PERMEABILITY OF GRANULAR SUBBASE MATERIALS

Interim Report
for
Project MLR-90-4

September 1991

Project Development Division

Iowa Department
of Transportation

Interim Report
for
MLR-90-4

Permeability of Granular Subbase Materials

by

Frank K. Miyagawa
Assistant to the Cement and Concrete Engineer
515-239-1088
FAX: 515-239-1092
Office of Materials
Project Development Division
Iowa Department of Transportation
Ames, Iowa 50010

September 1991

TECHNICAL REPORT TITLE PAGE

1. REPORT NO.	2. REPORT DATE
MLR-90-4	September 1991

3. TITLE AND SUBTITLE	4. TYPE OF REPORT & PERIOD COVERED
Permeability of Granular Subbase Materials	Interim Report, 7-91 to 9-91

5. AUTHOR(S)	6. PERFORMING ORGANIZATION ADDRESS
Frank K. Miyagawa Asst to Cement & Concrete Engr.	Iowa Department of Transportation Materials Department 800 Lincoln Way Ames, Iowa 50010

7. ACKNOWLEDGEMENT OF COOPERATING ORGANIZATIONS

8. ABSTRACT

The purpose of this research was to evaluate the materials Iowa uses as a granular subbase and to determine if it provides adequate drainage.

Numerous laboratory and in-situ tests were conducted on the materials currently being used in Iowa. The following conclusions can be made based on the test results:

1. The crushed concrete that is used as a subbase material has a relatively low permeability compared to many other materials used by other states.

2. Further research and tests are needed to find the necessary parameters for crushed concrete to make sure it is providing its optimum drainage and preventing premature damage of the pavement.

3. We have definitely made improvements in drainage in the past few months, but there are many areas that we can improve on that will increase the permeability of this material and insure that the pavement system is safe from premature damage due to water.

The current gradation specification for granular subbase material at the start of this study was:

Sieve #	% Passing
1"	100
#8	10-35
#50	0-15
#200	0-6

9. KEY WORDS	10. NO. OF PAGES
Permeable base Granular subbase Drainage Drainable bases	71

TABLE OF CONTENTS

DISCLAIMER

ACKNOWLEDGEMENT

I would like to personally thank all of the people who made this research possible. The nature of this research and testing involved coordination and cooperation between many different offices and people.

First, I would like to thank my boss, Champ Narotam, for giving me the opportunity to take over this project and having the confidence in me to get the job done. Also, Kumari Bharil did an excellent job of recording all the results of the work she did before I took over the project.

Wayne Strum was extremely helpful and cooperative in fitting in my requests for tests during the busiest part of the year. Cliff Dalbey was very helpful in obtaining all of the necessary equipment needed to run the field tests.

Reilly Construction deserves recognition for their cooperation in making various changes throughout the project. All of the construction people at the various sites I visited are too numerous to mention by name, but were nonetheless instrumental in helping obtain samples and answering questions about the projects.

Bob Steffes was extremely helpful in conducting tests and making the long trips to projects.

The second is that there is no standard method for measuring the permeability of a granular subbase material in the lab or the field.

The last thing to keep in mind is that the crushed concrete that Iowa uses is very different from the materials many other states use and the properties and behavior of this material are also very different.

These facts are important when discussing permeability because it is difficult to compare permeabilities and properties of materials when different test methods and materials are being used.

PREVIOUS TESTING

Kumari Bharil started this research and conducted many laboratory tests on various materials that Iowa uses for a granular subbase. The lab tests were conducted on a permeameter that was built to ASTM specifications for determining the permeability of materials that had low permeabilities, like soils. The permeability results from those tests and the different gradations are shown in Appendix A, pages 22 and 23.

The results of these tests would indicate that the materials being used in Iowa provide a range of permeabilities that is quite acceptable.

Since there was no standard procedure for measuring the in-situ permeability of a granular subbase material, a procedure was developed to obtain a relative idea of the permeability of the material.

This simple procedure consisted of coring out approximately a 4" diameter hole to a depth of 4"-5", filling the hole with 1 liter of water, and timing how long it took to drain from the hole.

We conducted in-situ tests on projects across the state that used crushed concrete and crushed stone for a granular subbase material. The results of these tests are in Appendix B, pages 29-36. The results from the field tests indicate that the virgin crushed stone material is providing adequate drainage, while the crushed concrete is not draining as well as anticipated.

CEDAR COUNTY PROJECT

We had an excellent opportunity to gather information about permeability on a project on I-80 in Cedar County near Tipton.

An agreement was made with the contractor to make changes in the gradation of the granular subbase material and to evaluate the effects on permeability. The letter and details of the project are in Appendix C, pages 38-43.

significantly at the grade. We conducted gradation tests at the plant and from the field and found that there was a very severe breakdown in the crushed concrete. We attributed the breakdown to handling and over-compacting of the material. The differences in gradation are shown on pages 13-14.

There was also a severe problem with stockpile segregation. The segregation was noticeable just by looking at the stockpile. The results of field tests on pages 28-36 show how much the permeability varied in the same area due to segregation.

In an attempt to prevent breakdown of material and increase permeability, we called for a maximum number of 4 compaction passes with a steel-drummed roller.

Another problem encountered on this project was that the contractor was picking up the old existing subbase material in the removal of the pavement for crushing. This old material was very poor in quality and added fines to the subbase which reduced the permeability.

We made another change in the gradation that should improve the permeability. The change calls for a maximum of 20% passing the #8 sieve. This material is being produced and used on the project. Gradation results of this new material are on page 68. The reports show that the % passing the #8 sieve is

The problem encountered with stockpile segregation is being corrected by monitoring the gradation from the belt before the stockpile and after it leaves the stockpile to insure there isn't any significant differences in gradation.

The construction inspectors are closely monitoring the removal of the existing pavement to make sure the contractor is not picking up the old existing subbase material that would lower the permeability.

RECOMMENDATIONS

Although we have made changes that improve the permeability of the crushed concrete, there is still some additional work that needs to be done. The following are my recommendations for the rest of this research:

1. Determine the compaction requirements that keep the subbase stable and at a density that provides good permeability.

2. Conduct lab tests with the NJFHP and the ASTM device and see how the results compare for similar materials. Hopefully, tests will show a correlation between the two methods and field tests. The NJFHP is a quick and easy device to determine permeability and if it can be proven that it provides valid results and a correlation with the ASTM device, we should look into buying or making these

7. The crushed concrete sets up and becomes very hard after being in place. Cores should be taken down through the subbase and tested to see if the hardened crushed concrete still drains after it sets up.

SUMMARY

There has been many recent changes to improve the permeability of the material used as a granular subbase. We are on the right track for improving the pavement system and need to keep making improvements. Additional tests are needed to finish this research project. Most of the testing should be completed this winter and some additional test conducted next summer.

TABLE TITLES

1. Gradations From I-80 Cedar County - 1" Crushed Concrete
2. Gradations From I-80 Cedar County - 1.5" Crushed Concrete
3. New Jersey Falling Head Permeameter (NJFHP) Results
4. New Jersey Falling Head Permeameter Results 1.5" Crushed Concrete-Scalped, Cedar County, I-80

TABLE 2

GRADATIONS FROM I–80 CEDAR COUNTY

1.5" CRUSHED CONCRETE

STOCKPILE

1.5"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
100	88	72	54	43	29	22	17	13	9.2	6.9	5.5

IN–PLACE

1.5"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
100	94	82	71	59	41	30	23	17	12	9.0	7.0
100	96	90	83	76	64	48	36	27	18	13	10
100	94	88	77	65	47	36	27	21	14	10	8.2

SPEC 10–25 0–15 0–6

TABLE 4

NEW JERSEY FALLING HEAD PERMEAMETER RESULTS

TRIAL	DENSITY (pcf)	PERMEABILITY (K, ft/day)	MATERIAL
1	96	67	1"
2	98	439	1"
3	115	58	1"
4	87	2288	1.5"
5	91	1905	1.5"
6	93	1532	1.5"
7	100	694	1.5"
8	106	443	1.5"
9	111	101	1.5"
10	119	181	1.5"
11	120	43	1.5"
12	121	64	1.5"
13	129	21	1.5"

FIGURE CAPTIONS

1. Permeability Results

APPENDICES

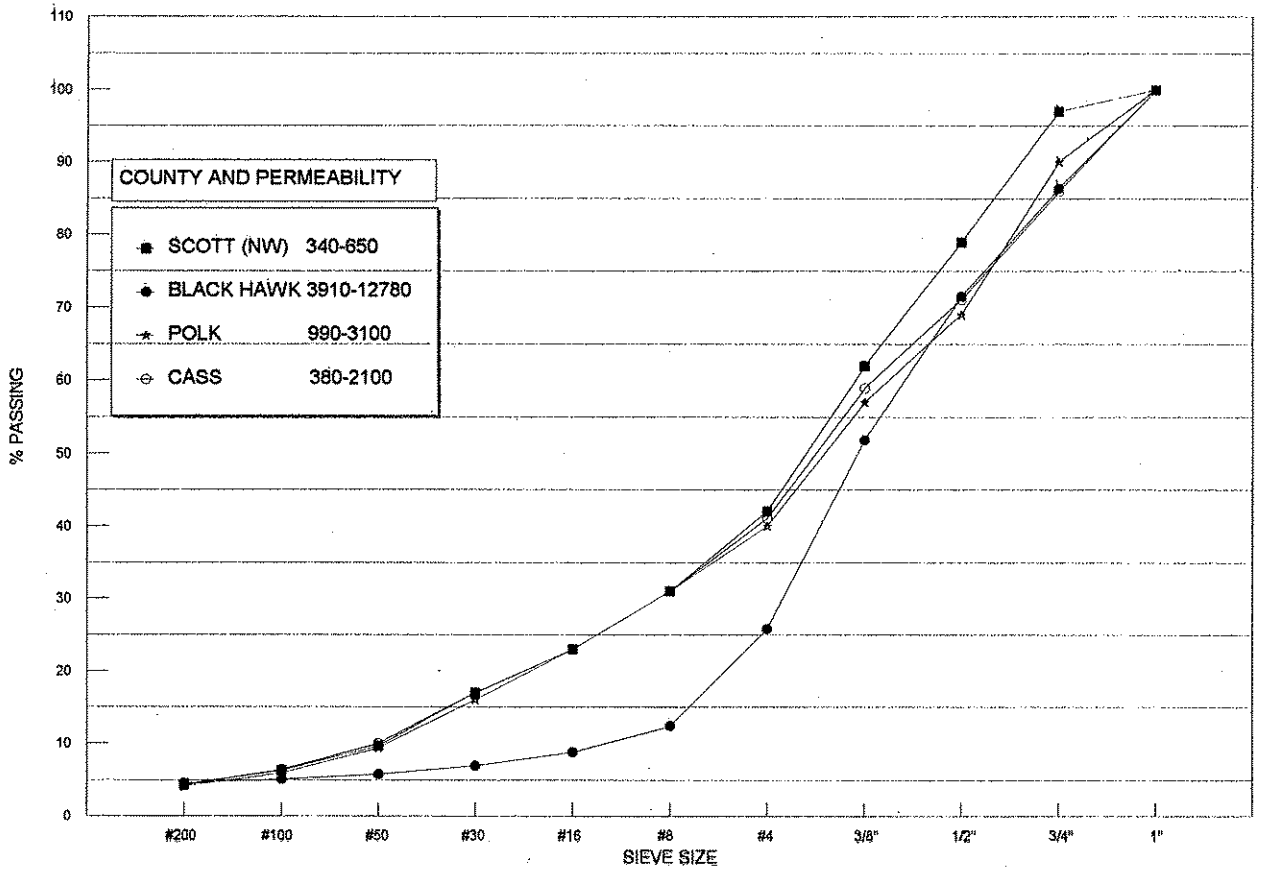
APPENDIX A

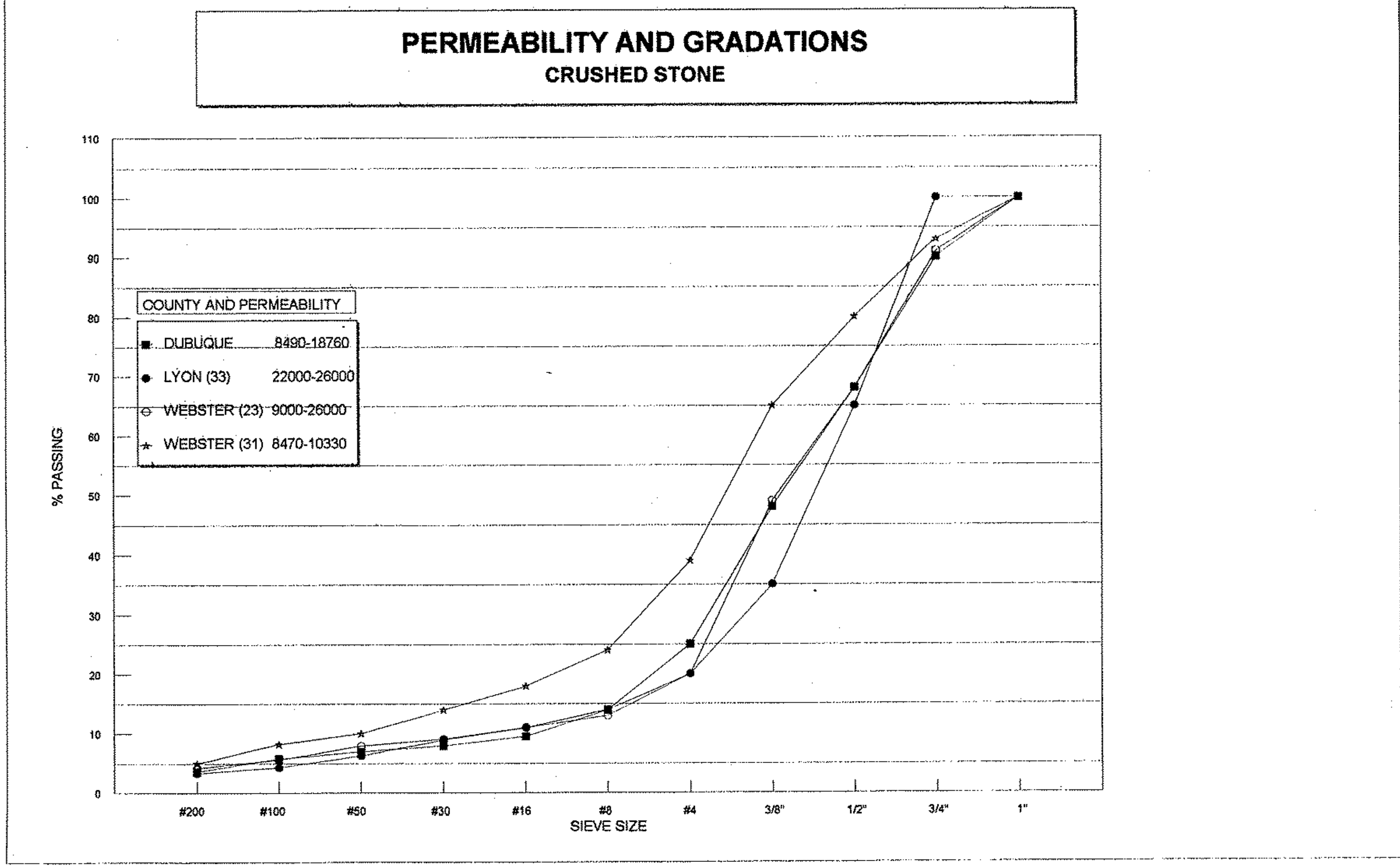
Lab Permeability Results and Gradations

SIEVE #	BLACK HAWK 3910-12780	SCOTT (98) 10340-14280	POLK 990-3100	LYON (25) 200-275	WEBSTER (31) 8470-10330
			PERCENT PASSING		
1"	100	100	100	100	100
3/4"	86.4	100	90	100	93
1/2"	71.5	100	69	96	80
3/8"	51.8	95	57	84	65
#4	25.8	52	40	65	39
#8	12.4	22	31	48	24
#16	8.8	8.9	23	35	18
#30	6.9	5.2	16	22	14
#50	5.8	3.8	9.4	8.4	10
#100	5.1	2.7	6	4.2	8.2
#200	4.5	2.4	4.1	3.5	5

PERMEABILITY AND GRADATIONS

CRUSHED CONCRETE




PERMEABILITY AND GRADATIONS
CRUSHED STONE
% PASSING
0
10
20
30
40
50
60
70
80
90
100
110
COUNTY AND PERMEABILITY
DUBUQUE 8490-18760
LYON (33) 22000-26000
WEBSTER (23) 9000-26000
WEBSTER (31) 8470-10330
#200
#100
#50
#30
#16
#8
#4
3/8"
1/2"
3/4"
1"
SIEVE SIZE

Appendix B

In-situ Test Results

IN-SITU PERMEABILITY RESULTS

DATE TESTED: JULY 2, 1991

PROJECT: I-80

TYPE OF SUBBASE MATERIAL: CRUSHED CONCRETE

LOCATION: CASS CO

TEST NUMBER	PERMEABILITY (K FT/DAY)
1	198
2	35 ***
3	58 ***
4	0 ***
5	58 ***
AVERAGE K	70

*** HOLE DID NOT DRAIN

IN-SITU PERMEABILITY RESULTS

DATE TESTED: JULY 10, 1991
PROJECT: I-80
TYPE OF SUBBASE MATERIAL: CRUSHED CONCRTE
LOCATION: POWESHEIK CO.

TEST NUMBER	PERMEABILITY (K FT/DAY)
1	38 ***
2	58 ***
3	58 ***
4	50 ***
5	9 ***
6	50 ***
7	500
8	280
9	170
10	86
11	115
12	58 ***
13	184
14	109

AVERAGE K **126**

*** **HOLE DID NOT DRAIN**

IN-SITU PERMEABILITY RESULTS

DATE TESTED: AUG 1, 1991

PROJECT: I-80

TYPE OF SUBBASE MATERIAL: CRUSHED CONCRTE 1" MATERIAL

LOCATION: CEDAR CO.

TEST NUMBER	PERMEABILITY (K FT/DAY)
1	38 ***
2	48 ***
3	166
4	105
AVERAGE K	89

*** HOLE DID NOT DRAIN

IN-SITU PERMEABILITY RESULTS

DATE TESTED: AUG 13, 1991
PROJECT: I-80
TYPE OF SUBBASE MATERIAL: CRUSHED CONCRTE 1.5" MATERIAL
LOCATION: CEDAR CO.

TEST NUMBER	PERMEABILITY (K FT/DAY)
1	80
2	70
3	17 ***
4	51 ***
5	1256
6	863

AVERAGE K **390**

*** HOLE DID NOT DRAIN

NOTE:
THERE WAS SEVERE OBVIOUS SEGREGATION
PERMEABILITY MUCH LOWER

Appendix C

I-80 in Cedar County Project

IOWA DEPARTMENT OF TRANSPORTATION

TO OFFICE: District Six Materials

DATE: July 25, 1991

ATTENTION: Roger Boulet

REF. NO.: 435.01

FROM: Bernard C. Brown

OFFICE: Materials Engineer

SUBJECT: Granular Subbase - I-80 Cedar County

As we discussed recently, we are interested in altering the gradation of the granular subbase to enhance the drainability on the above referenced project. Kermit Dirks' July 18, 1991 memo (attached) outlines the plan for an in-place evaluation. I support the plan as does Tom Cackler.

The Central Construction Office will be formally contacting the district to arrange for this test section. The purpose of this memo is to advise you that we should have at least 5 gradation tests on the crushed material going into each of these test sections. If you can get representative samples from the compacted subbase we would like to have 5 gradation tests from each of these sections also.

I'm not sure what the proper way to evaluate permeability should be but at the very least the contractor should be prepared to use a truck to deposit water on each section.

Please keep us advised of the construction schedule so we can be on the scene for the tests.

Please let me know if you have any questions.

BCB:esb
ATTACHMENT
cc: D. A. Anderson
E. T. Cackler
K. L. Dirks

IOWA DEPARTMENT OF TRANSPORTATION

TO OFFICE: District 6

DATE: August 16, 1991

ATTENTION: Bruce Kuehl

REF. NO.: Cedar County
IR-80-7(57)265

FROM: Thomas R. Jacobson

OFFICE: Office of Construction

SUBJECT: Granular Subbase

This letter serves to confirm our telephone conversation this morning and authorize changes in the granular subbase material.

The items to be changed include:

1. The broken concrete pavement is to be passed through a 2" scalper screen prior to crushing. The material passing through the 2" screen is to be wasted.

2. Lower the no. 8 sieve passing requirement to 10-20 percent. The modified gradation will be:

   100 percent passing the no. 1 1/2" sieve

   10-20 percent passing the no. 8 sieve

   0-15 percent passing the no. 50 sieve

   0-6 percent passing the no. 200 sieve

3. The changes will be evaluated after approximately one mile of this material is placed.

TRJ:pc
cc: D. Anderson
M. Burr
R. Boulet
M. Brandl
K. Dirks
J. Lane
D. Mathis, FHWA

cc. B. C. Brown
Marks
Champ
Frank
Jim Grove

8/20/91

File 435.01

Aug 19, 1991

K. Dirks
T. Jacobson
J. Grove
F. Miyagawa
V. Marks
R. Boulet, B. Kuehl
D. Mathis
B. Brown
T. Cockleu

IMPORTANT NOTE

Error Correction

This is to correct an error I made in my note of Aug 16, 1991 about granular subbase road way density. The density from four passes of a static roller should have been 118.5 lbs per cu. ft. instead of 101.2 which I reported. This drops the estimate permeability to something below 50 feet per day.

J. Lane

Appendix D

New Jersey Falling Head Permeameter Procedure

Q-1 COMPACTION OF NON-STABILIZED OPEN-GRADED (NSOG) BASE COURSE MATERIALS

1. Scope

This method of test determines the density of NSOG base course material and outlines the procedure for compaction in preparation for falling head permeability testing.

2. Apparatus

Modified NSOG compaction equipment as shown in Figures 2 and 3.

A Burmister Vibratory Table meeting ASTM D-2049.

Four (4) inch diameter permeability molds with #16 sieve screen.

12 lb. lead surcharge.

A heavy duty scale capable of weighing samples up to 20 Kg. with an accuracy of $\pm$ 1 gram.

A steel ruler with 1/100 of an inch gradations.

A stopwatch capable of 0.1 second accuracy.

3. Procedure

Place the 4 inch diameter mold into the recess of the bottom retainer on the Burmister Table. Secure the retainer to the table with threaded rods and wing nuts.

Weigh out 3.5 lb. of NSOG material and place the sample loosely into the mold and level the surface. Enter the weight of sample into Figure 6.

Place the spacer plate onto the mold and level the surface. Fit the top retainer plate over the threaded rods and cylinder mold.

Secure the top retainer with wing nuts.

Q-2 COMPACTION OF BITUMINOUS-STABILIZED OPEN-GRADED (BSOG) BASE COURSE MATERIAL

1. Scope

This method of test describes the procedure for determining the compacted density of BSOG base course material in preparation for falling head permeability testing.

2. Apparatus

Modified BSOG compaction apparatus as described in Figures 4 and 5 and illustrated in ASTM D-1074.

8.5" high x 4" I.D. steel molds as shown in Figure 5.

A Lancaster mechanical mixer with at least 5 lb. capacity suficient to blend an asphalt cement stone mix.

An Instron Universal testing machine or similar device capable of producing accurate molding pressures up to 2000 psi or 25,000 lbs. total load.

A heating oven capable of heating materials to at least 325°F.

4 inch diameter paper discs.

3. Procedure

Weigh out approximately 5 lbs. of materials for a BSOG mix.

Heat all materials to be blended and the mixing utensils to appropriate temperatures to assure compaction of the mix in the mold at 250°F as follows:

a. Stone to 325°F

b. Asphalt Cement to 275°F

c. Mixing utensils and bowls to 325°F

If BSOG mix has already been batched (samples taken from field), heat the mix to 300°F.

4. Calculations

Measure the compacted density of each BSOG sample as follows:

$$\text{Density} = \frac{W_{\text{sample}}}{V_{\text{sample}}}$$

where:

w = Weight of compacted sample (lbs.) = 3.5 lbs.

$$V = \frac{\text{Height of Sample (in)} \times (12.56\ \text{in}^2)}{1728}$$

5. Report

The densities of five compacted BSOG samples shall be reported on Figure 6, Compaction and Permeability Data Sheet.

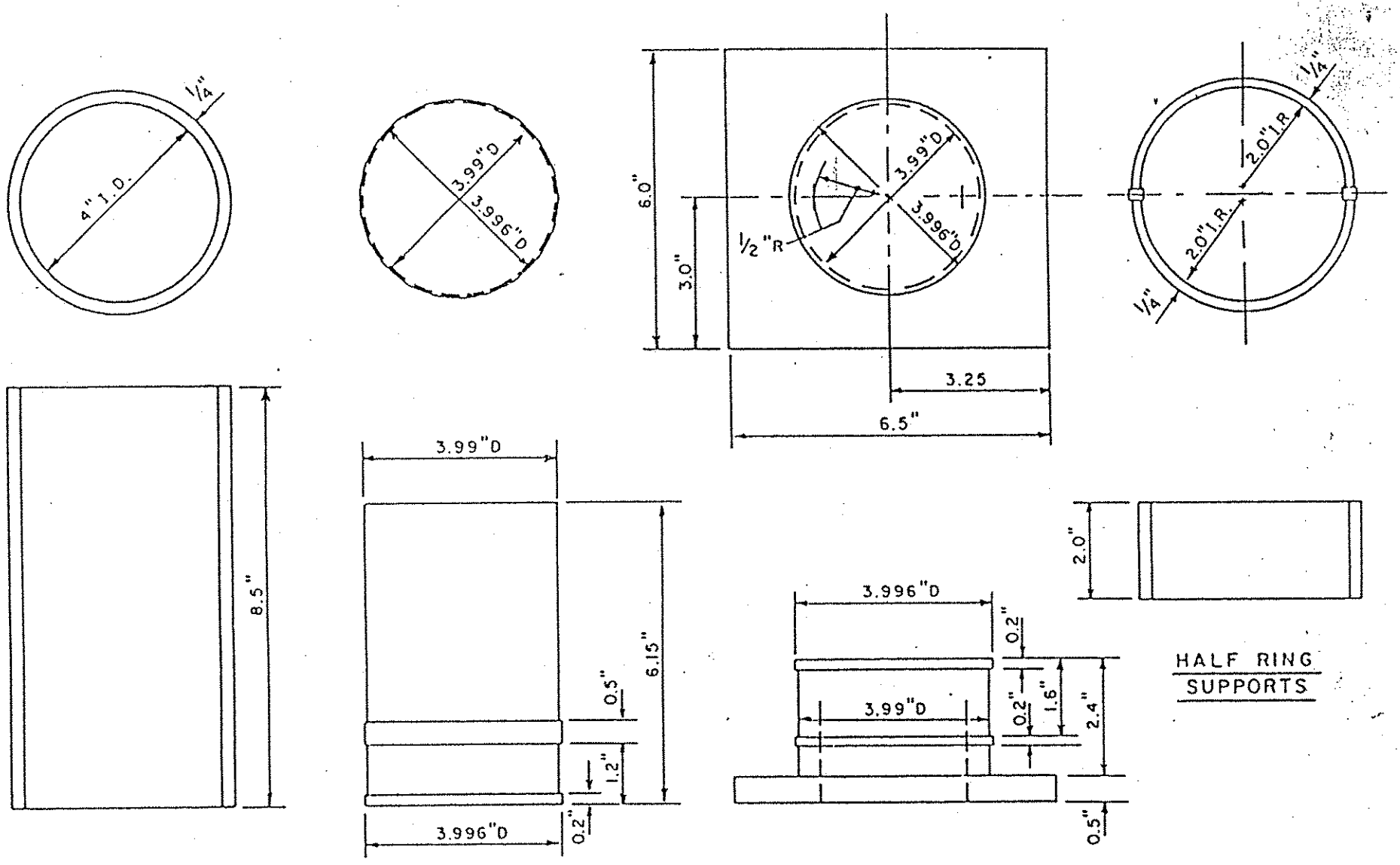


FIGURE 5 BSOG COMPACTION EQUIPMENT ASSESSORIES.

SCALE : 1" = 3"

Place a rubber gasket at the top edge of the cylinder mold.

Place the upper support ring and plastic standpipe on top of the 4" diameter cylinder mold. Lock the upper support ring to the cylinder mold with the wing nuts.

The permeameter is now assembled and ready for permeability testing.

Place the assembled permeameter near the water source and suitable drain.

With the bottom flapgate closed, fill the plastic standpipe to overflowing with water from the cold water tap.

Once the standpipe is overflowing with water, start the permeability flow test by opening the bottom flapgate to allow water to flow through the sample. Start the watch at the time of opening the flapgate.

When the water level in the plastic standpipe reaches the predetermined mark situated 15.75" below the top of the standpipe, stop the watch.

Record the time in seconds on Figure 6, Compaction and Permeability Data Sheet.

Note the compacted height of the NSOG or BSOG sample (L) in inches.

Repeat the permeability test with additional compacted NSOG or BSOG samples for a total of 5 trials.

4. Calculations

Use Figure 6, Compaction and Permeability Data Sheet to calculate the permeability of the open graded materials.

Calculate the falling head permeability (K) as follows:

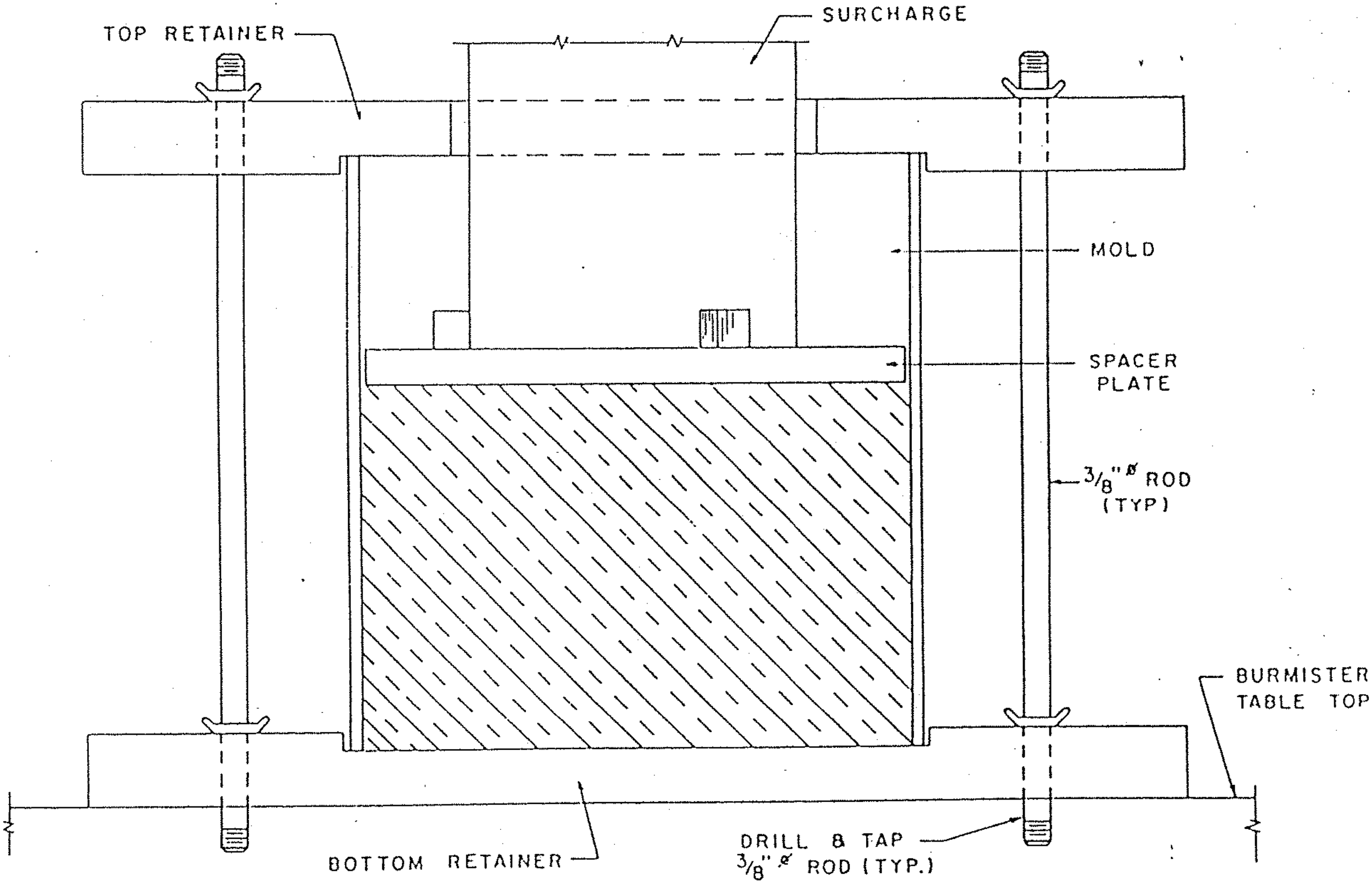


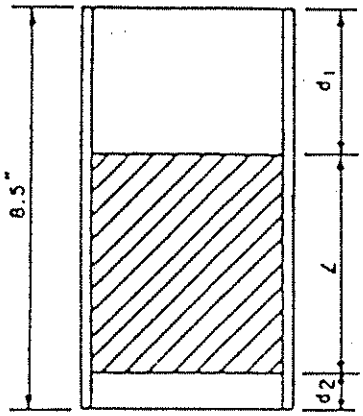
FIGURE "D3 MODIFIED BURMISTER EQUIPMENT ASSEMBLY.
+2

SCALE: 1" = 2"

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND DEMONSTRATION

COMPACTION AND PERMEABILITY DATA SHEET
COMPACTION OF NSOG / BSOG MATERIAL (circle one)

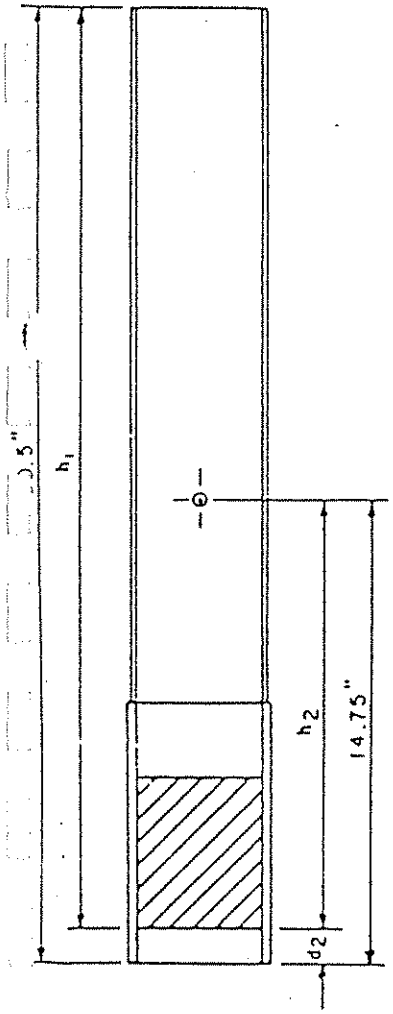
NJDOT SPECIFICATION: _____ SPEC. PERMEABILITY: _____
PROJECT: _____ SECTION: _____ COUNTY: _____
MATERIAL: _____ STONE SIZE: _____
SOURCE: _____ QUARRY: _____



CYLINDER MOLD

DENSITY OF O.G. MATERIALS

Date	d1 (inch)	d2 (inch)	L=8.5 - (d1+d2)	Sample Weight W (lb)	Sample Volume V=12.6L (cu in)	Density $\frac{W}{V} * 1728$ (pcf)



PERMEAMETER

PERMEABILITY OF O.G. MATERIALS

Trials	Time (sec)	h1 = 30.5-d2 (in)	h2 = 14.75-d2 (in)	$\frac{L}{T}$ (in) (sec)	$\ln\left(\frac{h1}{h2}\right)$	$K\left(\frac{L}{T}\right)\left(\frac{h1}{\ln h2}\right) * (7200)$ (ft/day)

GRADATION OF O.G. MATERIALS

	Sieve Size	1.5	1	Ø.5	No. 4	No. 8	No. 16	No. 50	P.I.	
#1	% PASS									
#2	% PASS									
SPEC	% PASS									

ATTACHMENT ONE COPY TO O.R.

Appendix E

MLR-90-4 Reports and Updates

ATTN: Bernie Brown Aug 27, 1991

FROM: Frank Miyagawa

SUBJECT: Summary of I-80 in Cedar Co. project

The following is a brief summary of the work that has been completed on the I-80 project in Cedar County regarding the permeability of granular subbase materials:

SECTION #1

The first mile section of subbase material was the standard 1" top size crushed concrete meeting gradation specification #4121. In-situ and lab permeability tests were conducted and showed that the material did not draining as well as it should have. Gradation tests revealed that there was a significant breakdown of the material from the stockpile to the grade. This first section has been paved over.

SECTION #2

The second section of material was the 1.5" top size material with a change in the maximum percent passing the #8 sieve from 35% to 25%. In-situ and lab permeability tests were also conducted on this material. There was a slight improvement in permeability compared to the 1" material, but the permeability was still relatively low. Gradation reports also showed a significant breakdown of material as with the 1" material.

SECTION #3

The third section of subbase involved a change in construction procedures. A maximum number of 4 passes with a steel-drum roller operating in the static mode or a pneumatic-tired roller was specified. Gradation tests are being conducted to determine if the new procedure decreases the amount of breakdown.

SECTION #4

The fourth section of material was produced with special care in making sure that the old base material from the existing pavement was not disturbed when the pavement was removed. This resulted in a material that kept the % passing the #8 sieve around 20-23%.

SECTION #5

The fifth section of crushed concrete is starting to be produced. This material will have a target of 17% passing the #8 sieve. This will be achieved by scalping the material through a 2" screen to remove some of the fines.

ATTN: Bernie Brown Sept 3, 1991

FROM: Frank Miyagawa

SUBJECT: Permeability Update

Bob Steffes and I traveled to the I-80 project in Cedar County on Aug 28 to obtain samples from the scalped crushed concrete and to conduct in-situ permeability tests.

As of Aug 28, the contractor was producing the new scalped crushed concrete at the plant, but it had not been used yet at the grade. The samples we obtained at the plant were from the belt, so the samples should be representative. In-situ permeability tests were performed on the 1.5" material that was produced without scalping and that was running around 20-25% passing the #8 sieve.

The in-situ test results were slightly better for the material that had the number of compaction passes limited to four. There were still some areas that took over 35 minutes to drain. However, most of the holes did drain. This would indicate that there is some improvement due to the new construction changes.

Laboratory permeability tests were conducted on the stockpile-scalped material. Attached are the results of those tests and a graph comparing the theoretical curves for the scalped vs. non-scalped material. There is significant improvement in permeability at lower densities for the scalped material, but it is clear that as the density approaches 115-120 pcf that there is little difference between the two materials. The in-place-scalped material would most likely have a lower permeability at the grade due to material breakdown. Laboratory tests are being conducted to evaluate the breakdown effects of the new construction procedures.

There was one interesting difference between the two materials. The scalped material was not as dense as the non-scalped material with the same compaction energy. For the standard proctor, the maximum density achieved in the New Jersey Falling Head Permeameter was 123 pcf, with two other samples only at 112 pcf. The maximum density achieved on the first material for a standard proctor was 129 pcf, with most running around 120 pcf. Although the accuracy of determining densities with the permeameter is subject to question, the two materials were compacted under similar conditions and this difference in characteristics is something that should be looked in to further.

There seems to be some improvement in permeability with the new procedures and material. However, it is obvious that the density has a great impact on the permeability of this material regardless of gradation. A possible solution would be to look at specifying a **maximum** density for the crushed concrete. Other

ATTN: Bernie Brown September 18, 1991

FROM: Frank Miyagawa

SUBJECT: Summary of I-80 in Cedar Co. project

The following is a brief summary of the work that has been completed on the I-80 project in Cedar County regarding the permeability of granular subbase materials:

SECTION #1

The first mile section of subbase material was the standard 1" top size crushed concrete meeting gradation specification #4121. In-situ and lab permeability tests were conducted and showed that the material did not drain as well as it should have. Gradation tests revealed that there was a significant breakdown of the material from the stockpile to the grade. This first section has been paved over.

SECTION #2

The second section of material was the 1.5" top size material with a change in the maximum percent passing the #8 sieve from 35% to 25%. In-situ and lab permeability tests were also conducted on this material. There was a slight improvement in permeability compared to the 1" material, but the permeability was still relatively low. Gradation reports also showed a significant breakdown of material as with the 1" material. This section has also been paved over.

SECTION #3

The third section of subbase involved a change in construction procedures. A maximum number of 4 passes with a steel-drum roller operating in the static mode or a pneumatic-tired roller was specified. This section has been paved.

SECTION #4

The fourth section of material was produced with special care in making sure that the old base material from the existing pavement was not disturbed when the pavement was removed and with the change in compaction as section #3. This resulted in a material that kept the % passing the #8 sieve around 20-23%. In place gradation tests showed that the amount of breakdown with this new construction procedure was much less than before. The percent passing the #8 was 25.7 on the sample we obtained.

SECTION #5

The fifth section of crushed concrete is being produced and placed. Gradation tests show that the % passing the #8 is about 17-18% and the % passing the #200 is around 2-4.5%. In-situ tests need to be run and samples need to be obtained. This low amount of fines is being achieved by bleeding off about 12% of the fines after crushing. This is different from the original idea of scalping off material passing a 2" sieve before crushing. The contractor believed scalping over a 2" sieve would result in

Appendix F

Iowa DOT and Production Gradations

Form 821278
2-89

Iowa Department of Transportation

CERTIFIED GRADATION TEST REPORT

County Cedar
Project IR-80-7(57)265--12-16
Contractor Fred Carlson Co.
Contract No. 33011
Design
Date 8/08/91 Report No. D1ML-189-19

☐ Certified Sample
☒ Monitor Sample
☐ Verification Sample

RECYCLED CR. CONC. FROM JUST W. OF THE CEDAR RIVER, EASTERLY TO APPROX. 1/2 MILE EAST OF THE SCOTT COUNTY

Source Name LINE ON I-80 T-203A No. ____ Source Location ____ Sec. ____ Twp. ____ Range ____ County ____

Material Granular Subbase, 1" Class ____ Gradation No. 12 Beds ____

Material Producer Reilly Const. Destination Jobsite Sampled At Recycle Plant and off of Grade

Date Sampled	Sample Identification	Sampled By	Tested By	Sieve Analysis — in.	1 in.	¾ in.	½ in.	⅜ in.	No. 4	Percent Passing No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	Other Test Results			Comp.	Tons
*Production Limits			Max.		100					35			15		6					
			Min.							10			0		0	Sampled at				
7/30	D1RA-91	Lamantia, Wood, McCull	Abbott		100	90	79	68	47	34	25	17	9.3	5.4	3.4		Plant			
7/31	D1JL-121	"	Lowder		100	91	79	65	45	34	24	16	8.5	4.9	3.1		Plant			
7/31	D1JL-122	"	Lowder		100	94	81	66	46	35	27	19	12	8.4	6.2		Grade			
8/01	D1RA-93	Abbott McCull	Abbott	100	99	91	81	70	50	36	27	18	9.6	5.7	3.7		Plant			
8/01	D1RA-94	"	Abbott		100	89	80	71	52	39	30	22	13	8.9	6.6		Grade			
8/02	D1RA-95	Abbott Wood	Abbott		100	87	73	61	43	31	23	15	7.5	4.0	2.2		Plant			
8/02	D1AW-28	"	Wood		100	89	79	67	47	34	26	19	12	8.5	6.4		Grade			
8/02	D1AW-27	"	Wood		100	88	73	61	41	30	22	15	8.0	4.8	3.2		Plant			

Note to County and Resident Engineers—If County or Project Number is incorrect, please notify Inspector and Ames Office Promptly. Corrected Reports will be Issued.

Comments ____

ESTIMATED QUANTITY ____ Tons

TOTAL PREVIOUSLY CERTIFIED ____ Tons

TOTAL CERTIFIED TO DATE ____ Tons

CERTIFICATION NUMBER ____

*AGREED by the contractor/producer

Reported By Harold E McCullough

Representing IDOT

Distribution: White Copy - District Materials Engineer; Canary Copy - Project Consruction Engineer; Pink Copy - Certified Technician; Goldenrod Copy - Area Inspector

69

n°6212
1-76

County Cedar
Project IR-80-7(52)245--12-16
Contract No. C33011
Design
Date 8/3/91
Report No. D13-91

Iowa Department of Transportation

DAILY CERTIFIED GRADATION TEST REPORT

Plant Location Wilton-Cedar Source Location I-80 Sec. Twp. Range County Cedar
Material #2 grav. sub & #30 spec. bkfill Material Producer Reilly Const. Co., Inc. Beds
Contractor Fred Carlson Co. Destination I-80 Sampled at Stream flow mill 7/26-8/2, 1991

Lab. No.	IDENTIFICATION OF SAMPLES		Sieve Analysis — in.	1 in.	¾ in.	½ in.	⅜ in.	No. 4	Percent Passing No. 8	No. 16	No. 30	No. 50	No. 100	No. 200		
*Production Limits		Max.							35			15		6		
		Min.		100					15			–		–		
D88-91	7/26/91			100	84	67	54	36	26	20	14	8.2	5.1	3.5		1500 ton
D89	7/29		(100)	98	88	74	62	44	33	26	19	12	7.7	4.5	non-comp., fixed problem in plant	1500 ton
D90	7/29			100	89	78	66	46	33	25	19	13	8.9	6.2	non-comp., changed operators	1500 ton
D91	7/30			100	87	75	62	42	30	22	16	9.9	6.5	4.4		1500 ton
D92	7/31			100	89	74	60	40	29	21	14	8.4	5.1	3.3		1500 ton
D93	8/1			100	87	77	62	44	31	22	15	8.7	5.0	3.1		1500 ton
D94	8/2			100	86	70	58	40	27	19	13	7.4	4.6	3.1		1500 ton

Note to County and Resident Engineers—If County or Project Number is incorrect, please notify Inspector and Ames Office Promptly. Corrected Reports will be issued.

Comments copies to: Roger Boulet
Harold McCullough
Sue Hotchkiss
Reilly office
C M

*APPROVED by the contractor/producer

(Check One)

ESTIMATED QUANTITY 10,500 {Cu. Yd. / Tons}
TOTAL PREVIOUSLY CERTIFIED — {Cu. Yd. / Tons}
TOTAL CERTIFIED TO DATE 10,500 {Cu. Yd. / Tons}
CERTIFICATION NUMBER 1352
Sampled and Tested By Susan K. Hotchkiss
Representing Reilly Construction Co., Inc.

Distribution: White Copy-Materials Office; Canary Copy-Materials/Engineer; Pink Copy-Resident Construction Engineer/County Engineer; Goldenrod Copy-Certified Technician