID SP.GR.	2.45	2.41	2.38
% VOIDS - CALC.	8.9	8.7	4.5
RICE SP. GR.	2.43	2.40	2.36
% VOIDS - RICE	9.1	6.1	4.0
% WATER ABSORPTION - AGGREGATE	0.74	0.74	0.74
% VOIDS IN THE MINERAL AGGREGATE	21.1	21.3	21.4
% V.M.A. FILLED WITH ASPHALT	58.0	68.5	78.9
CALCULATED ASPH.FILM THICKNESS(MICRONS)	9.1	10.9	12.6
FILLER/BITUMEN RATIO		0.6	

A CONTENT OF 7.0% ASPHALT - CHEMCRETE IS RECOMMENDED TO START THE JOB

COPIES:
ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
R. HUMPHREY
D. JESPERSEN
D. JORDISON
R. SHELQUIST
L. ZEARLEY
IOWA ROAD BUILDERS
V. MARKS
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: SPECIAL SAND LAB NO. ABD0-143

INTENDED USE:

SIZE SPEC. NO. 852-857-861E REPORTED 9-2-80

COUNTY STORY PROJECT L-WA-180--73-85
L-F-180--73-85

CONTRACTOR IA. ROAD BUILDERS

PROJ. LOCATION ON E57 ON N. LINE SEC. 31-83-24, 1 MI.; FROM W 1/4 COR. 20-84-24 SOUTH 2.4 MI. TO C & NW RAILROAD.
AGG. SOURCES SAND-WILLIAMS PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-469

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	96	87	72	53	35	18	6.5	4.3

TOLERANCE:

75 BLOW MARSHALL DENSITY		2.28	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	SUGAR CREEK - 914 POISES		
PLASTICITY INDEX	N.P.		
% ASPH. IN MIX	6.0	7.0	8.0
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	698	852	917
FLOW - 0.01 IN.	6	7	9
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.22	2.27	2.28
BULK SP. GR. COMB. DRY AGG.	2.658	2.658	2.658
SP. GR. ASPH. @ 77 F.	1.029	1.029	1.029
CALC. SOLID SP.GR.	2.45	2.41	2.38
% VOIDS - CALC.	9.3	5.9	4.1
RICE SP. GR.	2.43	2.40	2.36
% VOIDS - RICE	8.6	5.3	3.4
% WATER ABSORPTION - AGGREGATE	0.74	0.74	0.74
% VOIDS IN THE MINERAL AGGREGATE	21.5	20.6	21.1
% V.M.A. FILLED WITH ASPHALT	56.7	71.4	80.5
CALCULATED ASPH.FILM THICKNESS(MICRONS)	9.1	10.8	12.6
FILLER/BITUMEN RATIO		0.6	

A CONTENT OF 7.0% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:
~~ASPH.~~ MIX DESIGN
PROJECTS LISTED ABOVE
JESPERSON
R. HUMPHREY
R. SHELQUIST
L. ZEARLEY
IA. ROAD BUILDERS
MARKS
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - MISCELLANEOUS MATERIALS
LAB LOCATION AMES

MATERIAL ASPHALT CHEM-CRETE LAB NO. AB0-197

INTENDED USE SPECIAL SAND MIXTURE & TYPE B CLASS 2 ACC

COUNTY STORY PROJ NO. L-WA-180--73-85
L-F-180--73-85

DESIGN CONTRACT NO.

PRODUCER CHEM-CRETE CORP. CONTRACTOR IOWA ROAD BUILDERS

SOURCE BEAUMONT, TEXAS

UNIT OF MATERIAL ONE TANKER. 38,440 LBS.

SAMPLED BY BOB HOBSON SENDER'S NO. 1FB0-149

DATE SAMPLED 9/10/80 REC'D 9/11/80 REPORTED 9/16/80

SPECIFIC GRAVITY AT 60 F/60 F.	0.994
SOFT. POINT: METHOD (R & B)	
PENETRATION AT 77 F. 100 GMS. 5 SEC.	
FLASH POINT	
SOLUBLE IN TRICHLOROETHYLENE	99.49%
DUCTILITY AT 77 F.	
SPOT TEST	
KINEMATIC VISCOSITY @ 140 F., CENTISTOKES	3056
THIN FILM LOSS ON HEATING 5 HRS AT 325 F.	1.96%
% ORIGINAL PENETRATION (THIN FILM RES.)	
PENETRATION OF RES. AT 77 F. 100 GMS. 5 SEC.	
DUCTILITY AT 77 F. (THIN FILM RES.)	37 CMS.
ABSOLUTE VISCOSITY ORIGINAL 140 F. 30 CM HG	31 POISES
ABSOLUTE VISCOSITY THIN FILM RES. 140 F. 30 CM HG	532 POISES
KIN. VISCOSITY ORIGINAL @ 275 F.	

COPIES:
ASPHALT
R. HUMPHREY
PROJECTS LISTED ABOVE

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

B-7 1-4) Ductilad D1002
5) Grams of Aggregate Chips Recovered

LBD ASPHALT PRODUCTS COMPANY

A Lubrizol Company

Ductilad™ D1002

A High Performance Liquid Additive Containing Polymer To Enhance The Life And Durability Of Asphalt Cements

Innovative Asphalt Technology/Ductilad Products Group

DUCTILAD™ D1002 is a liquid polymeric additive formulated to enhance the life and durability of asphalt cements and asphalt paving mixtures. DUCTILAD D1002 is particularly valuable when added to asphalt binders used in chip-seals or other surface treatments. DUCTILAD D1002 improves the initial "stickiness" of the asphalt cement and provides the binder with better long-term aged properties.

Primary factors affecting the durability and service life of a chip-seal or surface treatment are the amount of hardening of the asphalt binder during construction and the rate of age-hardening that the binder later displays during its service life. Throughout the United States, chip-seals have suffered premature failures due to the rapid oxidative aging of the asphalt binder and the attendant lack of chip adhesion.

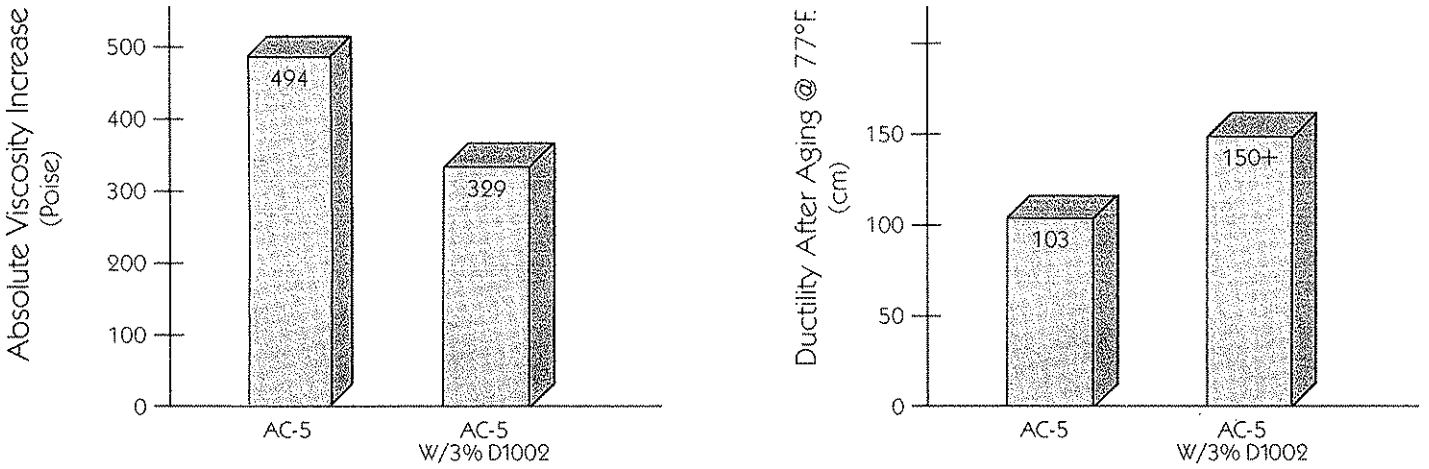
Many physical characteristics of a surface seal, such as asphalt film thickness, aggregate properties, and environmental factors, affect the rate at which the asphalt cement will age and harden during the seal's service life. Consequently, an accelerated laboratory test to accurately predict the actual in-service aging and hardening is not available. However, a binder's tendency to age may be evaluated through some common laboratory tests.

Thin film oven tests of asphalt cements are widely used to measure changes in properties when asphalts are exposed, as thin films, to air at high temperatures. The relative changes in the asphalt cements' properties are used to judge expected field performance. The effectiveness of DUCTILAD D1002 can be evaluated in these thin film oven tests. The ASTM D1754 procedure exposes a static film of asphalt cement to heat and air while the ASTM D2872 procedure exposes a moving or rolling film. The California Department of Transportation has developed a modified rolling thin film oven test to simulate the severe aging that an asphalt binder faces in the California deserts.

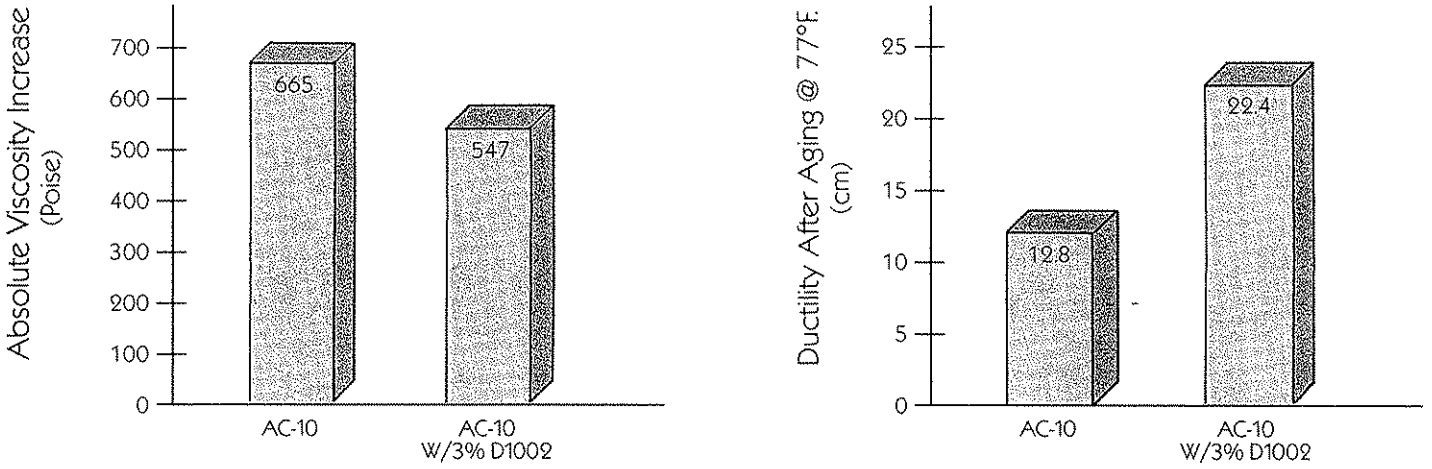
DUCTILAD D1002 when added at 1-4% by weight to asphalt cement dramatically changes the character of the asphalt cement. Additionally, DUCTILAD D1002 allows the asphalt binder to better maintain its' initial characteristics after aging. On the facing page, the results from several thin film oven tests are shown. The results offer strong evidence that DUCTILAD D1002 reduces the aging of asphalt cements when exposed to severe conditions. The lowered viscosity increase and improved retained ductility means that the asphalt binder still has much of its original life and "stickiness" left, and this translates to longer chip-seal life.

DUCTILAD D1002 is designed for use in all surface seals and will not affect the design or placement of these seals. More detailed information about DUCTILAD D1002 is available upon request.

A. Thin Film Oven Tests (ASTM D1754)

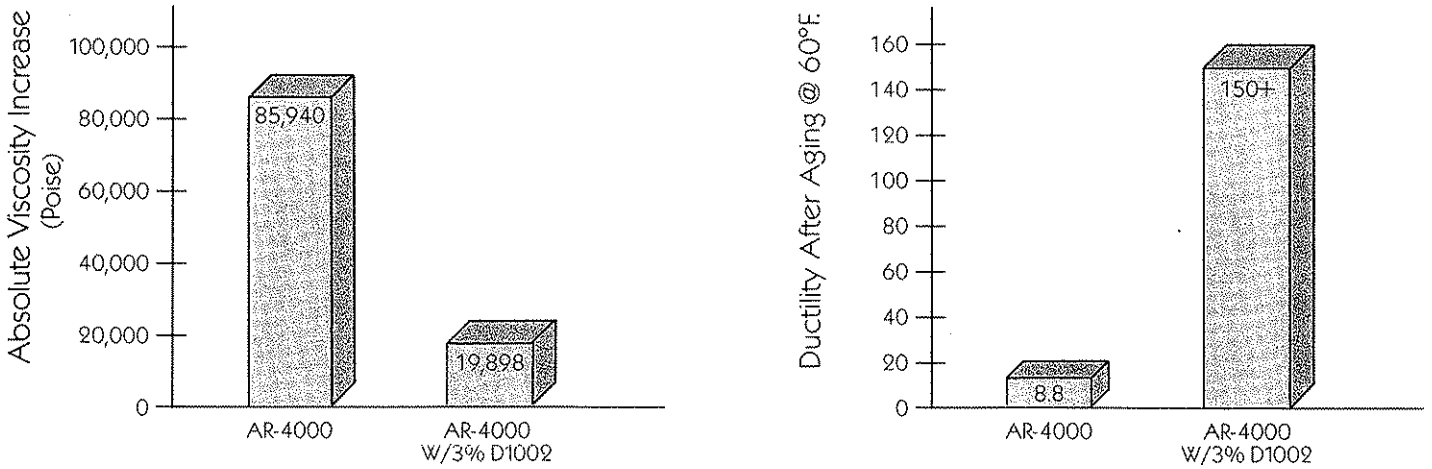


DUCTILAD D1002 treated asphalt binders display improved aged characteristics.



DUCTILAD D1002 retains more of the AC's original viscosity and ductility under laboratory aging tests.

B. California Tilt Oven Asphalt Durability Test



Under simulated desert conditions, DUCTILAD D1002's improvements are dramatic.

DUCTILAD™ D1002 ASPHALT ADDITIVE

Description:

DUCTILAD D1002 asphalt additive is an easy to handle liquid containing polymer for use in chip-seals and other surface seals. DUCTILAD D1002 improves the tackiness of the asphalt binder while improving the aged properties of the binder.

Typical Properties:

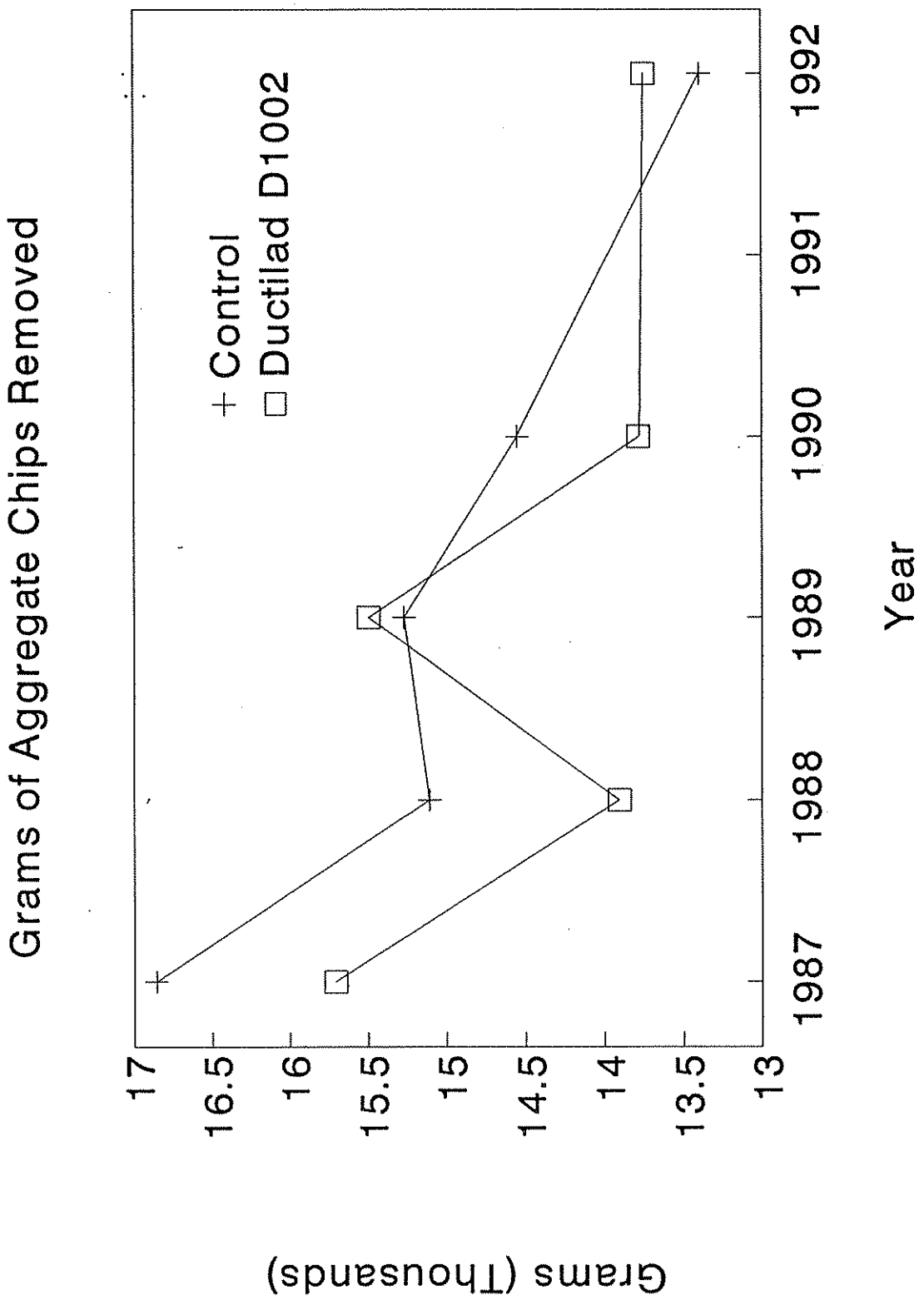
Form:	Liquid
Appearance:	Clear, Amber
Viscosity (104°F.):	6,000 cSt
(212°F.):	750 cSt
LBS/GAL:	7.56
Flash Point (C.O.C.):	310°F.
Pour Point:	23°F.

Availability:

Bulk (tank car or tank truck),
55 gallon non-returnable drums.
FOB Painesville, Ohio; Deer Park, Texas

Contact:

LBD Asphalt Products Company
29400 Lakeland Blvd.
Wickliffe, Ohio 44092
Phone: (216) 261-2681


Grams of Aggregate Chips Removed
+ Control
□ Ductilad D1002
17
16.5
16
15.5
15
14.5
14
13.5
13
1987
1988
1989
1990
1991
1992
Year
Grams (Thousands)

B-8 1) Ralumac

CORRECTED REPORT

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION DISTRICT 1

MIX, TYPE AND CLASS: RALUMAC LAB NO. ABD2-135

INTENDED USE:

SIZE 3/8" SPEC. NO. SP-413 DATE REPORTED 08-31-82

COUNTY POLK & BOONE PROJECT MP-1700--69-77
MP-1701--69-08

CONTRACTOR N.B. WEST

PROJ. LOCATION U.S. 69 FROM JUST N. OF 1ST STREET IN ANKENY N. 5.0 MILES
ON IOWA 17 FROM JUST N. OF U.S. 30 NORTH & EAST, APPROX. 3 MILES
AGG. SOURCES 3/8" CR. LST. - AMES MINE - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT2-401

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
				100	80	56	42	34	24	17	12

TOLERANCE:			
PARTS RALUMAC ADDED	10	12	14
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	RALUMAC		
PLASTICITY INDEX			
%ASPH. IN MIX	6.0	7.1	8.2
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	3700	3722	2667
FLOW - 0.01 IN.	13	16	25
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.33	2.34	2.36
BULK SP. GR. COMB. DRY AGG.	2.617	2.617	2.617
SP. GR. ASPH. @ 77 F.	1.026	1.026	1.026
CALC. SOLID SP.GR.	2.43	2.39	2.35
% VOIDS - CALC.	4.1	2.1	-0.3
RICE SP. GR.			
% VOIDS - RICE			
% WATER ABSORPTION - AGGREGATE	1.31	1.31	1.31
% VOIDS IN THE MINERAL AGGREGATE	16.3	16.9	17.2
% V.M.A. FILLED WITH ASPHALT	74.9	87.4	101.5
CALCULATED ASPH.FILM THICKNESS(MICRONS)	5.5	6.7	7.9

A CONTENT OF 11 PARTS TOTAL EMULSION AND 9 PARTS TOTAL WATER IS RECOMMENDED TO START THE JOB. THE MIXTURE ALSO CONTAINS 2 PARTS TYPE 1 CEMENT AND 2 PARTS ADDITIVE P.

COPIES:
ASPH. MIX DESIGN
R. HUMPHREY
B. DUNSHEE
R. SHELQUIST
L. ZEARLEY
T. CACKLER
N.B. WEST
KEN GILL
DIST. 1 LAB
F. BLAIR

KENNETH M. MEEKS
DISTRICT 1 MATERIALS

SIGNED: BERNARD C. BROWN

B-9 1) UltraPave

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS 2 LAB NO. ABD3-87

INTENDED USE:

SIZE 3/4" SPEC. NO. 915 DATE REPORTED 7-6-83

COUNTY STORY PROJECT SN-4793(3)--51-85

CONTRACTOR MANATTS

PROJ. LOCATION ON E. 29 FROM S14 3 MI. N OF NEVADA EAST 3.0 MILES

AGG. SOURCES 3/4" GRAVEL - BROCK PIT-STORY CO.; 3/4" CR. GRAVEL-CHRISTENSON PIT-STORY CO.; 3/4" WASHED GRAVEL-CHRISTENSON PIT - STORY CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT3-378; 15% AAT3-379; 20% AAT3-380

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	85	70	59	51	42	34	17	7.1	4.42
TOLERANCE: 98/100			7	7	6		5				3*

75 BLOW MARSHALL DENSITY		2.35	
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 974 POISES		
PLASTICITY INDEX	N.P.		
% ASPH. IN MIX	5.5	6.5	7.5
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	1387	1137	870
FLOW - 0.01 IN.	7	9	15
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.32	2.33	2.34
BULK SP. GR. COMB. DRY AGG.	2.655	2.655	2.655
SP. GR. ASPH. @ 77 F.	1.029	1.029	1.029
CALC. SOLID SP.GR.	2.48	2.44	2.40
% VOIDS - CALC.	6.3	4.5	2.7
RICE SP. GR.	2.45	2.41	2.38
% VOIDS - RICE	5.2	3.4	1.7
% WATER ABSORPTION - AGGREGATE	1.18	1.18	1.18
% VOIDS IN THE MINERAL AGGREGATE	17.4	18.0	18.5
% V.M.A. FILLED WITH ASPHALT	64.0	75.1	85.6
CALCULATED ASPH.FILM THICKNESS(MICRONS)	8.5	10.4	12.2
FILLER/BITUMEN RATIO		0.7	

A CONTENT OF 6.50% ASPHALT IS RECOMMENDED TO START THE JOB.
* ALSO CONTROLLED BY FILLER/BITUMEN RATIO.

COPIES:
ASPH. MIX DESIGN
SN-4793(3)--51-85, STORY
R. HUMPHREY
JESPERSON
D. JORDISON
R. SHELQUIST
L. ZEARLEY
MANATTS
W. OPPEDAL

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

B-10	1) Asphadur	Binder
	2) Asphadur	Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A ASPHADUR LAB NO. ABD8-4

INTENDED USE: BINDER

SIZE 3/4 SPEC. NO. 1048, SP-729 DATE REPORTED 3/31/88

COUNTY POTTAWATTAMIE PROJECT IR-480-1(117)0--12-78

CONTRACTOR OMNI ENGR.

PROJ. LOCATION MO. RIVER TO I-29

AGG. SOURCES CR. LST. & SAND - SCHILDBERG, CRESCENT, POTTAWATTAMIE CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 85% AAT8-25; 15% AAT8-26

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	80	61	36	24	20	16	7.5	5.9	5.4
TOLERANCE: 98/100		7		7	7	5		4			2*

ASPHADUR ADDED

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH 2350 POISES		
PLASTICITY INDEX			
% ASPH. IN MIX	4.25	5.25	6.25
NUMBER OF MARSHALL BLOWS	75	75	75
MARSHALL STABILITY - LBS.	3065	2857	2605
FLOW - 0.01 IN.	13	14	16
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.338	2.359	2.360
BULK SP. GR. COMB. DRY AGG.	2.633	2.633	2.633
SP. GR. ASPH. @ 77 F.	1.036	1.036	1.036
CALC. SOLID SP.GR.	2.503	2.466	2.431
% VOIDS - CALC.	6.59	4.35	2.92
RICE SP. GR.	2.459	2.426	2.411
% VOIDS - RICE	4.92	2.76	2.12
% WATER ABSORPTION - AGGREGATE	1.11	1.11	1.11
% VOIDS IN THE MINERAL AGGREGATE	14.98	15.11	15.97
% V.M.A. FILLED WITH ASPHALT	56.03	71.19	81.73
CALCULATED ASPH.FILM THICKNESS(MICRONS)	8.25	10.48	12.71
FILLER/BITUMEN RATIO		1.17	

A CONTENT OF 4.6% ASPHALT IS RECOMMENDED TO START THE JOB.
*ALSO CONTROLLED BY FILLER/BITUMEN RATIO. NUC. CAL.: INVALID

COPIES:
ASPHALT MIX DESIGN
~~IR-~~480-1(117)0--12-78, POTTAWATTAMIE
G. MILLER
W. COOK
R. MONROE
J. SMYTHE
D. HEINS
OMNI ENGR.
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A ASPHADUR LAB NO. ABD8-9

INTENDED USE: SURFACE

SIZE 3/4" SPEC. NO. 1048 DATE REPORTED 4/5/88

COUNTY POTTAWATTAMIE PROJECT IR-480-1(117)0--12-78

CONTRACTOR OMNI ENGR.

PROJ. LOCATION MO. RIVER TO I-29

AGG. SOURCES QUARTZITE CONC. MATLS., SIOUX FALLS S.D.; CR. LST. -SCHILDBERG, CRESCENT, POTTAWATTAMIE CO.; SAND - MARTIN MARIETTA, GRETNA NE
JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT8-27; 20% AAT8-28; 15% AAT8-29

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	95	69	48	37	31	23	15	9.1	6.3	4.9
TOLERANCE:		95/100	7	7	7	5	4				2*

HYDRATED LIME & ASPHADUR - ADDED

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 2350 POISES	
PLASTICITY INDEX		
% ASPH. IN MIX	4.0	5.0
NUMBER OF MARSHALL BLOWS	75	75
MARSHALL STABILITY - LBS.	3515	3497
FLOW - 0.01 IN.	11	18
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.356	2.379
BULK SP. GR. COMB. DRY AGG.	2.634	2.634
[illegible]	1.036	1.036
CALC. SOLID SP.GR.	2.492	2.456
% VOIDS - CALC.	5.47	3.15
RICE SP. GR.	2.472	2.440
% VOIDS - RICE	4.69	2.50
% WATER ABSORPTION - AGGREGATE	0.40	0.40
% VOIDS IN THE MINERAL AGGREGATE	14.13	14.20
% V.M.A. FILLED WITH ASPHALT	61.28	77.80
CALCULATED ASPH.FILM THICKNESS(MICRONS)	8.33	10.52
FILLER/BITUMEN RATIO	1.14	

A CONTENT OF 4.3% ASPHALT IS RECOMMENDED TO START THE JOB.
* ALSO CONTROLLED BY FILLER/BITUMEN RATIO. NUC. CAL: NONE,
NOT ENOUGH MATERIAL.
COPIES:
ASPHALT MIX DESIGN
~~IR-480-~~1(117)0--12-78, POTTAWATTAMIE
G. MILLER
W. COOK
R. MONROE
J. SMYTHE
D. HEINS
OMNI ENGRS.
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

B-11	1) Ralumac	Design
	2) Ralumac	Performance
	3) Ralumac	Rut Filling

KOCH MATERIALS COMPANY
Chicago, Il.

DATE: 06-08-88 SALESMAN: Bill Miteff

CUSTOMER: Scott Const. FILE #: RAL-8804

SOURCE: Franklin, Wi. Agg. #1

RALUMAC MICROSURFACING DESIGN

GRADATION:

Sieve Size	Percent Retained	Percent Passing	Ralumac Type I Spec.	Ralumac Type II Spec.
3/8	0.0	100.0	100	100
#4	7.0	93.0	90 - 100	70 - 90
8	26.8	66.2	65 - 90	45 - 65
16	23.5	42.7	40 - 65	30 - 50
30	13.8	29.0	25 - 45	19 - 34
50	9.9	19.0	15 - 30	12 - 25
100	6.6	12.4	10 - 21	7 - 18
200	4.5	7.9	5 - 13	4 - 12

MARSHALL SPECIMEN:

Residual Asphalt Content	Stability at 140 F lbs.	Flow .01 inch	VMA	VTM	Density lbs/cf
6.0	3055	9	19.7	7.0	142.8
6.5	3067	13	19.6	5.8	143.7
7.0	3702	15	17.7	2.4	147.9
7.5	3336	14	17.9	1.6	148.2

COHESION TESTS:

% PC	% Water	% Add	% Emul	Max. Mix Time	Set Time	Cohesion at (min.) 15	30	60
1/4	5	2	10	120"	7'	17	17	17
1/2	5	2	10	90"	6'	19	19	20
3/4	5	2	10	80"	6'	16	19	19
1/2	4	3	10	110"	6'	17	18	18

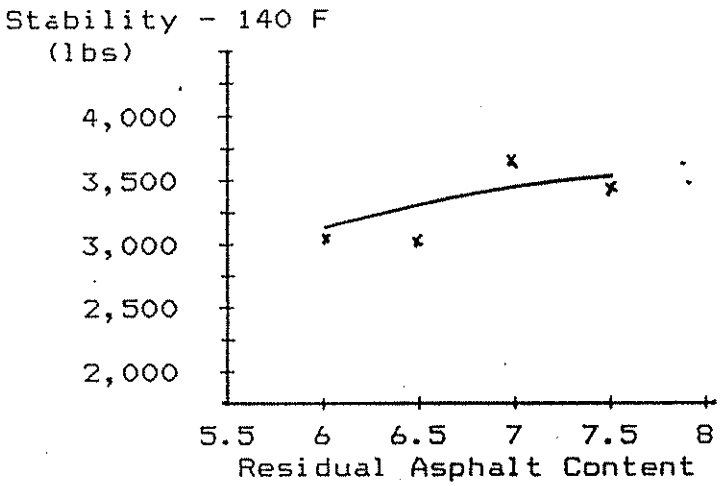
KOCH MATERIALS COMPANY
Chicago, Il.

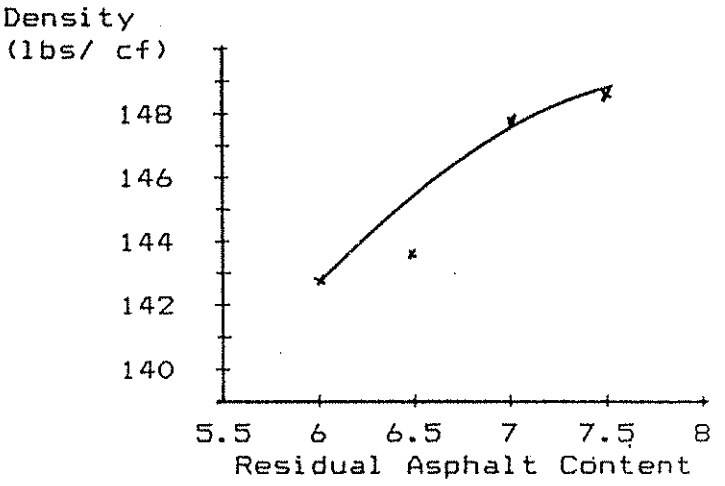
DATE: 06-08-88 FILE #: RAL-8804

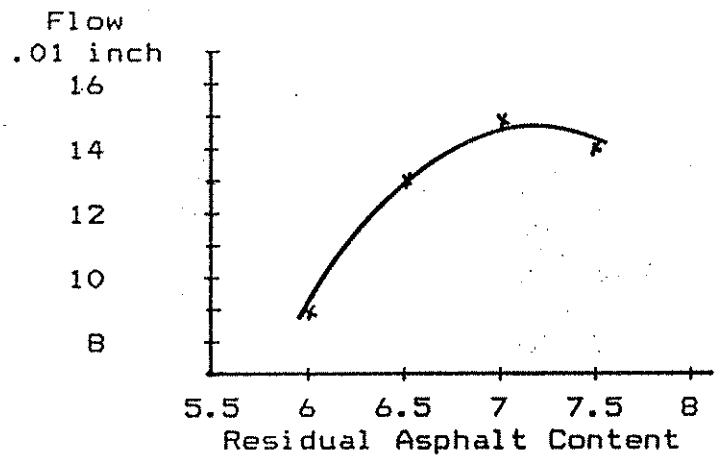
CUSTOMER: Scott Const. SOURCE: Franklin, Wi. #1

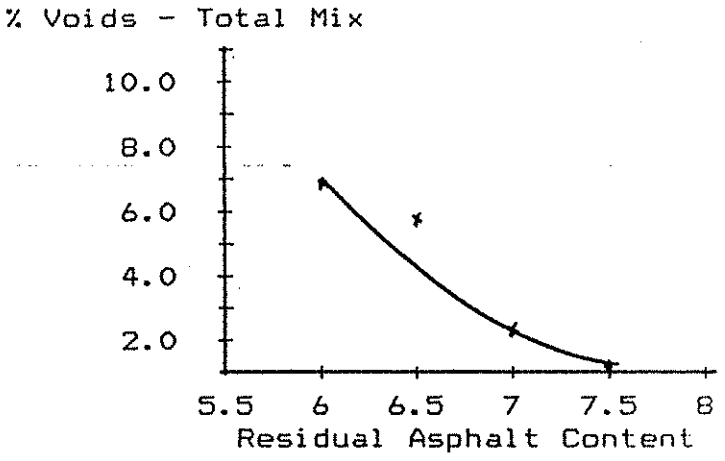
SALESMAN: Bill Miteff

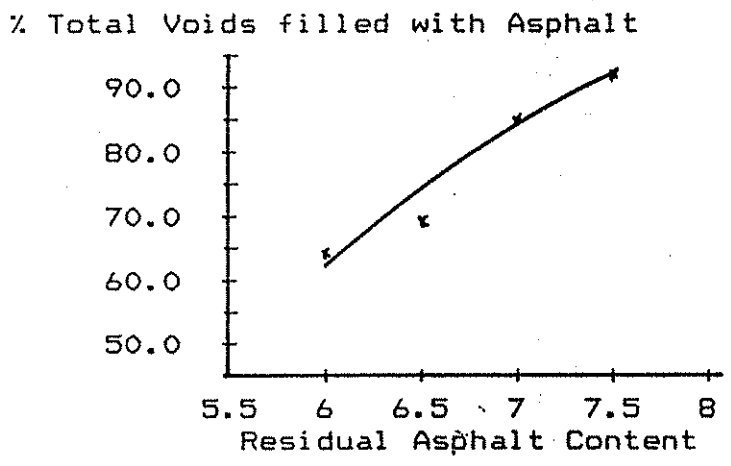
Performence Properties vs. Residual Asphalt Content

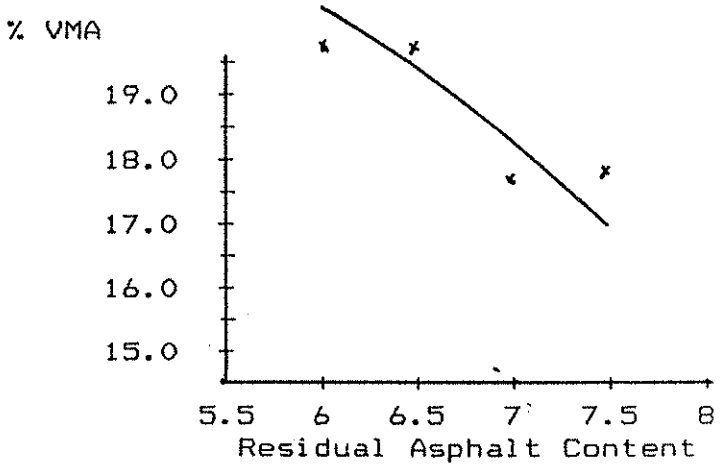












Rut Filling with Micro-Surfacing

Rut Width	Lbs./Sq. Yd. Laid					
72"	25	50	75	99	124	149
66"	23	45	68	91	114	136
60"	21	41	62	82	103	123
54"	19	37	56	74	93	111
48"	17	33	50	66	83	99
36"	13	25	37	50	62	75
Rut Depth	.25"	.50"	.75"	1.0"	1.25"	1.50"

The 48" and the 72" wide rut boxes are most commonly used. When the rut boxes are in use, any rut demanding more than 50 lbs./sq. yd. is pulled in two or more passes.

Micro-Surfacing

Pounds per square yard-straight surfacing

36"	12	25	37	49
by	1/8"	1/4"	3/8"	1/2"

B-12	1) PAC 30	Binder/Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX TYPE AND CLASS: TYPE A LAB NO. ABD6-93

INTENDED USE: BINDER & SURFACE

SIZE 1/2" SPEC. NO. 1010 DATE REPORTED 6/23/86

COUNTY POLK PROJECT W.O. 0206-85-009

CONTRACTOR D. M. ASPHALT

PROJ. LOCATION IN DES MOINES ON FLEUR DR. FROM MCKINLEY TO R.R. VIADUCT

AGG. SOURCES QUARTZIT - WEAVER, SAUK CO., WI.; LST. CHIPS - MARTIN MARIETTA, AMES MINE, STORY CO.; SAND - HALLETT, E. D. M., POLK CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 55% AAT6-272; 12.5% AAT6-273; 32.5% AAT6-275

JOB MIX FORMULA - COMBINED GRADATION

-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	95	68	52	40	26	14	6.9	5.0
TOLERANCE:			98/100	7	7	5		4			2

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	BITUCOTE POLYMERIZED-2450 POISES	
PLASTICITY INDEX		
% ASPH. IN MIX	5.5	6.5
NUMBER OF MARSHALL BLOWS	75	75
MARSHALL STABILITY - LBS.	2213	2027
FLOW - 0.01 IN.	9	11
% SP.GR. BY DISPLACEMENT(LAB DENS.)	2.321	2.347
BULK SP. GR. COMB. DRY AGG.	2.646	2.646
% SP. GR. ASPH. @ 77 F.	1.025	1.025
CALC. SOLID SP.GR.	2.449	2.414
% VOIDS - CALC.	5.23	2.76
RICE SP. GR.	2.443	2.414
% VOIDS - RICE	4.99	2.78
% WATER ABSORPTION - AGGREGATE	0.54	0.54
% VOIDS IN THE MINERAL AGGREGATE	17.11	17.07
% V.M.A. FILLED WITH ASPHALT	69.42	83.83
CALCULATED ASPH.FILM THICKNESS(MICRONS)	9.42	11.34
FILLER/BITUMEN RATIO	0.85	

OPTIMUM ASPHALT CONTENT OF 5.9% ASPHALT IS RECOMMENDED TO START THE JOB.
NOTE: ASPHALT DID NOT COMPLY WITH ALL P.A.C. 30 CRITERIA.
COPIES:
ASPH. MIX DESIGN
W.O. 0206-85--009, POLK
DISTRICT 1 ENGR.
J. BELLIZZI
R. MONROE
K. MCLAUGHLIN
D. HEINS G. Hlavka (6-26-86)
D. M. ASPHALT
V. OPPEDAL
M. Trueblood
Dist 1 Lab

SIGNED: MAX I. SHEELER

B-13	1) PAC 30	Surface
	2) PAC 30	Binder

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD8-147

INTENDED USE: SURFACE

SIZE 1/2 SPEC. NO. 1048 DATE REPORTED 8-1-88

COUNTY STORY PROJECT FN-69-5(36)--21-85

CONTRACTOR MANATTS

PROJ. LOCATION IN AMES ON DUFF SQUAW DR. TO SO. 4TH & ON GRAND AVE.

AGG. SOURCES CR. GRAVEL-HALLETT, BOONE, BOONE CO; CR. LST- MARTIN MARIETTA; AMES MINE,STORY CO; SAND-HALLETT, CHRISTENSEN PIT, STORY CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 40% AAT8-646; 35% AAT8-647; 25% AAT8-648

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
			100	86	56	40	31	20	11	6.0	4.5

TOLERANCE: 92/100 7 7 5 4 2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 2106 POISES		
PLASTICITY INDEX			
% ASPH. IN MIX	4.0	5.0	6.0
NUMBER OF MARSHALL BLOWS	75	75	75
MARSHALL STABILITY - LBS.	3707	3430	3053
FLOW - 0.01 IN.	9	10	11
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.369	2.392	2.411
BULK SP. GR. COMB. DRY AGG.	2.695	2.695	2.695
SP. GR. ASPH. @ 77 F.	0.9963	0.9963	0.9963
CALC. SOLID SP.GR.	2.561	2.519	2.479
% VOIDS - CALC.	7.48	5.06	2.76
RICE SP. GR.	2.531	2.483	2.451
% VOIDS - RICE	6.40	3.66	1.03
% WATER ABSORPTION - AGGREGATE	1.21	1.21	1.21
% VOIDS IN THE MINERAL AGGREGATE	15.61	15.68	15.91
% V.M.A. FILLED WITH ASPHALT	52.07	67.75	82.63
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.91	8.94	10.98
FILLER/BITUMEN RATIO		0.94	

A CONTENT OF 4.8% ASPHALT IS RECOMMENDED TO START THE JOB.
*ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
NUC. CAL: TEMP= 210; WT= 7200; SLOPE= 4.44; I'CEPT= (-5.15)
COPIES:
ASPHALT MIX DESIGN
R. MUMM
T. JACOBSON
R. MONROE
J. SMYTHE
D. HEINS
MANATTS
W. OPPEDAL
FN-69-5(36)--21-85, STORY

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD8-136

INTENDED USE: BINDER

SIZE 3/4" SPEC. NO. 1040 DATE REPORTED 7/19/88

COUNTY STORY PROJECT FN-69-5(36)--21-85

CONTRACTOR MANATTS

PROJ. LOCATION ON S. DUFF AVE. AND ON NORTH GRAND IN AMES

AGG. SOURCES CR. LST. & CHIPS - MARTIN MARIETTA, AMES MINE, STORY CO.;
SAND - HALLETTS, CHRISTENSEN PIT, STORY CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT8-566; 10% AAT8-567; 25% AAT8-568

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	86	70	48	35	27	18	9.0	5.2	4.4
TOLERANCE: 98/100		7	7	7	5		4				2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY	KOCH - 2106 POISES		
PLASTICITY INDEX			
% ASPH. IN MIX	3.75	4.75	5.75
NUMBER OF MARSHALL BLOWS	75	75	75
MARSHALL STABILITY - LBS.	2790	3037	2683
FLOW - 0.01 IN.	8	7	7
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.344	2.389	2.397
BULK SP. GR. COMB. DRY AGG.	2.693	2.693	2.693
SP. GR. ASPH. @ 77 F.	1.020	1.020	1.020
CALC. SOLID SP.GR.	2.594	2.553	2.514
% VOIDS - CALC.	9.65	6.44	4.65
RICE SP. GR.	2.520	2.487	2.461
% VOIDS - RICE	6.98	3.94	2.60
% WATER ABSORPTION - AGGREGATE	1.85	1.85	1.85
% VOIDS IN THE MINERAL AGGREGATE	16.22	15.50	16.11
% V.M.A. FILLED WITH ASPHALT	40.51	58.45	71.16
CALCULATED ASPH.FILM THICKNESS(MICRONS)	6.36	8.60	10.85
FILLER/BITUMEN RATIO		0.94	

A CONTENT OF 4.7% ASPHALT IS RECOMMENDED TO START THE JOB.
* ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
NUC. CAL. INVALID
COPIES:
ASPH. MIX DESIGN
FN 69-5(36)--21-85, STORY
R. MUMM
T. JACOBSON
R. MONROE
J. SMYTHE
D. HEINS
MANATTS
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

B-14	1) Conventional	Binder
	2) PAC 40	Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A RECYCLED LAB NO. ABD7-72

INTENDED USE: BINDER

SIZE 3/4" SPEC. NO. 1030 DATE REPORTED 6/17/87
O'BRIEN 1036
COUNTY OSCEOLA PROJECT FN-60-3(11)--21-71

CONTRACTOR ROHLIN

PROJ. LOCATION FROM U.S. 18 IN SHELDON TO C&NW RR IN SIBLEY
MILLED @ 6.20% - PROJECT; 1/4" CR. LST. & 3/4" CHIPS - MIDWEST
AGG. SOURCES LIMESTONE, GILMORE CITY, POCAHONTAS CO.; PIT RUN GRAVEL -
HALLETTS, 28-98-42, OSCEOLA CO.
JOB MIX FORMULA AGGREGATE PROPORTIONS: 35% ABC7-114; 26% AAT7-429; 25% AAT7-428
14% AAT7-430

JOB MIX FORMULA - COMBINED GRADATION

1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
		100	91	80	60	45	32	23	12	7.3	5.4
TOLERANCE: 98/100		7	7	7	5			4			2*

% ASPHALT ADDED	2.33	3.33	4.33
ASPHALT SOURCE AND APPROXIMATE VISCOSITY	AMOCO - 299 POISES		
PLASTICITY INDEX			
% ASPH. IN MIX	4.5	5.5	6.5
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	3367	3013	2767
FLOW - 0.01 IN.	10-	10	13
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.344	2.376	2.392
BULK SP. GR. COMB. DRY AGG.	2.649	2.649	2.649
SP. GR. ASPH. @ 77 F.	1.020	1.020	1.020
CALC. SOLID SP.GR.	2.502	2.465	2.428
% VOIDS - CALC.	6.33	3.60	1.50
RICE SP. GR.	2.479	2.446	2.422
% VOIDS - RICE	5.45	2.86	1.24
% WATER ABSORPTION - AGGREGATE	1.07	1.07	1.07
% VOIDS IN THE MINERAL AGGREGATE	15.50	15.24	15.57
% V.M.A. FILLED WITH ASPHALT	59.16	76.34	90.36
CALCULATED ASPH.FILM THICKNESS(MICRONS)	7.38	9.34	11.34
FILLER/BITUMEN RATIO		1.04	

A CONTENT OF 5.2% ASPHALT IS RECOMMENDED TO START THE JOB.
THIS IS AN ADD. 3.03% AC 2.5; *ALSO CONTROLLED BY FILLER/BIT RATIO
NUC. CAL.: TEMP = 215; WT = 7300; SLOPE = 4.04; I'CEPT = (-3.51)
COPIES:
ASPHALT MIX DESIGN
FN-60-3(11)--21-71 O'BRIEN
C. LEONARD
W. BENNETT
R.MONROE
J. SMYTHE
D. HEINS
ROHLIN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE A LAB NO. ABD7-204

INTENDED USE: SURFACE

SIZE 3/4 SPEC. NO. 1036 DATE REPORTED 9-16-87

COUNTY O'BRIEN PROJECT FN-60-3(11)--21-71

CONTRACTOR ROHLIN

PROJ. LOCATION FROM U.S. 18 TO RR IN SIBLEY

AGG. SOURCES CR. GRAVEL & GRAVEL- ROHLIN, 32-98-37, DICKINSON CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT7-1120; 35% AAT7-1121

JOB MIX FORMULA - COMBINED GRADATION										
1-1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100	99	76	62	46	36	27	19	10	6.7	5.4
TOLERANCE: 98/100		7		7	7	5		4			2*

ASPHALT SOURCE AND APPROXIMATE VISCOSITY JEBRO - 3350 POISES

PLASTICITY INDEX			
% ASPH. IN MIX	4.75	5.75	6.75
NUMBER OF MARSHALL BLOWS	50	50	50
MARSHALL STABILITY - LBS.	3250	2952	2583
FLOW - 0.01 IN.	12	18	20
SP.GR. BY DISPLACEMENT(LAB DENS.)	2.369	2.403	2.395
BULK SP. GR. COMB. DRY AGG.	2.674	2.674	2.674
SP. GR. ASPH. @ 77 F.	1.034	1.034	1.034
CALC. SOLID SP.GR.	2.516	2.480	2.444
% VOIDS - CALC.	5.91	3.12	2.01
RICE SP. GR.	2.500	2.449	2.415
% VOIDS - RICE	5.24	1.88	0.83
% WATER ABSORPTION - AGGREGATE	1.09	1.08	1.08
% VOIDS IN THE MINERAL AGGREGATE	15.4	15.30	16.48
% V.M.A. FILLED WITH ASPHALT	62.15	79.60	87.80
CALCULATED ASPH.FILM THICKNESS(MICRONS)	8.67	10.84	13.06
FILLER/BITUMEN RATIO		1.08	

A CONTENT OF 5.0% ASPHALT IS RECOMMENDED TO START THE JOB.
*ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
MOC. CAL.: NONE
COPIES:
ASPHALT MIX DESIGN
FN 60-3(11)--21-71, O'BRIEN
C. LEONARD
W. BENNETT
R. MONROE
J. SMYTHE
D. HEINS
ROHLIN
W. OPPEDAL

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

B-15	1) PAC 30	Surface

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT MIX DESIGN
LAB LOCATION - AMES

LAB NO....:ABD9-0106

MATERIAL.....:TYPE A MODIFIED
INTENDED USE....:SURFACE
PROJECT NO.....:W.O. 0206-87-003
COUNTY.....:POLK
SPEC NO.....:1070.00
SAMPLED BY.....:
DATE SAMPLED:
CONTRACTOR:DES MOINES ASPHALT
SIZE.....:1/2
SENDER NO.:
DATE RECEIVED:
DATE REPORTED: 06/08/89
PROJ. LOCATION: ON FLEUR DRIVE IN DES MOINES

- -

AGG SOURCES: CR. LST- MARTIN MARIETTA, AMES MINE, STORY CO.;
QUARTZITE- MARTIN MARIETTA, ROCK SPRINGS, WI;
SAND- HALLETT, EDM, POLK CO.

JOB MIX FORMULA-COMB. GRADATION

1 1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100.0	92.0	75.0	58.0	44.0	35.0	24.0	10.0	5.4		4.6

TOLERANCE /100 :

	98	7	7	5	4	2

MATERIAL MIX	A85006	AWI004	A77522		
% AGGR. PROP.	50.00	15.00	35.00	0.00	0.00

% ASPHALT IN MIX	4.75	5.75	0.00	0.00
NUMBER OF MARSHALL BLOWS	75	75	0	0
MARSHALL STABILITY - LBS.	2870	2583	0	0
FLOW - 0.01 IN.	9	11	0	0
SP GR BY DISPLACEMENT (LAB DENS)	2.372	2.385	0.000	0.000
BULK SP. GR. COMB. DRY AGG.	2.667	2.667	0.000	0.000
SP. GR. ASPH. @ 77 F.	1.024	1.024	0.000	0.000
CALC. SOLID SP. GR.	2.508	2.471	0.000	0.000
% VOIDS - CALC.	5.44	3.48	0.00	0.00
RICE SP.GR.	2.473	2.436	0.000	0.000
% VOIDS - RICE	4.08	2.09	0.00	0.00
% WATER ABSORPTION - AGGREGATE	1.05	1.05	0.00	0.00
% VOIDS IN MINERAL AGGREGATE	15.29	15.72	0.00	0.00
% V.M.A. FILLED WITH ASPHALT	64.40	77.88	0.00	0.00
CALC. ASPH. FILM THICK. MICRONS	8.39	10.37	0.00	0.00
FILLER/BITUMEN RATIO	0.00	0.97	0.00	0.00

A CONTENT OF 4.75% ASPHALT IS RECOMMENDED TO START THE JOB.
TOLERANCE ON #200 ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
COPIES TO:
CENTRAL LAB
DES MOINES ASPHALT
DIST. 1
R. MONROE
W. OPPEDAL
D. HEINS
CITY OF DES MOINES

BEC6
TB

6/14
DISPOSITION:

SIGNED: ORRIS J. LANE, JR.

Appendix C
Core Density and Percent Air

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0018

MATERIAL.....:ASPHALT CORES Site #1
PROJECT NO.....:HR-542
COUNTY.....:JASPER
UNIT OF MATERIAL:Conventional Cores #51, 52, 53, 54 EB Driving Lane
CORES 51&52 1/4 PT. 53 & 54 OWT 51A, 52A, 53A,
54A ARE THE BINDER CORES
SAMPLED BY.....:C. ANDERSON SENDER NO.:ACA1-12
DATE SAMPLED: 11/06/91 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORE	51	SURFACE	2.341	4.6
	52	SURFACE	2.367	3.4
	53	SURFACE	2.367	3.6
	54	SURFACE	2.370	3.1
	51A	BINDER	2.318	6.8
	52A	BINDER	2.328	5.4
	53A	BINDER	2.360	3.6
	54A	BINDER	2.344	5.8

Material: Asphalt Cores Site #1 Lab No. ABE1-0019
Project No: HR-542
County: Jasper
Unit of Material: PAC 40 SBS Cores 55, 56, 57, 58 EB Driving Lane
Cores 55, 56 OWT; 57, 58 1/4 PT.
55A, 56A, 57A, 58A are the Binder Cores
Sampled by: Anderson Sender No.: ACA1-13
Date sampled: 11-6-90 Date received: 2-13-91 Date Reported: 2-21-91

			Density	% Air (HPM)
Core	55	Surface	2.373	3.7
	56	Surface	2.385	3.2
	57	Surface	2.370	4.3
	58	Surface	2.334	--
	55A	Binder	2.306	8.4
	56A	Binder	2.392	3.4
	57A	Binder	2.366	3.3
	58A	Binder	2.355	5.8

COPIES TO:
CENTRAL LAB C. ANDERSON

DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

ooooo

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0015

MATERIAL.....:ASPHALT CORES Site #2
PROJECT NO.....:HR-542
COUNTY.....:CLINTON
UNIT OF MATERIAL: Conventional Cores 35, 36, 37, 38
CORES 35 & 36 1/4 PT., 37 & 38 OWP
35A,36A,37A,38A, ARE THE BINDER CORES
SAMPLED BY.....:STEFFES SENDER NO.:
DATE SAMPLED: 11/15/89 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORE	35	SURFACE	2.324	5.5
	36	SURFACE	2.320	5.7
	37	SURFACE	2.378	3.0
	38	SURFACE	2.370	3.5
	35A	BINDER	2.281	7.2
	36A	BINDER	2.259	7.5
	37A	BINDER	2.336	5.9
	38A	BINDER	2.336	5.6

Material: Asphalt Cores Site #2 ABE1-0014
Project No: HR-542
County: Clinton
Unit of Material: PAC 40 SBN Cores #31, 32, 33, 34, 39, 40, 41, 42
Cores 31, 32, 39, 40 1/4 PT. 33, 34, 41, 42 OWP
31A, 32A, 33A, 34A, 39A, 40A, 41A, 42A are binder cores
Sampled by: Steffes Sender no.: ACA1-08
Date Sampled: 1-15-89 Date received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Core	31	Surface	2.274	7.7
	32	Surface	2.251	8.4
	33	Surface	2.323	5.9
	34	Surface	2.318	5.7
	39	Surface	2.338	4.7
	40	Surface	2.337	4.7
	41	Surface	2.332	5.3
	42	Surface	2.335	5.2
	31A	Binder	2.235	9.3
	32A	Binder	2.217	--
	33A	Binder	2.252	11.7
	34A	Binder	2.290	6.9
	39A	Binder	2.345	4.6
	40A	Binder	2.347	3.9
	41A	Binder	2.318	5.3
	42A	Binder	2.313	5.5

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DISPOSITION:

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

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IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0009

MATERIAL.....:ASPHALT CORES Site #3
PROJECT NO.....:HR-542
COUNTY.....:O'BRIEN
UNIT OF MATERIAL: Conventional Cores #9, 10, 11, 12 WBL - Inside
9 & 10 1/4 PT. 11 & 12 OWP
9A, 10A, 11A, 12A ARE THE BINDER CORES
SAMPLED BY.....:R. STEFFES SENDER NO.:ACA1-03
DATE SAMPLED: 09/25/89 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

CORES	SURFACE	DENSITIES	% AIR (HPM)
9	"	2.345	5.3
10	"	2.365	5.0
11	"	2.342	4.7
12	BINDER	2.329	5.2
9A	"	2.285	6.6
10A	"	2.290	6.0
11A	"	2.280	7.1
12A	"	2.292	6.2

Material: Asphalt Cores Site #3 Lab No.: ABE1-0010
Project no: HR-542
County: O'Brien
Unit of Material: PAC 40 SBR Cores #13, 14, 15, 16 WBL - Inside
Cores 13 & 14 1/4 PT. 15 & 16 OWP 13A, 14A, 15A
16A are the Binder Cores
Sampled by: Steffes Sender No: ACA1-04
Date sampled: 09-25-89 Date Received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Cores	13	Surface	2.231	--
	14	Surface	2.260	8.6
	15	Surface	2.287	--
	16	Surface	2.309	6.8
	13A	Binder	2.329	5.1
	14A	Binder	2.329	5.3
	15A	Binder	2.352	4.3
	16A	Binder	2.340	4.5

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OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0013
MATERIAL.....:ASPHALT CORES Sites #4 & #10
PROJECT NO.....:HR-542
COUNTY.....:POTTAWATTAMIE
UNIT OF MATERIAL:ASPHADUR CORES 25,26,27,28,29,30 EBL; CORES 25,26
27, 1/4 PT.; 28,29,30 OWP; TOP LAYER 1988
25A,26A,27A,28A,29A,30A ARE THE BINDER CORES
SAMPLED BY.....:STEFFES SENDER NO.:ACA1-07
DATE SAMPLED: 09/27/89 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORES	25	SURFACE	2.379	2.6
	26	SURFACE	2.308	5.7
	27	SURFACE	2.290	6.3
	28	SURFACE	2.323	5.3
	29	SURFACE	2.250	8.3
	30	SURFACE	2.368	2.8
	25A	BINDER	2.199	10.2
	26A	BINDER	2.211	7.8
	27A	BINDER	2.205	9.4
	28A	BINDER	2.196	9.4
	29A	BINDER	2.209	10.4
	30A	BINDER	2.198	10.3

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OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0012

MATERIAL.....:ASPHALT CORES Site #5
PROJECT NO.....:HR-542
COUNTY.....:WOODBURY
UNIT OF MATERIAL: Conventional Cores 21, 22, 23, 24 WBL - Outside
CORES #21 & 22 OWP; 23 & 24 1/4 PT.
21A, 22A, 23A, 24A ARE THE BINDER CORES
SAMPLED BY.....:R. STEFFES SENDER NO.:ACA1-06
DATE SAMPLED: 09/26/89 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORES	21	SURFACE	2.380	3.8
	22	SURFACE	2.375	3.3
	23	SURFACE	2.338	5.4
	24	SURFACE	2.340	5.3
	21A	BINDER	2.337	5.0
	22A	BINDER	2.332	5.2
	23A	BINDER	2.318	6.5
	24A	BINDER	2.307	6.5

Material: Asphalt Cores Site #5 Lab No: ABE1-0011
Project No: HR-542
County: Woodbury
Unit of Material: AC-13 Cores 17, 18, 19, 20 WBL - Outside
Cores 17 & 18 1/4 PT., 19 & 20 OWP
17A, 18A, 19A, 20A are the binder cores
Sampled by: Steffes Sender No: ACA1-05
Date Sampled: 09-26-89 Date Received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Cores	17	Surface	2.279	6.2
	18	Surface	2.257	--
	19	Surface	2.287	5.9
	20	Surface	2.311	5.2
	17A	Binder	2.287	6.0
	18A	Binder	2.286	6.1
	19A	Binder	2.274	5.8
	20A	Binder	2.224	--

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IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0023

MATERIAL.....:ASPHALT CORES Site #11
PROJECT NO.....:HR-542
COUNTY.....:WEBSTER
UNIT OF MATERIAL:RALUMAC CORES #67, 68, 69, 70 OWP NB DRIVING
SAMPLED BY.....:STEFFES SENDER NO.:ACA1-16
DATE SAMPLED: 06/17/88 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORE	67	SURFACE	1.955	23.4
	68	SURFACE	2.056	12.8
	69	SURFACE	2.153	15.6
	70	SURFACE	2.115	16.8

Material: Asphalt Cores Site #12 Lab No: ABE1-0020
Project No: HR-542
County: Polk
Unit of Material: PAC 30 SBS Cores 59, 60, 61, 62 SB Driving Lane
Cores 59 & 60 1/4 PT.; 61 & 62 OWT
59A, 60A, 61A, 62A are the binder cores
Sampled by: Anderson Sender No: ACA1-14
Date Sampled: Date received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Core	59	Surface	2.302	5.8
	60	Surface	2.317	5.2
	61	Surface	2.271	7.3
	62	Surface	2.301	5.9
	59A	Binder	2.259	6.8
	60A	Binder	2.293	4.0
	61A	Binder	2.298	3.4
	62A	Binder	2.320	4.4

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IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0017

MATERIAL.....:ASPHALT CORES Site #13
PROJECT NO.....:HR-542
COUNTY.....:STORY
UNIT OF MATERIAL: Conventional Cores 47, 48, 49, 50 NB Driving Lane
CORES 47 & 48 OWT CORES 49 & 50 1/4 PT.
47A, 48A, 49A, 50A, ARE THE BINDER CORES
SAMPLED BY.....:C. ANDERSON SENDER NO.:ACA1-11
DATE SAMPLED: 11/08/90 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

			DENSITY	% AIR (HPM)
CORE	47	SURFACE	2.391	3.9
	48	SURFACE	2.392	4.1
	49	SURFACE	2.390	4.0
	50	SURFACE	2.383	4.8
	47A	BINDER	2.348	6.4
	48A	BINDER	2.392	4.9
	49A	BINDER	2.373	4.4
	50A	BINDER	2.332	6.1

Material: Asphalt Cores Site #13 Lab No: ABE1-0016
Project No: HR-542
County: Story
Unit of Material: PAC-30 SBS Cores 43, 44, 45, 46 Driving Lane
Cores 43, 44 OWT; Cores 45, 46 1/4 Point;
43A, 44A, 45A, 46A are the Binder Cores
Sampled by: ANderson Sender NO: ACA1-10
Date sampled: 11-08-90 Date Received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Core	43	Surface	2.367	5.7
	44	Surface	2.368	5.7
	45	Surface	2.373	5.8
	46	Surface	2.362	5.8
	43A	Binder	2.374	5.3
	44A	Binder	2.369	5.7
	45A	Binder	2.349	6.5
	46A	Binder	2.336	6.7

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IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0007

MATERIAL.....:ASPHALT CORES Site #14
PROJECT NO.....:HR-542
COUNTY.....:O'BRIEN
UNIT OF MATERIAL: Conventional Cores #1, 2, 3, 4 SBL: 1 & 2 OWP; 3 & 4 1/4 PT.
1A, 2A, 3A, 4A ARE THE BINDER CORES
SAMPLED BY.....:R. STEFFES SENDER NO.:ACA1-01
DATE SAMPLED: 09/25/89 DATE RECEIVED: 02/13/91 DATE REPORTED: 03/21/91

		DENSITY	% AIR (HPM)
CORES 1	SURFACE	2.320	5.4
2	SURFACE	2.309	6.1
3	SURFACE	2.311	6.7
4	SURFACE	2.308	6.5
1A	BINDER	2.329	5.5
2A	BINDER	2.319	5.6
3A	BINDER	2.333	5.3
4A	BINDER	2.331	5.7

Material: Asphalt Cores Site #14 Lab No: ABE1-0008
Project No: HR-542
County: O'Brien
Unit of Material: PAC 40 SBR Cores #5, 6, 7, 8 SBL
5 & 6 OWP 7 & 8 1/4 PT.; 5A, 6A, 7A, 8A are the
binder cores
Sampled by: STeffes Sender no: ACA1-02
Date Sampled: 09-25-89 Date Received: 02-13-91 Date Reported: 03-21-91

			Density	% Air (HPM)
Core	5	Surface	2.324	3.5
	6	Surface	2.351	3.5
	7	Surface	2.311	--
	8	Surface	2.328	4.4
	5A	Binder	2.283	6.6
	6A	Binder	2.286	7.0
	7A	Binder	2.314	6.1
	8A	Binder	2.298	6.2

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IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE CORES
LAB LOCATION - AMES

LAB NO....:ABE1-0021

MATERIAL.....:ASPHALT CORES Site #15
PROJECT NO.....:HR-542
COUNTY.....:POLK
UNIT OF MATERIAL:PAC 30 SBS Cores 63, 64, 65, 66 SB Driving Lane
CORES 63 & 64 1/4 PT.; 65 & 66 OWT
63A,64A,65A,66A ARE THE BINDER CORES
SAMPLED BY.....:ANDERSON SENDER NO.:ACA1-15
DATE SAMPLED: DATE RECEIVED: 02/13/91 DATE REPORTED: 02/21/91

			DENSITY	% AIR (HPM)
CORE	63	SURFACE	2.382	3.6
	64	SURFACE	2.314	--
	65	SURFACE	2.402	2.6
	66	SURFACE	2.399	3.5
	63A	BINDER	2.338	5.3
	64A	BINDER	2.399	4.1
	65A	BINDER	2.390	2.9
	66A	BINDER	2.394	3.2

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