SKID RESISTANCE PERFORMANCE OF MELTER SLAG-BASED SURFACE DRESSINGS ON HAWKES BAY RURAL STATE HIGHWAYS

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Rural State highways in Hawkes Bay present tight curvilinear alignments, high percentage of heavy commercial traffic and local aggregates with relatively low skid resistance.

SH 5: 69 km
AADT: 3000
HCV: 23%
Max Alt: 600m
Regional Strategic
Search for Good Aggregate

- Lack of local aggregates to provide the required skid resistance
- A number of aggregates from different regions were evaluated
- One of these aggregates was Melter Slag
- Melter slag was slightly more difficult to use than the natural aggregates but appeared to be providing good initial performance
Melter Slag Production Process

New Zealand Steel's Iron Plant

Goal and Concentrated Iron Sand

Coal delivered by rail from Hunter
High grade ore from the Hunter mine is delivered via a gravity pipe line from the site of the Hunter mine to the steel mill.

Multi Hearth Furnaces (4)

Waste fractions in the ore are removed off.

Rotary Kilns (4)

Lime and limestone are reduced to generate iron as a charge in the blast furnace.

Carbon dust is reduced to produce basic slag.

Elevated Transfer Container

Hot Reduced Primary Concentrate and residual Carbon.

Iron Blast Furnace

Iron is converted to metallic iron.

Melters (2)

Primary concentrates is melted by electricity and impurities are removed as slag.

Slag Bowl

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government
The major mineral constituents of the melter slag can be divided into three types:

- complex titanium oxides, which have a needle-like form
- spinels and similar metal oxide, which have a rather equi-dimensional shape
- calcium bearing oxides and silicates

The titanium oxides in particular provide strength and a high degree of microtexture.
Melter Slag and PSV

The PSV is between 57 and 60. However GMS is very resistant to long term polishing.

Figure 9(b) Melter slag: polished surface x 200mag

Figure 7(b) Fine grained greywacke sandstone G2: polished surface x 200mag
Ideal comparison

- GMS was placed on SH5 in the same location to replace high PSV natural aggregate
- Five sites with different stress conditions were considered
- Data provided 10 plots of comparison between natural aggregate and GMS
Sites Used in the Study
## Comparison GMS Versus Natural Aggregate

<table>
<thead>
<tr>
<th>Melter Slag Reseal Site Number</th>
<th>Natural Aggregate Years of data</th>
<th>Melter Slag Years of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>6 (2002 - 2007)</td>
<td>7 (2008 - 2014)</td>
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</tbody>
</table>
Decrease in Skid Resistance (Straight Roads)
Decrease in Skid Resistance (Curves)
Plot of all data on straights

\[ y = -0.0494\ln(x) + 0.6373 \]
\[ R^2 = 0.6718 \]

\[ y = -0.0290\ln(x) + 0.5734 \]
\[ R^2 = 0.1906 \]

GMS 0.53
Natural Aggregate 0.51
Plot of all data on Curves

- **GMS 0.50**
- **Natural Aggregate 0.46**
SH5 Crashes 2006 to 2011

- Wet Road Crashes
- Intermittent
- Dry Road Crashes
- Total Crashes

Year

Number of Crashes

- Linear (Wet Road Crashes)
- Linear (Total Crashes)
The Disadvantages of Using GMS

- GMS require up to 25% more binder than natural aggregate
- GMS denser so more expensive cartage
- GNS can react with road markings so the first application may need to be replaced quickly
Concluding Remarks

- GMS generally shows a steady decrease in skid resistance over time while the natural aggregate data is less consistent.
- Clear indication that reduction in skid resistance with age is greater on corners than on straights.
- GMS shows improved skid resistance performance over natural aggregate particularly on curves.