SDDOT/SDLTAP Gravel Road Experimental Project Update

Ken Skorseth, SDLTAP Program Manager
Reason for Project

• More than 75% of local roads in SD are unpaved – managing them is a challenge!

• Biggest complaints from public are: rough condition (generally from corrugation or “washboard” in surface) and too much loose aggregate on the surface makes it hard to control a vehicle.

• How critical is gravel quality to this and how does it affect total cost of maintenance?
Focus of Test Project

• Primary focus is on **effect of gravel quality** on life-cycle cost of gravel road maintenance

• Three types of gravel used in study:
  1. Substandard but commonly used – meets no spec except top size control – one inch minus.
  2. Barely meets SDDOT Gravel Surfacing Spec – percent passing #200 sieve is low and/or plasticity index (PI) at bottom of range at 4
  3. Modified SDDOT Spec – higher minimums of 10% passing #200 sieve and PI at 7.
Three test sections were built:

Primary focus on Brookings County section in 2013
Substandard Gravel
SD Standard Specification
Modified Specification

Buffer Sections
Compacted and Uncompacted Sections
Compacted and Uncompacted Sections

Sections

Sections
Each section was built with three to four inches of new gravel after existing surface was prepared and shaped. Compaction/non compaction comparison as well.
One of the biggest challenges was finding gravel that meets the modified SDDOT Specification: “Shall have minimum plasticity index (PI) of seven”. (Even higher minimum was considered in project planning)
One way to meet modified spec – blend different material from separate sources

This was done on one section in Brookings Co and one section in Custer Co
Is this the future? More blending or “manufacturing” to get high quality gravel – processing from a natural clay source here:
Road mixing natural clay to get a high quality surface gravel
Please note this area
Some sections showed contrast in performance quickly due to gravel quality

Custer County Test Sections
Brookings County Test Sections

Substandard Section

Modified Section

Only one month after construction
Substandard gravel loosens in 31 days. Loose aggregate (or float) is 1 ¼ to 1 ½ inches between the wheel paths.

Modified material has only 1/4 to 3/8 inch of loose aggregate (float) between the wheel paths in the same 31 days.
Current Status of Project

• SDLTAP has accumulated photo documentation on all sections over the past two years.

• Measurement and documentation has been done on these distress types in 2012 & 2013:
  1. Accumulation of loose aggregate (float)
  2. Changes in top width from time of construction
  3. Presence of corrugation (washboard) on surface
  4. Change in roadway crown
The float test (loose aggregate)
Simply remove loose aggregate from a 10 inch cross section, weigh it and convert that to a one-mile section.
Change is top-width is measured on traveled way – hinge point to hinge point
Corrugation (washboard): Hard to quantify in extent, fairly easy to measure severity
Crown: measured with a laser level
Difference in 2012 & 2013 maintenance seasons:

<table>
<thead>
<tr>
<th>Date</th>
<th>Precip</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/01/2013</td>
<td></td>
</tr>
<tr>
<td>10/02/2013</td>
<td></td>
</tr>
<tr>
<td>10/03/2013</td>
<td></td>
</tr>
<tr>
<td>10/04/2013</td>
<td></td>
</tr>
<tr>
<td>10/05/2013</td>
<td></td>
</tr>
<tr>
<td>10/06/2013</td>
<td></td>
</tr>
<tr>
<td>10/07/2013</td>
<td></td>
</tr>
<tr>
<td>10/08/2013</td>
<td></td>
</tr>
<tr>
<td>10/09/2013</td>
<td></td>
</tr>
<tr>
<td>10/10/2013</td>
<td></td>
</tr>
<tr>
<td>10/11/2013</td>
<td></td>
</tr>
<tr>
<td>10/12/2013</td>
<td></td>
</tr>
<tr>
<td>10/13/2013</td>
<td></td>
</tr>
<tr>
<td>10/14/2013</td>
<td></td>
</tr>
<tr>
<td>10/15/2013</td>
<td></td>
</tr>
<tr>
<td>10/16/2013</td>
<td></td>
</tr>
<tr>
<td>10/17/2013</td>
<td></td>
</tr>
<tr>
<td>10/18/2013</td>
<td></td>
</tr>
<tr>
<td>10/19/2013</td>
<td></td>
</tr>
<tr>
<td>10/20/2013</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>2.94</td>
</tr>
</tbody>
</table>

Cooler, wetter season in 2013 – 2.94 inches of rain in previous 20 days – most of that in three days prior to the last test.
Brookings Section – Loose Aggregate 2012

Substandard Compacted Uncompacted

Standard Spec Uncompacted Compacted

Modified Spec

405 tons

71 tons
Brooking Section – Loose aggregate 2013

Tons per mile (October 2013)

- Substandard-Compacted
- Substandard-Uncompacted
- Standard-Uncompacted
- Standard-Compacted
- Modified

186 tons
16 tons
Loose aggregate comparison 2012 & 2013

Tons per mile (October 2013)

Tons per mile (October 2012)
Corrugation (Washboard)

• No corrugation observed on any sections meeting at least minimum standard specification.

• However, substandard section had corrugation the beginning of light corrugation only two days after blade maintenance after nearly three inches of rain.
Change in Roadway Width

Constructed Width – 21.5 ft on all sections

Current width ranges from 22 ft on modified section (top bar) to 25.25 ft on substandard section (bottom bar)
Substandard section – aggregate has moved outward over 4 ft since construction
Modified section has moved outward only six inches since construction
Problems with roadway crown

Desired Crown

Actual Crown

(10-18-13)
Dynamic Cone Penetrometer Testing

• Provide a measure of the in-situ strength of the base and subgrade
• A 17.6-pound weight is raised to a height of 1.8 feet and then dropped, driving the cone into the soil
• The variation in blows needed to drive the rod to a specified depth is an indicator of strength and stability of the subgrade
Field Use of Dynamic Cone Penetrometer

- Provide a measure of the in-situ strength of the subgrade
- A 17.6-pound weight is raised to a height of 1.8 foot and then dropped, driving the cone into the soil
- The variation in blows needed to drive the rod to a specified depth is an indicator of strength and stability of the subgrade
Test location layout

- Brookings Co. Gravel Test Section (214<sup>th</sup> St.)

Section 1 - Bowes - Below Specs Compacted
Section 2 - Bowes - Below Specs Uncompacted
Section 3 - Dupraz Meets Specs. Uncompacted
Section 4 - Dupraz Meets Specs. Compacted
Section 5 - Dupraz + Clay Above Specs. Compacted

Note: Not drawn to scale.
DCP Results

Different trend in strength in modified section:
View of Substandard section – 10-18-13
View of Modified section – 10-18-13
Does the modified section rut in wet weather? No, virtually no rutting observed.
Any traffic on this road?
Some other aggregate comparisons:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Percent fractured faces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substandard – one inch top size control</td>
<td>2FF=36.15% 1FF=10.4%</td>
</tr>
<tr>
<td></td>
<td><strong>Total=46.6%</strong></td>
</tr>
<tr>
<td>Standard – three-quarter inch top size control</td>
<td>2FF=58.7% 1FF=5.0%</td>
</tr>
<tr>
<td></td>
<td><strong>Total = 63.7%</strong></td>
</tr>
<tr>
<td>Modified – three quarter inch top size control</td>
<td>2FF=51.5% 1FF=8.4%</td>
</tr>
<tr>
<td></td>
<td><strong>Total = 59.9%</strong></td>
</tr>
</tbody>
</table>
Percent of fracture of stone (natural aggregate sources)

- **One fractured face**
- **Two fractured faces**
- **Total percent fractured faces**

Bar chart showing the percentage of fractured faces for Substandard Mat'l, Standard Mat'l, and Modified Mat'l in the categories of One fractured face, Two fractured faces, and Total percent fractured faces.
Concluding Points

• Meeting basic SDDOT standard surface gravel specification reduces loose aggregate by 1/3 to 1/2.

• Widest differential was in Brookings County near end of corn harvest in 2012 with 405 tons of loose aggregate on substandard section to only 71 tons on modified section.

• No corrugation ever observed on standard or modified material.
Concluding Points (Con’t)

• Most interesting fact thus far: Brookings has done blade maintenance up to four times on substandard section to only once on modified!

• A negative aspect: we are getting a lot of push-back from aggregate producers who would prefer to produce as they always have – no close control of % passing the #200 sieve and plasticity index.
THANK YOU!