



Surface Characteristics Next Generation Grooving and Grinding Iowa Test Site Construction

James K. Cable

Final Report



Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Surface Characteristics Next Generation Grooving and Grinding Iowa Test Site Construction		5. Report Date September 2010	
		6. Performing Organization Code	
7. Author(s) James K. Cable and Paul Wiegand		8. Performing Organization Report No.	
9. Performing Organization Name and Address National Concrete Pavement Technology Center Iowa State University 2711 South Loop Drive, Suite 4700 Ames, IA 50010-8664		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No.	
12. Sponsoring Organization Name and Address Federal Highway Administration U.S. Department of Transportation 400 7 th Street SW Washington, DC 20590		13. Type of Report and Period Covered	
		14. Sponsoring Agency Code	
15. Supplementary Notes Visit www.cptechcenter.org for color PDF files of this and other research reports.			
16. Abstract The National Concrete Pavement Technology Center (National CP Tech Center) has been involved in a surface characteristics project for six years (2004-2010) with the Federal Highway Administration (FHWA) and the American Concrete Pavement Association (ACPA). The objectives of that study are to investigate ways to reduce tire-pavement noise, while retaining surface friction, in both new and aged concrete pavements. Much has been learned about the potential for using grinding methods to reduce noise, while retaining the frictional characteristics of the pavement surface, following the paving of a test section on US 30 in Tama County, Iowa in 2005. A Next Generation Concrete Surface (NGCS), which combines grooving and grinding, was identified, and the National CP Tech Center, in partnership with the International Grinding and Grooving Association (IGGA) and the Iowa Department of Transportation (Iowa DOT), decided to add this technology to the US 30 test site for evaluation. The pavement will now be allowed to accommodate traffic for a period of greater than 30 days to allow both the texture to stabilize and the removal of any remaining residue from the grinding operation. At the end of that time, the three new sections will be tested in the same manner as the adjacent 18 sections to measure the surface characteristics resulting from the construction. This report provides a detailed description of the construction of the three new sections: conventional diamond ground surface, standard ground surface with grooving, and NGCS.			
17. Key Words concrete pavement construction test site—concrete pavement surface characteristics—concrete pavement construction test site—next generation concrete surface—tire-pavement noise—US Highway 30-Iowa pavement test site		18. Distribution Statement No restrictions.	
19. Security Classification (of this report) Unclassified.	20. Security Classification (of this page) Unclassified.	21. No. of Pages 44	22. Price NA

Table of Contents

Table of Figures	vii
Acknowledgements.....	ix
Introduction/Background.....	1
Construction Objectives.....	1
Construction Process	1
Future Actions	4
Appendix A. Construction Photos	A-1
Appendix B. DRAFT - Guide Specification	B-1

Table of Figures

Figure 1. Surface texturing train in place on day one.....	1
Figure 2. Pregrind longitudinal tined surface.....	2
Figure 3. Diamond Products PC-6000 in peration	3
Figure 4. Comparative view of tined and ground surface.....	4
Figure 5. Standard ground surface texture	5
Figure 6. Fine grind head (19 inches).....	6
Figure 7. Diamond Products C-150 machine and tender	7
Figure 8. Typical traffic control for stage one and two construction.....	8
Figure 9. Test surfaces after stage one and two work completed	9
Figure 10. Fine ground surface	10
Figure 11. Tined vs. standard grind vs. fine grind surface	11
Figure 12. Standard grind vs. fine grind surface.....	12
Figure 13. Grooving head (32 inches).....	13
Figure 14. Grooving head (0.75-inch blade spacing).....	14
Figure 15. Next Generation grooved (3/4" c-c blades) and ground surface	15
Figure 16. Next Generation surface (3/4" c-c; 1/4" deep).....	16
Figure 17. View of existing texture, Next Generation, grind and groove and grind only surfaces (milepost 149).....	17
Figure 18. New Next Generation surface test section.....	18
Figure 19. Next Generation detailed surface texture.....	19
Figure 20. Next Generation pavement surface area	20
Figure 21. Ground and grooved surface test section.....	21
Figure 22. Ground and grooved detailed surface texture.....	22
Figure 23. Ground and grooved pavement surface area.....	23
Figure 24. Ground surface test section	24
Figure 25. Ground surface detailed test section.....	25
Figure 26. Ground pavement surface area.....	26

Acknowledgements

The research staff wishes to thank the International Grooving and Grinding Association (IGGA) and the Grinding Division of Manatts, Inc. for their cooperation in the construction of this surface texture section of US 30. Special thanks also goes to the members of the Iowa Department of Transportation (Iowa DOT), Tama County maintenance staff and the Central Administration for their work in the traffic control area and allowing the three test segments to be constructed on an existing pavement. Without all of these partners' cooperation, the activity could not have happened. It is a pleasure to work in a state where all industry partners come together to make research happen.

Introduction/Background

The National Concrete Pavement Technology Center (National CP Tech Center) has been involved in a surface characteristics project for six years (2004-2010) with the Federal Highway Administration (FHWA) and the American Concrete Pavement Association (ACPA). The objectives of that study are to investigate ways to reduce tire-pavement noise, while retaining surface friction, in both new and aged concrete pavements.

In conjunction with a 2005 concrete paving project on US 30 in Tama County, Iowa, a series of 18 test sections of different surface textures were constructed. They included combinations of longitudinal and transverse tining, drag texturing, turf texturing, and one ground surface section.

Since 2005, much has been learned about the potential for using grinding methods to reduce noise, while retaining frictional characteristics of the pavement surface. Following the paving of the test section in Iowa, a Next Generation Concrete Surface (NGCS) that combines grooving and grinding was identified. The National CP Tech Center, in partnership with the International Grinding and Grooving Association (IGGA) and the Iowa Department of Transportation (Iowa DOT), decided to add this technology to the US 30 test site for evaluation.

Construction Objectives

The original objective of this construction was to build two sections of concrete surface that would provide one standard diamond ground surface and one NGCS for testing. Manatts, Inc., the contractor selected for this project, suggested the addition of a third section. This section would combine the standard ground surface with grooving for testing purposes. This suggestion was accepted by the Iowa DOT, IGGA, and National CP Tech Center staff.

Construction Process

The original 2005 surface characteristics project involved the eastbound two lanes of US 30 between a point $\frac{3}{4}$ mile east of the Marshall/Tama county line, easterly from Station 107+00 to Station 152+00 (metric) in Tama County. There existed some 700 meters between the end of these research sections and the end of the project, to allow for addition of the new grinding work. In July, 2010, the Iowa DOT changed the traffic control east of this project for completion of the next four-lane segment. In doing so, there was no longer adequate room for three test sections and traffic control on the 2005 surface characteristics project.

The research team found adequate space in the project just west of the 2005 surface characteristics project. This project was constructed prior to the 2005 project and extended from Stations 88+74.91, easterly to Station 107+00 (metric). A section from Station 100+00 to 106+00 was selected for the grinding test site. This site provided adequate site distance for traffic control and a tangent section of roadway. The roadway is on a +2.6368% grade from west to east.

Three test segments were identified between stations 100 and 106.

Test segment	Station	Surface
One	100+00 to 102+00	Next Generation concrete
Two	102+00 to 104+00	Conventional grind and grooved
Three	104+00 to 106+00	Conventional grind only

The contractor elected to do the work in three stages. The grinding train is shown in Figure 1 with two grinders and the associated water support equipment for Stage one. (All figures are in Appendix A.) Stage one consisted of grinding the entire surface between stations 100+00 and 106+00 to the best profile possible, while also removing much to all of the longitudinal tinning of the existing surface (See Figure 2).

This required the removal of up to ¼ inch of surface depth in some areas. This work was accomplished by the use of a Diamond Products PC 6000 with a 48-inch cutting head (See Figure 3). The pavement cross section consisted of a 4.2-meter (14-foot) driving lane and a 3.6-meter (12-foot) passing lane.

Work began in the outside lane, with the first pass being made adjacent to, but inside, the edge line and rumble strips. Figure 4 illustrates the visual difference in surface texture that comes from the standard grinding head with 18-inch-diameter blades, 0.125 inches in face width, with 0.11-inch spacers between blades. A close view of the finished standard grind surface is seen in Figure 5.

Four passes were made in this lane to complete it and this required that the grinding extend just to the left of the pavement centerline. Three passes were required in the passing lane to cover the area between centerline and the yellow edge line. This left approximately 10 inches between the centerline and the ground surface and 10 inches between the pavement edge and the ground surface. Edge line markings were retained in this operation, but the centerline was partially removed.

The second stage of the work involved the removal of any burrs from the surface with a special head 19 inches long with used 12-inch-diameter blades, 0.123 inches in width, stacked beside each other (no spacers) as seen in Figure 6. The worn blade faces allowed for a spacing of 0.004 inches between cutting surfaces. This was accomplished with a Diamond Products Model C-150 that worked immediately

behind the larger machine (See Figure 7). This work was done only on the segment one surface (station 100+00 to 102+00).

The work on stage one and two progressed across the driving lane until complete. A view of the traffic control used for this work is seen in Figure 8. When the driving lane stages one and two were completed, the equipment was loaded and removed from the work area to allow the Iowa DOT to switch the traffic to the driving lane from the passing lane.

Work continued in the passing lane in the same manner as the driving lane with grinding beginning at the outer edge and moving to the centerline. Grinding was accomplished with the same machines working in the same areas as was the case in the driving lane.

All of stage one and two work was completed between 8:05 a.m. and 7:30 p.m. Traffic control was removed by 8 p.m. on August 16, 2010. The finished product of stages one and two are shown in Figures 9 and 10, with the overall and close-up views of the diamond ground (standard and fine) surfaces. The change in surface texture from the longitudinal tinning to a finely ground surface obtained in stages one and two is illustrated in Figures 11 and 12.

Stage three involved switching out the 19-inch head on the C-150 machine for a 32-inch head that contained the new 12-inch diameter grooving blades with a 0.125-inch face width, spaced 0.75-inches, center to center of blade (See Figures 13 and 14). The cutting depth was established at 0.25-inches and checked with a tire tread gage. The same blade configuration was used for the NGCS and the standard longitudinal grooving segment.

This work began and was completed by 6:30 p.m. on August 17, 2010. The finished NGCS is illustrated in Figures 15 and 16. A view of the completed three-section project is shown in Figure 17, with the existing longitudinal tining texture in the foreground and the three test sections in the distance, to the top of the hill.

The detailed view and pavement lane surface for each finished product of this work are best illustrated in the Figure 18-26 photos:

Figures	Illustrate test section
18-20	NGCS
21-23	Conventional ground and grooved
24-26	Conventional ground

Slurry from the grinding and grooving operations was deposited in the outside ditch and median areas as the work progressed along the project length.

The test segments, as developed, do not expressly meet the NGCS guide specifications that have been developed by the ACPA and the IGGA (See Appendix B). Those guide specifications were not used on this project and are included in the appendix for information only. Final specifications for NGCS are yet to be developed.

The main differences between the guide specification and the US 30 construction relate to the texture on the “land” and the spacing and depth of the groove. The guide specification indicates a spacing of $\frac{1}{2}$ to $\frac{5}{8}$ inches with a depth of $\frac{1}{8}$ to $\frac{3}{16}$ inches. This project developed $\frac{1}{4}$ -inch deep grooves and $\frac{3}{4}$ -inch spacing. Testing will determine if there are significant differences in surface characteristics attributable to these minor differences.

Future Actions

The pavement will now be allowed to accommodate the US 30 traffic for a period of greater than 30 days to allow both the texture to stabilize and the removal of any remaining residue from the grinding operation. At the end of that time, the three sections will be tested in the same manner as the adjacent 18 sections to measure the surface characteristics resulting from the construction.

Appendix A. Construction Photos



Figure 1. Surface texturing train in place on day one



Figure 2. Pregrind longitudinal tined surface



Figure 3. Diamond Products PC-6000 in peration



Figure 4. Comparative view of tined and ground surface



Figure 5. Standard ground surface texture



Figure 6. Fine grind head (19 inches)



Figure 7. Diamond Products C-150 machine and tender



Figure 8. Typical traffic control for stage one and two construction



Figure 9. Test surfaces after stage one and two work completed



Figure 10. Fine ground surface



Figure 11. Tined vs. standard grind vs. fine grind surface



Figure 12. Standard grind vs. fine grind surface



Figure 13. Grooving head (32 inches)

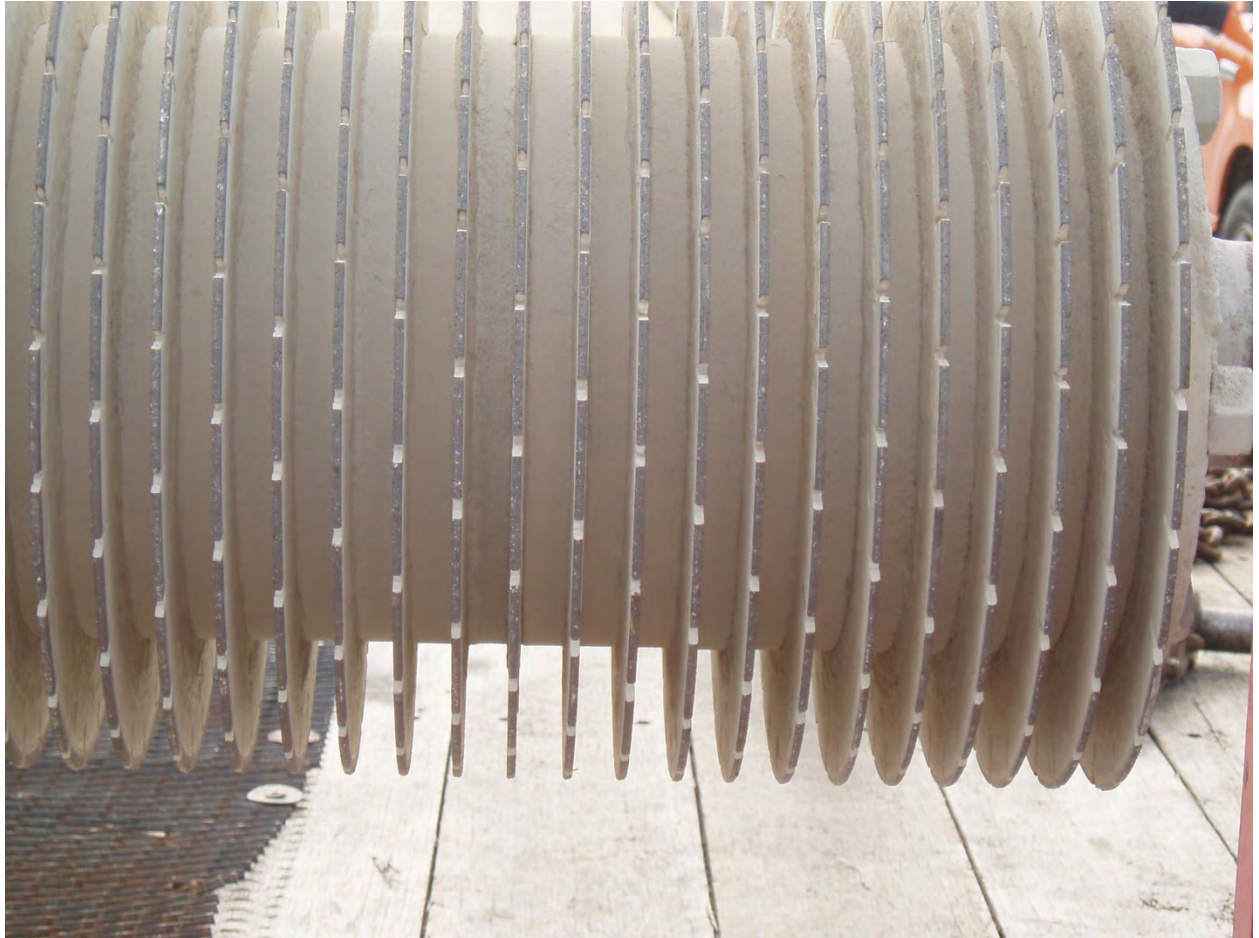


Figure 14. Grooving head (0.75-inch blade spacing)



Figure 15. Next Generation grooved (3/4" c-c blades) and ground surface



Figure 16. Next Generation surface (3/4" c-c; 1/4" deep)



Figure 17. View of existing texture, Next Generation, grind and groove and grind only surfaces (milepost 149)



Figure 18. New Next Generation surface test section



Figure 19. Next Generation detailed surface texture



Figure 20. Next Generation pavement surface area



Figure 21. Ground and grooved surface test section



Figure 22. Ground and grooved detailed surface texture



Figure 23. Ground and grooved pavement surface area



Figure 24. Ground surface test section



Figure 25. Ground surface detailed test section



Figure 26. Ground pavement surface area

Appendix B. DRAFT - Guide Specification

Next Generation Concrete Surface Texture

This guide specification was not used during this project. It is included as general information only.

DESCRIPTION -

This work consists of constructing a Next Generation Concrete Surface (NGCS) texture utilizing diamond grinding and grooving on an existing Portland cement concrete pavement. This test section will aid the industry in developing a new standard for quiet concrete pavement and to that end this specification includes additional controls and safeguards to ensure proper construction.

REQUIREMENTS -

A. Equipment - Grinding shall be done utilizing diamond blades mounted on a self-propelled machine designed specifically for diamond grinding and texturing pavement. The equipment shall weigh a minimum 40,000 lbs (grinding head included) and be of a size that will grind a strip at least 4 feet wide in a single pass. Grinding equipment that causes ravels, aggregate fractures, spalls, or disturbance to the transverse or longitudinal joints shall not be permitted. The equipment shall have a positive means of vacuuming the grinding residue from the pavement surface and will leave the pavement in a clean condition.

B. NGCS Construction – The construction of the NGCS can be accomplished as a single pass or two-pass operation as determined by the contractor. The existing pavement shall be pre-ground over the entire surface with a conventional diamond grinding process (e.g. 125 blades and 110 spacers for example). The NGCS surface will be constructed after the pre-grinding has been completed. The pre-grinding must remove 100% of the existing surface texture on 98% of the pavement surface area. The construction operation shall be scheduled and proceed in a manner that produces a neat, uniform finished surface. A conventional diamond ground feather pass will be required on adjacent shoulders and ramps to maintain a consistent cross slope and ensure pavement surface drainage. The contractor shall provide a single lane test grind of 500 ft in length to demonstrate that the equipment and procedures are capable of attaining the desired surface. The contractor will not be allowed to proceed any further until the test grind has been approved in writing by the Department of Transportation.

Single-pass operation. – The construction operation will provide a flush ground surface that contains longitudinal grooves and shall be constructed in one, single-pass operation. The diamond blade stack will consist of two types of diamond grinding blades arranged to provide a flush ground surface as well as those required to produce the longitudinal grooves. The diamond blade stack shall be mounted on a 4 ft grinding head, stacked with 0.125 blades separated by 0.03 inch spacers. The blades used to produce the flush grind surface should be flat across with other flush grind blades (excluding grooving blades) when mounted. The complete head when stacked with all blades should be straight across its length without bowing when mounted on the diamond grinding machine. The grinding shall eliminate joint or crack faults and will provide lateral drainage by maintaining a constant cross slope between grinding passes in each lane. The cross slope of the pavement shall be as shown on the plans and shall have no depressions or misalignment of slope greater than 1/8 inch in 12 feet when measured with a 12-foot straightedge placed perpendicular to the centerline. Areas of

deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area. Grinding shall begin and end at lines normal to the pavement centerline at the project limits. No unground surface area between passes will be permitted. The blades used to create the longitudinal grooves will be 0.250 inches to 0.376 inches taller in diameter than the grinding blades used to create the flush ground surface. The longitudinal grooves will be spaced among the flush grind blade stack approximately 0.5 inches center to center. The grooves shall be constructed parallel to the centerline. The contractor shall use a guide to ensure proper alignment of the grooves to centerline.

Two-pass operation – This construction method will allow for two separate operations to construct the NGCS section. The first operation will create the flush ground surface. The flush grind blades shall be mounted on a 4ft grinding head, stacked with 0.125 blades separated by 0.030 spacers. The flush grind head shall be flat across the blades when mounted on the diamond grinding machine with no bowing of the head. The grinding shall eliminate joint or crack faults and provide lateral drainage by maintaining a constant cross slope between grinding extremities in each lane. The cross slope of the pavement shall be as shown on the plans and shall have no depressions or misalignment of slope greater than 1/8 inch in 12 feet when measured with a 12-foot straightedge placed perpendicular to the centerline. Areas of deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area. Grinding shall begin and end at lines normal to the pavement centerline at the project limits. No un-ground surface area between passes will be permitted. The second operation will provide the longitudinal grooves. The longitudinal grooves shall be 0.125 inches wide and will be 0.125 inches to 0.188 inches deep. The longitudinal grooves will be spaced approximately 0.5 inches center to center. The grooves shall be constructed parallel to the centerline. The contractor shall use a guide to ensure proper alignment of the grooves to centerline.

C. Final Surface Finish – The NGCS grinding process shall produce a pavement surface that is true to grade and uniform in appearance with a longitudinal grooved texture. The flush ground surface shall appear smooth and shall contain no ridges that exceed 0.03 inches. The longitudinal grooves shall be constructed parallel to the centerline. At a minimum 98% of the pavement surface shall be textured utilizing the NGCS. Depressed pavement areas due to subsidence, edge slump or other localized causes will be excluded from this requirement when approved by the engineer. The final surface will look similar to the photo in Appendix A

D. Slurry Removal - The contractor shall remove and dispose of all residue from the pavement surface in a manner and at a location to satisfy environmental regulations. Residue discharge/collection locations should be predetermined and specified by the contracting authority in the project documents on a job-by-job basis (side slope discharge vs. hauling and disposal). The contractor shall have the engineer's approval for the method of spreading and disposal of the residue prior to beginning any grinding operations.

Solid residue shall be removed from the pavement surface before any residue is blown by traffic action or wind. Residue shall not be permitted to encroach on open lanes. The residue shall not enter into gutters or closed drainage systems. Erosion control items that help prevent slurry discharge into drains and culverts (etc.) should be included within the spec to assure that uncontrolled slurry releases are prevented. These should be included as pay items.

The contractor may disperse residue onto unpaved shoulders, adjacent roadside embankments, or median ditch areas of divided highways where the residue runoff can percolate into the soil, unless specified otherwise in the contract.

Discharge of any residue runoff shall not flow into adjacent rivers, streams, lakes, ponds or other open bodies of water. Residue shall not be spread within 100 feet of any streams, lakes or other open bodies of water, or within 15 feet of a water filled ditch.

Grinding residue disposal requirements must be enforced vigorously and consistently.

E. Smoothness Requirements

An initial profile index of representative portions of the pavement will be available through the project contact person upon written request. This information represents a summary of conditions found to exist at the time the survey was made. This information is provided to give the contractor an idea of the condition of the pavement in regard to smoothness when bidding on this work. The contractor assumes the risk of error if the information is used for any purpose other than the intended purpose.

Each segment of the finished NGCS shall have a final profile with an International Roughness Index (IRI) of 60 inches/mile or less.

The profile testing shall be conducted in both wheel paths and the results averaged for the lane acceptance. Profile testing will be conducted at 0.1 mile intervals. The engineer may test for smoothness and bumps near the center line and at other spot locations where compliance is questionable. Additional grinding may be required.

The finished ground surface shall not include any bumps exceeding 0.3 inch in 25 feet. Depressed pavement areas due to subsidence, edge slump or other localized causes will be excluded from testing when approved by the engineer.

F. Example of the Next Generation Concrete Surface



