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SAND REJUVASEAL PERFORMANCE MONITORING REPORT

ENTWISTLE SAND REJUVASEAL DEMONSTRATION PROJECT

John Emery Geotechnical Engineering Limited (JEGEL)
for
Echelon Industries, Inc.

BACKGROUND

As requested by Echelon Industries, Inc. (Wm. J. Vandemark, President), John Emery Geotechnical Engineering (JEGEL), Consulting Engineers, (John Emery, Ph.D., P.Eng., President) has been monitoring the Alberta Infrastructure (AI) Entwistle Sand RejuvaSeal™ demonstration project since August 1999. This performance monitoring report covers the Sand RejuvaSeal technology for the Entwistle demonstration project (JEGEL, Echelon Industries and Alberta Infrastructure) and our site visit field observations of August, October and December 1999 and October 2000. The Alberta Infrastructure one year (one winter cycle) observations (ABTR/RD/TM-00/02, RejuvaSeal Demonstration Project, Entwistle, Alberta, September 12, 2000, Ted Harrison, P.Eng.) are very similar to JEGEL's. Our monitoring will be up-dated through a site visit later this year to cover two years (two winter cycles). For ease in following this JEGEL monitoring report, eight photographs, with descriptive notes, showing the Entwistle demonstration project site before Sand RejuvaSeal application and about one month, two months and one year after Sand RejuvaSeal application to the chip seal surface are attached.

There is considerable technical information on the growing, successful use of RejuvaSeal (coal-tar rejuvenator/sealer to US Federal Aviation Administration requirements) and Sanded RejuvaSeal (RejuvaSeal plus sand such as fine boiler slag (black beauty) or nonferrous slag) for airport asphalt pavement preventative maintenance, sealing and rejuvenation of aged (oxidized), deteriorated surfaces. Similar use of Sanded RejuvaSeal for highway asphalt pavement

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maintenance represents a natural extension of the airport experience and the need for higher quality road sand seals and scrub seals. The Sand RejuvaSeal rejuvenates the surface of the old asphalt pavement or chip seal (surface treatments) so that it both mitigates the surface oxidation (age hardening) and provides strong adhesion to the old surface. By incorporating a fine sand, the Sand Rejuvaseal provides wear resistance to traffic and maintenance wear and tear. Of particular importance for ravelling old asphalt surfaces or surface treatments (coarse aggregate loss for instance), the Sand RejuvaSeal tends to 'lock-up' the surface coarse aggregate with an enhanced matrix and reduce the rate of surface deterioration. From Sand RejuvaSeal airport experience and conventional emulsion sand seals and scrub seals, it is anticipated that Sand RejuvaSeal (quality controlled coal tar rejuvenator/sealer) should be effective for five to seven years in highway applications. The September 1999 Alberta Infrastructure Entwistle Sand RejuvaSeal demonstration project, in cooperation with Echelon Industries, was completed in order to assess the technical benefits of Sand RejuvaSeal as a surface maintenance (preservation) treatment.

DEMONSTRATION PROJECT SITE AND DETAILS

The Sand RejuvaSeal demonstration site is Alberta Infrastructure Highway 16A:08 (Junction of Highway 16 to Junction of Highway 22) near Entwistle, some 100 km west of Edmonton. Highway 16A:08 is essentially a fairly low traffic volume, old highway pavement section, parallel to the major provincial Highway 16. The Highway 16A:08 asphalt concrete pavement is 24 years old, with an aged deteriorating chip seal surface (surface treatment) as shown in Photographs 1 and 2. There has been significant loss of chip seal fines, resulting in the coarse aggregate being readily removed by traffic action and maintenance activities. The surface treated old asphalt pavement is in overall very poor condition with cracking, patching, some flushing, chip seal loss and some wheelpath rutting. At best, the chip seal surface is at its terminal serviceability condition (very poor condition) and presents a real challenge to demonstrate the effectiveness of Sand RejuvaSeal. This pavement section would normally be repaired and resurfaced with hot-mix asphalt as was done recently for the pavement section to the east of the demonstration project site.

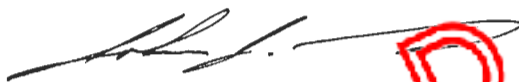
The Sand RejuvaSeal was placed on September 29, 1999, with the westbound lane chip seal surface treated and the eastbound lane left untreated as a control. As documented by Alberta Infrastructure and Echelon Industries, the westbound lane was first swept to remove all loose material from the chip seal surface. Then, RejuvaSeal test patches were applied at 0.18, 0.23 and 0.27 l/m² to evaluate the appropriate application rate. Based on these test patches, a RejuvaSeal application rate of 0.27 l/m² was selected. For comparative purposes, the first 287 m of the westbound lane (from east to west, 3.2 m wide) was treated with 0.23 l/m² of RejuvaSeal and then the next 1357 m were treated at the selected application rate of 0.27 l/m². A total of 5260 m² of chip seal surface was treated with RejuvaSeal. Approximately 0.48 kg of fine sand (fine boiler slag – ‘black beauty’) per m² was then applied to complete the Sand RejuvaSeal treatment of the chip seal surface. While ambient conditions were rather cool (about 15°C) and damp (light on and off drizzle), the Sand RejuvaSeal cured satisfactorily in two to four hours.

SITE VISIT FIELD OBSERVATIONS

The JEGEL site visit observations are best summarized through the descriptions given with Photographs 3 to 8 taken one month, two months and one year after the Sand RejuvaSeal treatment of the chip seal surface. After one year (one winter cycle), the Sand RejuvaSeal treated chip seal surface is in better condition, with a much lower rate of deterioration, than the untreated control chip seal surface. As also noted by Alberta Infrastructure, the surface of the treated chip seal is somewhat softer than the untreated control, indicating that the Sand RejuvaSeal has mitigated some of the asphalt age hardening and provided strong adhesion to the chip seal surface. The chip seal coarse aggregate is well coated with Sand RejuvaSeal, so that the coarse aggregate is ‘locked-in’ by the improved matrix. This reduction in ravelling potential (coarse aggregate loss) is very important. The sand has resulted in an overall ‘sandpaper’ like texture. The Sand RejuvaSeal also appears to have mitigated some of the secondary cracking through some edge softening.

It is JEGEL's technical opinion that the one-year performance of the Sand RejuvaSeal for the Entwistle Sand RejuvaSeal demonstration project exceeds our expectations from experience with conventional sand seals, and is most promising, particularly given the terminal serviceability condition of the chip seal surface prior to Sand RejuvaSeal treatment. Further performance monitoring is, of course, necessary to check the effective life of the Sand RejuvaSeal for highway applications, but about five years (similar to quality highway scrub seal) appears to be a reasonable assumption at this time. In summary, rejuvenation, adhesion, sealing, friction and wearing resistance are now demonstrated attributes of Sand RejuvaSeal for highway applications.

JOHN EMERY GEOTECHNICAL ENGINEERING LIMITED



John J. Emery, Ph.D., P.Eng.
President, Consulting Engineer





PHOTOGRAPH 1 Entwistle Sand RejuvaSeal Demonstration Project Site

August 14, 1999 [JJE]

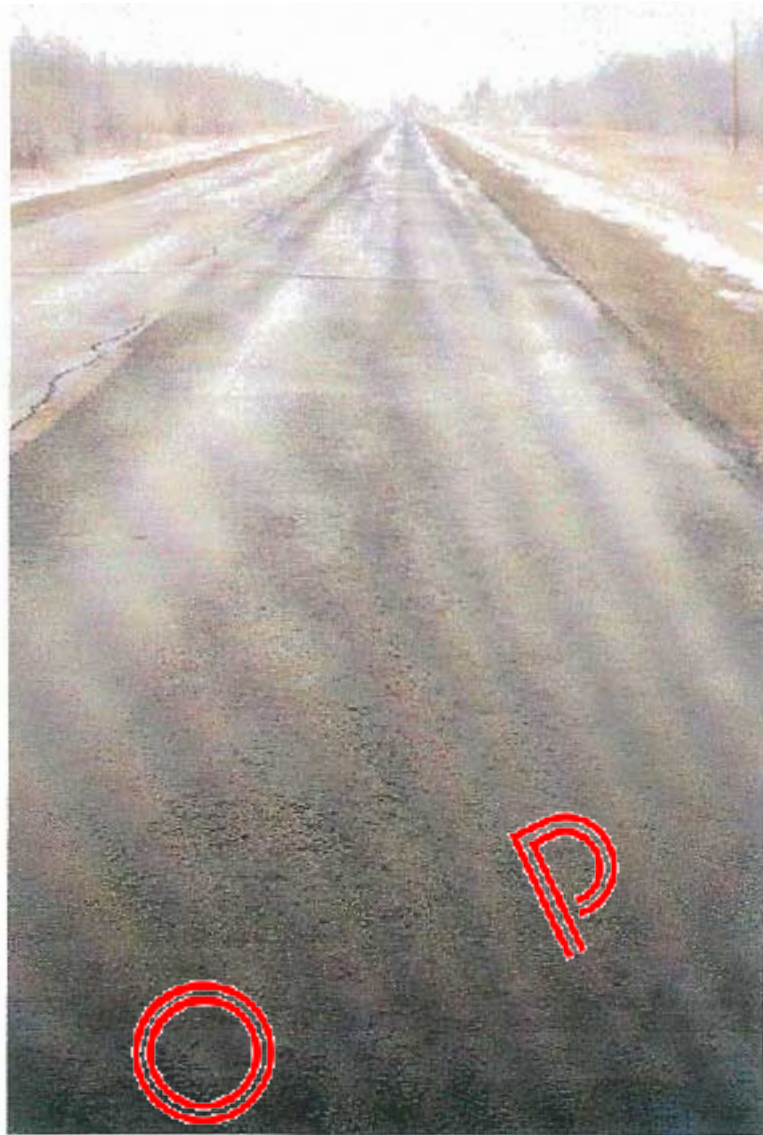
General view of the 44 year old asphalt concrete pavement, with an aged deteriorating chip seal surface, prior to application of the Sand RejuvaSeal. The chip seal is losing fines and coarse aggregate. The pavement is in overall very poor condition with cracking, patching, some flushing, chip seal loss and some wheel-path rutting. This pavement would normally be repaired and resurfaced with hot-mix asphalt.



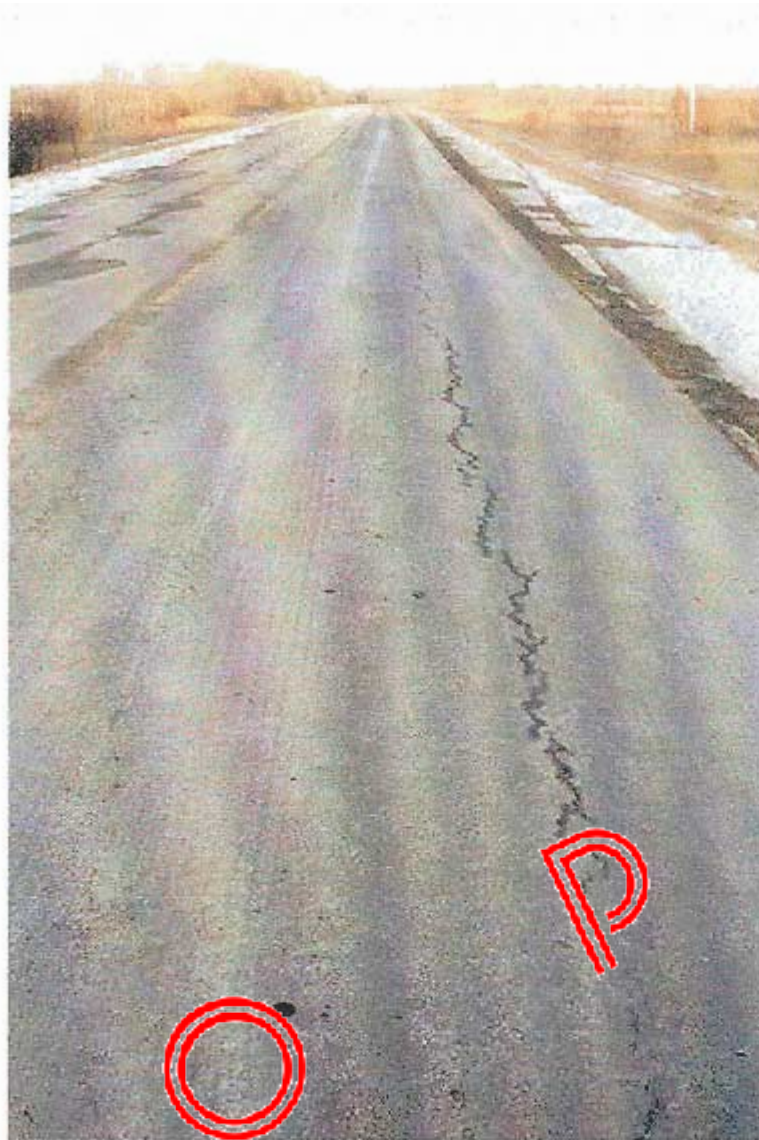
PHOTOGRAPH 2 Entwistle Sand RejuvaSeal Demonstration Project Site

August 14, 1999 [JJE]

Close-up view of the aged deteriorating chip seal surface (surface treatment) prior to application of the Sand RejuvaSeal. There has been significant loss of chip seal fines, resulting in the coarse aggregate being readily removed by traffic wear and maintenance activities. The main purpose of the demonstration project was to determine how well the Sand RejuvaSeal would limit the chip seal loss for this very poor condition pavement. The Sand RejuvaSeal was applied on September 29, 1999.



PHOTOGRAPH 3 Entwistle Sand RejuvaSeal Demonstration Project Performance
(Snowy/Wet Day) October 31, 1999 [JJE]
General view of the demonstration project one month after the Sand RejuvaSeal application. The Sand RejuvaSeal (0.27 l/m^2) was applied to the west bound lane (right side of photograph), with the east bound lane (left side of photograph) used as an untreated control. The Sand RejuvaSeal has a good appearance, particularly compared to the untreated control which is still deteriorating.



PHOTOGRAPH 4 Entwistle Sand RejuvaSeal Demonstration Project Performance
(Cold/Dry Day) December 4, 1999 [JJE]

General view of the demonstration project two months after the Sand RejuvaSeal application (close to photograph 3 location). The Sand RejuvaSeal (right side of photograph) has a good appearance after two months of cold, wet/snow condition and traffic/maintenance activities particularly compared to the untreated control which is still deteriorating (left side of photograph). The chip seal coarse aggregate has been 'locked' in-place by the Sand RejuvaSeal with some edge sealing of the existing cracks, thus limiting the deterioration of the chip seal.



PHOTOGRAPH 5 Entwistle Sand RejuvaSeal Demonstration Project Performance
October 2, 2000 [JJE]

General view of the demonstration project one year after the Sand RejuvaSeal application (close to Photographs 3 and 4 location). The Sand RejuvaSeal (right side of photograph) still has a good overall appearance, particularly compared to the untreated control which is still deteriorating (left side of photograph). The overall rate of deterioration for the Sand RejuvaSeal treated chip seal appears to be far less than for the untreated control. It should be noted that Sand RejuvaSeal will not stop pavement structural deterioration.



PHOTOGRAPH 6 Entwistle Sand RejuvaSeal Demonstration Project Performance
October 2, 2000 [JJE]

The coarse aggregate continues to be 'locked' in place by the Sand RejuvaSeal and this has reduced the rate of chip seal deterioration. There has been some winter maintenance (plow) chip seal damage (right side of photograph), but the treated chip seal appears to be in good condition, particularly compared to the untreated control.



PHOTOGRAPH 7 Entwistle Sand RejuvaSeal Demonstration Project Performance
October 2, 2000 [JJE]

Another general view of the demonstration project one year after the Sand RejuvaSeal application (to the west of Photograph 5). The Sand RejuvaSeal treated chip seal has a good overall appearance throughout (both for 0.27 l/m^2 as shown in Photographs 3 to 8 and 0.23 l/m^2 for a short trial at the east end of the demonstration project), particularly compared to the untreated chip seal that is clearly still deteriorating. The 0.27 l/m^2 treatment has a somewhat better appearance/performance than the 0.23 l/m^2 treatment.



PHOTOGRAPH 8 Entwistle Sand RejuvaSeal Demonstration Project Performance
October 2, 2000 [JJE]

Close-up view of the Sand RejuvaSeal treated chip seal (right side of the photograph) and the untreated control (left side of photograph) in Photograph 7 area. The action of the Sand RejuvaSeal in retaining ("locking") the chip seal coarse aggregate shows up quite clearly. The retention of chip seal coarse aggregate results in the desired reduction in the rate of chip seal deterioration.