A FIELD INVESTIGATION OF THE INFLUENCE OF TEXTURE ON RIDE QUALITY MEASUREMENTS

Bernard Igbafen Izevbekhai
Research Operations Engineer
Minnesota Department Of Transportation
1400 Gervais avenue, Maplewood MN 55109
Phone : 651 366 5454
Fax: 651 366 5461
Email bernard.izevbekhai@dot.state.mn.us

Corresponding Author: Bernard Igbafen Izevbekhai
Word Count 4211
Number of tables 4
Number of Figures 7
ABSTRACT
Prior to 2003 Minnesota Department of Transportation specified ride quality in the 2/10ths inch (2.5mm) blanking band. Application of this specification to many construction projects resulted in some undesirable riding conditions such as chatter that could not be penalized. To solve this problem, the department decided to change to a Zero blanking band en-route an international Roughness index (IRI) Specification. Contractors expressed concern that the zero blanking band may result in strict penalties since texture effects on ride measurement had not been quantified.

This investigation created un-textured strips between astro-turf textured finished strips on a paving project on US trunk Highway 212 between Olivia and Bird Island. A lightweight profiler and a California profilograph were used to measure ride quality, on each strip before and after joint-establishment. Further measurements were done on the surface after diamond grinding.

Results showed consistent deviation of 10 to 20 inches per mile of IRI between the textured and un-textured strips. The diamond ground surface was consistently lower than the un-textured surface by 5 inches per mile. A ProVAL Power spectrum density analysis showed similar high preponderant wavelengths attributed to joints and string lines but a myriad of low wavelength features associated with texturing and the texturing process. A better understanding of the influence of texture on ride measurements facilitates better specification for pavement smoothness and a more realistic incentive and disincentive algorithm.

INTRODUCTION
In his Federal Highway Report, Swanlund (1) stated that people want smooth pavements. Karamihas and Sayers (2) elucidate the use of blanking bands as filters in Profile Index (PI) measurements. In addition to meeting the comfort level of the users, pavement smoothness serves as a good evaluation tool for pavement performance. Most pavement defects including those of high severity and extent caused by loads and environment affect ride quality. Pavement smoothness is therefore a key factor in determining and measuring user satisfaction.

Minnesota Department of Transportation (Mn/DOT) and many State Departments of Transportation, use incentive programs to encourage smooth pavements. These are continuously refined with increasing knowledge of pavement profilometry. A study performed by the Smith et al (3) for NCHRP (Report I-31 1999) correlated increase in service life to various percentage improvements in ride quality. The study showed that a set of Portland cement concrete (PCC) sections in Alabama experienced increases of 11%, 28% and 56% respectively in service life for 10%, 25% and 50% increase in ride quality. Minnesota PCC experienced 6%, 15% and 30% increase in service life with the respective ride quality improvements. The NCHRP study concluded inter-alia, that ride improvement results in extended service life and that a pavement with an initially high ride quality will experience a slower rate of deterioration. Karamihas et al (8) explored the catenary of pavement stringlines and performed sensitivity analysis for the various catenary configurations and deduced that loose stringlines lead to remarkable increase in initial road roughness. Regular post construction monitoring has accentuated this phenomenon in the incentive algorithm made no provision for the chatter phenomenon though the overall smoothness was within acceptable limits.

Many other researchers have investigated various effects of surface characteristics on measured ride quality. Wilde, Izevbekhai and Krause (5) observed many ERD files in Minnesota during an implementation project from Profile Index to International Roughness Index. They observed effects of Joints / panels (16 ft wavelength) effects of the transversely traveling finisher 5 ft wavelength and the
effect of the 25 ft wavelength. In their Paper (8) they quantified the relative effects of these sources of measured roughness, comparing the PI versus the IRI. In either case there was remarkable influence of these three laser perceived roughness sources.

1.2 Response To Texture Joints and Pavement Irregularities
ASTM E –867 defines pavement smoothness as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the comfort level of the user). Roughness is an important pavement characteristic because it affects ride quality vehicle delay costs, fuel consumption and maintenance costs. Roughness features are transmitted to the driver who receives them in the tactile or visual path as roughness. Such vibrations are in the frequency range of 0 to 25 Hz. When frequencies are in the range of 25 to 20000 Hz, they can be received in the aural path as Noise. The human auditory system can perceive a frequency range of 500 to 8000 Hz. Ride is actually first received in the frequency domain and is translated in the spatial domain. A flow chart of the mechanism of a roughness is shown in Figure 1 below,

Kulakowski and Wambold (3) explained that frequency response of profilers is not uniform across wavelengths. The attenuation of certain resonant frequencies and the amplifications of others may then explain why minor surface finishing characteristics may have measurable effects on ride. Kulakowski and Wambold (3); Sayer and Karamihas (4), agree that an ideal profiler must exhibit uniform response to wavelengths between 2 ft and 32 ft. Kulakowski and Wambold (3) stated that the true response of a profiler is not uniform in practice.

Kulakowski and Wambold (3) explained that frequency response of profilers is not uniform across wavelengths. The attenuation of certain resonant frequencies and the amplifications of others may then explain why minor surface finishing characteristics may have measurable effects on ride. Kulakowski and Wambold (3); Sayer and Karamihas (4), agree that an ideal profiler must exhibit uniform response to wavelengths between 2 ft and 32 ft. Kulakowski and Wambold (3) stated that the true response of a profiler is not uniform in practice.

Fig 1 Schematics of Response devices

1.3 The Ride-Texture Problem And Study Objectives
Public agencies ensure that the public rides safely on pavements. Consequently, a pavement is expected to satisfy minimum safety requirements against skidding particularly in wet conditions where friction is reduced. To provide this safety levels, pavements are specified to be finished to a required level of texturing. The Minnesota Department of Transportation specifies a standard finishing Texture for Concrete Pavements. This is a texture of 1mm to 2 mm obtained by dragging an astro-turf carpet behind the paver. It is measured by the sand patch test According to ASTM E –965 (95) Technique for measuring texture by the sand volumetric method. Like many states in the union, Mn/DOT applies a 2/10ths blanking band to the measurement of ride. Blanking bands are arbitrarily chosen and are neither correlated to Standard profiler parameters nor derived from optimization processes. A non-zero blanking band hides
roughness irrespective of the cause and is therefore not encouraged by pavement Engineers but was grandfathered into most state DOT specs. Gradually States moving towards the IRI and PI of zero blanking bands encountered resistance from the contractors who are concerned with texture and joint effects.

Study objectives were:

a) To determine the effects of texturing on measured roughness.
b) To determine the effects of joints on measured roughness
c) To detect any paving operation or routine that also misrepresent true roughness.

2 TEST SECTION AND CONSTRUCTION PROCESS
THE USTH 212 Unbonded Overlay Project. Mn/DOT state project SP 6511-32 was located in Mn/DOT District 8 specifically between Hector and Bird Island. The existing roadway was a 4 lane jointed plain concrete pavement that had showed signs distress. In addition to rehabilitating these distresses, current traffic levels on TH 212 required increased pavement capacity. Two options that were explored were dowel bar retrofit, Bituminous-overlay and bonded-concrete overlay. The bonded overlay was finally chosen after considering distress types, intensity and severity in addition to anticipated traffic loads.

This state project was a suitable candidate to facilitate creation of an untextured strip adjacent to a textured strip in the same paving operation. This was a rural 4-lane divided highway that provided the necessary atmosphere for testing. Mn/DOT Office of Materials and Concrete Paving Association of Minnesota Mn/DOT District 7 as well as the Contractor Progressive Construction Industries, (PCI) and Duinick Brothers cooperated to facilitate the study. These factors influenced the choice of TH 212 as the site for this study.

2.1 Surface Texturing and Measurement of Ride
To measure roughness at the time of evaluation of smoothness in the project the test area was chosen as a 1850 –ft strip of the southbound lane. To minimize variability, a textured and an untextured segment were taken from the same paving operation and specifically from the same lane. Paving was done with a 24-ft paver to which an Astroturf drag set –up was attached to facilitate texturing in the same process as shown fig 2. The Astro turf was uniformly loaded to ensure full contact with plastic concrete and to assure that the dragging effect would cause the surface to be textured.
Figure 2. Indentation of a 3.5 ft of the inverted turf resulted in an untextured strip when the uniformly loaded turf was dragged longitudinally.

To create an untextured zone, a 3.5 ft strip was indented in the turf. That indented strip retained the smooth finish of the paver and was therefore untextured and to distinguish it from the textured section was described as smooth (texture). The next day, Mn/DOT and the contractor separately performed the first series of pavement ride evaluation, using the LISA Light weight Profiler and the 25 ft trussed California profilograph respectively. The profilograph runs were recorded as S1 S2 and S3 series and R1 R2 and R3 series. Subsequently, 3/8” joints were cut at 15-ft intervals for standard concrete panels. To study the effects of joints Profilograph runs were made on the textured and untextured strips with joints cut. Profile runs on the smooth (untextured) jointed sections and rough (Textured) jointed sections were recorded as SJ series: SJ1 SJ2 SJ3 and the RJ series RJ1 RJ2 RJ3.

Using ASTM 965. Mn/DOT conducted a sand patch test in the project area. An average of the texture was determined and recorded. To determine a texture reading on the smooth section was not feasible because a bounded spread of the glass beads was not possible. Moreover, the ASTM standard E-965 procedure could not measure the untextured pavement surfaces. Prior to opening the roadway to traffic, the smooth section had to be textured in order to provide friction. Technically, with the concrete already hardened, texturing was achieved by diamond grinding. After the untextured strip was ground, the ride was measured in series DG1 DG2 and DG3.

The two profilers were set to measure Profile Index using the required filter settings. These include the zero blanking band and 0.2 blanking band as well as default scallop setting and the 3rd order Butterworth filter. The measurements were done at the prescribed speed of 8-12 mph for the Lightweight profiler and at the walking speed of the California profilograph. The measuring laser of the lightweight profiler was aligned at the midline of the 3.5 ft strip of untextured pavement. This is different from the traditional measurement at the right wheel path of the lane of travel pavement in program delivery.

The two equipment were set to measure in Profile Index using the required filter settings. The lightweight profiler was also set to record IRI in addition to PI and RN.

To study the amplitudes caused by texturing, a profile plot for each measured profile was plotted with the Federal Highway Administration’s ProVAL program. The plots were also analyzed with the Power
Spectrum Density component of the ProVAL program in order to detect significant frequencies and wavelengths contributing to the measured ride quality. The acceleration PSD and the amplitude PSD were further investigated to study the wavelengths in some of the profiles and observe the preponderant frequencies in relation to the texturing or paving operation.

**Figure 3: California Profilograph and Mn/DOT Lightweight Profiler on TH 212 Project SP 6511-32.** Excess scrapings from the abrasive turf action coalesces with the pavement and adds to localized bumps. They are usually swept out as much as practicable before ride measurements. In practice the Snowplows remove the scrapings first snowfall in Minnesota.

### 3.0 RESULTS AND ANALYSIS

The results of profiler / profilograph tests are the profile indices obtained for the textured versus untextured sections before and after joints were cut at 15-ft spacing and for the diamond ground sections. The analyses of these values by blanking band adjustment and by (PSD) analysis are also discussed. Comparisons of results from the different equipment POWER Spectrum Density and from the different surface finishing are enunciated.

### 3.1 Result Tables and Profilograms.

Table 1 is a summary of all the profile runs conducted in the test sections. The test record carries a date entry as the first 3 digits
### TABLE 1 RESULTS OF PI AND IRI OBTAINED IN TEXTURED & UNTEXTURED STRIPS

<table>
<thead>
<tr>
<th>TEST #</th>
<th>RECORD #</th>
<th>DATE</th>
<th>SURFACE DESCRIPTION</th>
<th>PI (0.2-bb)</th>
<th>PI (0.2-bb)</th>
<th>PI (0-bb)</th>
<th>Texture Delta</th>
<th>Joint Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>924CSP1</td>
<td>9/24/2002</td>
<td>Untextured</td>
<td>17.57</td>
<td>46.26</td>
<td>3.98</td>
<td>16.60</td>
<td>0</td>
</tr>
<tr>
<td>S2</td>
<td>924CSP2</td>
<td>9/24/2002</td>
<td>Untextured</td>
<td>17.67</td>
<td>45.25</td>
<td>3.97</td>
<td>18.40</td>
<td>0</td>
</tr>
<tr>
<td>S3</td>
<td>924CSP3</td>
<td>9/24/2002</td>
<td>Untextured</td>
<td>17.40</td>
<td>45.55</td>
<td>3.98</td>
<td>19.10</td>
<td>0</td>
</tr>
<tr>
<td>R1</td>
<td>924CRP1</td>
<td>9/24/2002</td>
<td>Textured</td>
<td>26.43</td>
<td>54.01</td>
<td>3.97</td>
<td>23.30</td>
<td>1</td>
</tr>
<tr>
<td>R2</td>
<td>924CRP2</td>
<td>9/24/2002</td>
<td>Textured</td>
<td>24.74</td>
<td>51.85</td>
<td>3.68</td>
<td>24.70</td>
<td>0.10</td>
</tr>
<tr>
<td>R3</td>
<td>924CRP3</td>
<td>9/24/2002</td>
<td>Textured</td>
<td>26.60</td>
<td>56.86</td>
<td>3.67</td>
<td>23.10</td>
<td>0.20</td>
</tr>
<tr>
<td>S4</td>
<td>924CSP4</td>
<td>9/24/2002</td>
<td>Untextured + Joints</td>
<td>18.80</td>
<td>45.56</td>
<td>3.97</td>
<td>18.60</td>
<td>0.10</td>
</tr>
<tr>
<td>S5</td>
<td>924CSP5</td>
<td>9/24/2002</td>
<td>Untextured + Joints</td>
<td>19.50</td>
<td>48.68</td>
<td>3.68</td>
<td>18.10</td>
<td>0.17</td>
</tr>
<tr>
<td>S6</td>
<td>924CSP6</td>
<td>9/24/2002</td>
<td>Untextured + Joints</td>
<td>18.80</td>
<td>48.71</td>
<td>3.67</td>
<td>NM</td>
<td>0.20</td>
</tr>
<tr>
<td>R4</td>
<td>924CRP1</td>
<td>9/24/2002</td>
<td>Textured + Joints</td>
<td>27.73</td>
<td>69.16</td>
<td>3.68</td>
<td>22.20</td>
<td>0.13</td>
</tr>
<tr>
<td>R5</td>
<td>924CRP2</td>
<td>9/24/2002</td>
<td>Textured + Joints</td>
<td>25.57</td>
<td>66.07</td>
<td>3.68</td>
<td>23.30</td>
<td>0.27</td>
</tr>
<tr>
<td>R6</td>
<td>924CRP3</td>
<td>9/24/2002</td>
<td>Textured + Joints</td>
<td>27.15</td>
<td>65.02</td>
<td>3.67</td>
<td>NM</td>
<td>0.20</td>
</tr>
<tr>
<td>S4A</td>
<td>927CSP1</td>
<td>9/27/2002</td>
<td>Untextured + Joints</td>
<td>18.87</td>
<td>46.14</td>
<td>3.87</td>
<td>18.60</td>
<td>0.13</td>
</tr>
<tr>
<td>S5A</td>
<td>927CSP2</td>
<td>9/27/2002</td>
<td>Untextured + Joints</td>
<td>19.50</td>
<td>46.22</td>
<td>3.84</td>
<td>18.10</td>
<td>0.17</td>
</tr>
<tr>
<td>S6A</td>
<td>927CSP3</td>
<td>9/27/2002</td>
<td>Untextured + Joints</td>
<td>18.80</td>
<td>45.35</td>
<td>3.85</td>
<td>NM</td>
<td>0.20</td>
</tr>
<tr>
<td>R4A</td>
<td>927CRP1</td>
<td>9/27/2002</td>
<td>Textured + Joints</td>
<td>27.27</td>
<td>70.44</td>
<td>3.60</td>
<td>22.20</td>
<td>0.13</td>
</tr>
<tr>
<td>R5A</td>
<td>927CRP2</td>
<td>9/27/2002</td>
<td>Textured + Joints</td>
<td>31.00</td>
<td>65.59</td>
<td>3.60</td>
<td>23.30</td>
<td>0.27</td>
</tr>
<tr>
<td>R6A</td>
<td>927CRP3</td>
<td>9/27/2002</td>
<td>Textured + Joints</td>
<td>22.97</td>
<td>56.85</td>
<td>3.79</td>
<td>22.20</td>
<td>0.20</td>
</tr>
<tr>
<td>R7</td>
<td>927CRP4</td>
<td>9/27/2002</td>
<td>Textured + Joints</td>
<td>22.80</td>
<td>58.37</td>
<td>3.71</td>
<td>22.20</td>
<td>0.20</td>
</tr>
<tr>
<td>DG1</td>
<td>1108DG1</td>
<td>11/8/2002</td>
<td>Textured + Ground + Joints</td>
<td>14.83</td>
<td>46.14</td>
<td>4.01</td>
<td>14.83</td>
<td>0.14</td>
</tr>
<tr>
<td>DG2</td>
<td>1108DG2</td>
<td>11/8/2002</td>
<td>Textured + Ground + Joints</td>
<td>13.93</td>
<td>46.22</td>
<td>4.10</td>
<td>13.93</td>
<td>0.27</td>
</tr>
<tr>
<td>DG3</td>
<td>1108DG3</td>
<td>11/8/2002</td>
<td>Textured + Ground + Joints</td>
<td>13.70</td>
<td>45.35</td>
<td>4.00</td>
<td>13.70</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The 4th digit is the surface type (C for concrete The 5th digit represents the surface treatment where “S” stands for smooth or untextured and “R” stands for Rough or Textured and the last digit is a run #. The Test code correlated to the Profilograms and power spectrum density reports with the same test code but with a leading 1. The Lightweight profiler defaults to that mode. Although the California Profilograph had her unique coding for the runs, they were all labeled according to the corresponding test with the lightweight Profiler. Subsequent tables include the Bar charts that show the various PI obtained for various Surface finish.
The results of profiler / profilograph tests are the profile indices obtained for the textured section, untextured sections before and after joints were cut at 15-ft spacing and for the diamond ground sections. The analyses of these values by blanking band adjustment and by (PSD) analysis are also discussed. Comparisons of results from the different equipment POWER Spectrum Density and from the different surface finishing are enunciated. These units are Profile Index, (inches per mile), International Roughness Index in Inches per mile and ride number (a dimensionless quantity). Ride number increases with increasing ride quality from zero to 5 and is not the same as the present serviceability rating or index that is on a similar scale. The non-contact profilers would read RN directly but a PSR is a comfort level qualitative comfort level rating by a group of (human) raters. Apart from PSR and RN, all other units of measurement decrease with increasing ride quality. The .08 scallop height was an attempted simulation of measured texture of 0.078 mm. It will be possible in the future, given a larger database, to simulate texture from correlation curves.

The untextured section measured the lowest profile indices. The Lightweight profiler and the California profilograph measured as the average difference between the textured and the untextured surfaces as 8.8 inches per mile and 5.4 inches per mile respectively. Considering that both surface were constructed in the same operation except for the finishing texture in the two surfaces, the difference in PI is attributed to texture. When the test series S are compared to series RJ, a difference of 10 inches per mile was obtained from the Lightweight profiler. The additional 1-inch per mile is attributed to the effect of joints. This was not exactly the case with the California profilograph where there was an increase in smoothness between the rough surface prior to joints and the rough surface after joints. It was observed that most of the slurry formed from cutting the joints had set within the texturing and was very difficult to remove. This slurry somewhat mimicked a smoother section that was interpreted by the California Profilograph as smoother than the unjointed textured surface. We did consider the study of the effects of joints as inconclusive. The Lightweight profiler reads by a constant sweep of a laser point from the accelerometer to the surface below. It is therefore more likely to detect a joint than the California Profilograph that reads with a rolling wheel in contact with the surface.

The Diamond ground sections showed improved ride quality. An average PI of 13 inches per mile was observed in the diamond grinded surface. The difference between PI of the smooth and diamond ground surface is attributed to the actual pavement macro-texture and mega-texture. These have already been defined. A comparison between textured and untextured sections in both equipment resulted in 8.8 and 5.4 inches per mile (Profile Index) respectively is also attributed to the rate of data collection of the lightweight profiler.

The PROVAL program was used to run PSD analysis on the profiles. The PSD for the textured surface was superimposed on the untextured. The general trend that would represent pavement mega and macro texture was similar but the spikes indicative of the preponderant frequency were different. These observations are of tremendous implication in program delivery. Measuring roughness for the purpose of initial pavement evaluation contributes more than 50 percent of the roughness measurements in a given year. The initial measurements are affected by texture deduced from the foregoing. Consequently, a penalty is indirectly applied to a contractor who provides good ride and good friction compared to one who provides good ride and poor friction. The 1 table 1 shows about 20 percent change in profile International Roughness Index and about 25 percent change in PI due to texturing. In a similar report BYRUM () at the SURF conference in Canada observed 20 inches per mile change in IRI due to texture. This is similar to what we observed and buttress the fact that texture affected profile index in the test sections. Bryum (2004) used mathematical modeling to simulate texture. In the Minnesota test section adjacent untextured versus textured surface have been measured and studied. The Profilograms show differing feature of the textured, untextured and diamond ground sections. The PSDs also indicate differing preponderant frequencies that lend credence to the explanation of how micro-texture will affect
roughness. Gain does not always amount to unity in practice and uniform response though expected of profilographs between wavelengths of 2 and 32 ft is not obtained in practice. Further studies will investigate investigation will reveal what these resonant wavelengths are. Tined concrete is still used in most our bridges today but astro-turf is specified for paving. Mn/DOT views Astor turf as a Quiet Pavement-Texture-Ride Optimization solution.

Fig 5 PSD Of Textured Strip, Diamond Ground Strip and Untextured Strips. Spikes at 64 ft are attributed to the Quarter car Filter while the 50 and 25 ft spikes are due to stringlines.

Fig 6 PSD of Untextured Strip Still show active wavelengths at 15 ft intervals before the joints were cut, The Dowel baskets at this interval possibly introduces a15 ft waveform during paving.
4 PROPOSING AN INSTITUTIONAL RIDE TEXTURE INCENTIVE ALGORITHM
At present there is no state in the union that rewards good texture but every state has at least a penalty for poor ride and/or an incentive for good ride. Many Laser manufacturers have designed multiple lasers ranging from the triple point to the planar laser that mimics the tire footprint. Another approach is to provide incentive for good texture within the limit of pavement quietness.

4.1 The Texture Incentive algorithm
The algorithm for texture incentive shall follow the equation

\[ \text{INCT} = K (T - A) (T - B) \]

Where K is an incentive constant based on institutional standards
INCT is incentive based on Texture

\[ T = 2.9/2 = 1.45 \text{ and the roots of the function are } 1.9 \text{ and } 0.9 \text{ which are the upper and lower limits of acceptable texture.} \]
4.2 Ride Incentive algorithm

The proposed incentive will be a single equation that inflects near the zero incentive for the range of zero-incentive PI. This equation sets 23 inches per mile as the pivot for a zero blanking band.

\[
\text{INC}_{\text{Ride}} = \begin{cases} 
1370 - 35 \ PZ & \text{where } 0 < PZ <= 7 \\
1480 - 45 \ PZ & \text{where } 7 < PZ <= 15 \\
2260 - 98 \ PZ & \text{where } 15 < PZ <= 23 \\
0 & \text{where } 23 < PZ <= 31 \\
984 - 450 \ PZ & \text{where } 31 < PZ <= 39 \\
\end{cases} \\
\text{Diamond Grind where } PZ > 39
\]

For IRI, A VBA Program that allows easy application has also been developed for this proposed Texture and Ride Incentive algorithm

\[
\text{INC}_{\text{IRI}} = \begin{cases} 
1370 - 18 \ IRI & \text{where } 0 < IRI <= 30 \\
1480 - 22 \ IRI & \text{where } 30 < IRI <= 50 \ (\text{Incentive}) \\
0 & \text{where } 50 < IRI <= 70 \ (\text{Contract Price}) \\
984 - 450 \ IRI & \text{where } 70 < IRI <= 100 \ (\text{Disincentive}) \\
\end{cases} \\
\text{Diamond Grind where } IRI > 100 \ (\text{Corrective measure})
\]

CONCLUSION

The importance of ride quality in pavement infrastructure are identified as the leading pavement evaluation tool and discussed. Importance of providing good texture in order to provide a safe driving surface is accentuated.

Minnesota’s study of the effect of texturing on Pavement smoothness is reported. This study found that texture indeed affected ride to some degree in the test sections. The investigations carried out by Mn/DOT on Project SP 6511-32 in Bird Island Minnesota studied the effect of texture and joints on measured ride. Results showed profile index (PI) difference between the untextured sections and the textured as 8.8 inches per mile using the Light Weight Profilograph and 5.5 inches with the California profilograph. The LWP also recorded IRI difference of 20 inches per mile.

The study of the effect of joints was not concluded because the slurry formed from the early sawing of the pavement set between the texturing and mimicked a smoother surface giving lower PI a value. Mn/DOT plans to conclude that aspect of the study when a test section becomes available. Our PSD analysis indicated the existence of different resonant frequencies between the textured and untextured sections though the megaprofilograms were similar. The preponderant frequencies of the micro profilogram may be amplified by the profilers to result in such measurable difference in PI and IRI. The effect of texture on ride is important in program delivery because of how these known effect can be built in an incentive algorithm. As of today, no state in the Union, pays incentive for texture or friction. In August 2004, a Federal initiative mandated states to document performance of various surface finish for friction and texture. In response to this request, Mn/DOT is evaluating performance data for the Minnesota “Brain child”: the astro turf drag. This is Minnesota’s optimization of noise and friction while Mn/DOT eliminated tining from the paving specification.
5.2 Recommendations

It is recommended that agencies should include texture in the ride incentive specification. Software/program that does this for the incentives specification was developed in this study. A study of the effect of joints on profile index should be concluded if another test section is available.

6 ACKNOWLEDGEMENTS

Author acknowledges Doug Schwartz, Joe Thomas and Maria Masten of Mn./DOT, Matt Zeller of CPAM and Mark Snyder who was CPAM Director when this study was conducted.

7 REFERENCES


5. Byrum, C.R. “Study of the Effects of Concrete Macro/Mega Texture on IRI Values” Proceedings of the SURF Conference in Ontario Canada, April 2004


URL http://www.fhwa.dot.gov/legsregs/directives/techadvs/t504036.htm
IZEVBEKHAI B.I.