OTTA SEAL TRIALS IN KWAZULU-NATAL, SOUTH AFRICA

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Abstract

The blacktopping of low volume gravel roads is currently being considered by the Department of Transport of the province of KwaZulu-Natal as a result of difficulties in sourcing good quality gravels in some parts of the province. Traditional chip seals are used extensively in the province to upgrade gravel roads to surfaced standard. However, the high cost of the seals cannot be justified in gravel roads carrying less than 500 vehicles per day. Otta seals have been used successfully in many countries as low cost surfacing alternatives for low volume roads. This paper summarizes the observations on the performance of Otta seal trial sections constructed on a low volume gravel road on the outskirts of the city of Durban on the eastern coast of South Africa.

1. Introduction

About 70 percent of the declared road network in the KwaZulu-Natal province of the Republic of South Africa is of gravel standard. Many parts of the province lack suitable gravel sources resulting in high re-gravelling costs brought about by long haul distances and accelerated gravel loss. The provision of low cost waterproof surfacing on such gravel roads, even under relatively low traffic, can be economically justifiable.

Traditional chip seals are used extensively in the province to upgrade gravel roads to surfaced standard. However, the high cost of the seals cannot be justified in gravel roads carrying less than 500 vehicles per day. Otta seal trial sections were constructed on a gravel district road in the outskirts of Durban to assess the performance of this kind of surfacing as a possible lower cost alternative to traditional chip seals. This paper summaries the characteristics and observations on the performance of the Otta seal trial sections over a period of six months.

2. Test Site

The seal trial sections were constructed on a secondary gravel road (D435) linking two residential and commercial centres, 40 km west of Durban (Figure 1). The area in which the rest site was located has an attitude of 500 m above sea level and an average annual rainfall of 1000 mm. The trial road D435 carries an average daily traffic of 500 vehicles per day of which about 10 percent are heavy. This level of traffic is relatively high for a gravel road, necessitating continuous maintenance and frequent regravelling. Such a road is an ideal candidate for upgrading to a low cost blacktop surface.

Prior to surfacing road D435 was upgrading by widening the carriageway to 7m and improving drainage. The pavement layer consisted of a 300mm decomposed granite base over in-situ material. The base was constructed in two layers of 150mm each, treated with a sulphonated petroleum product (Road Bond) to improve compaction.

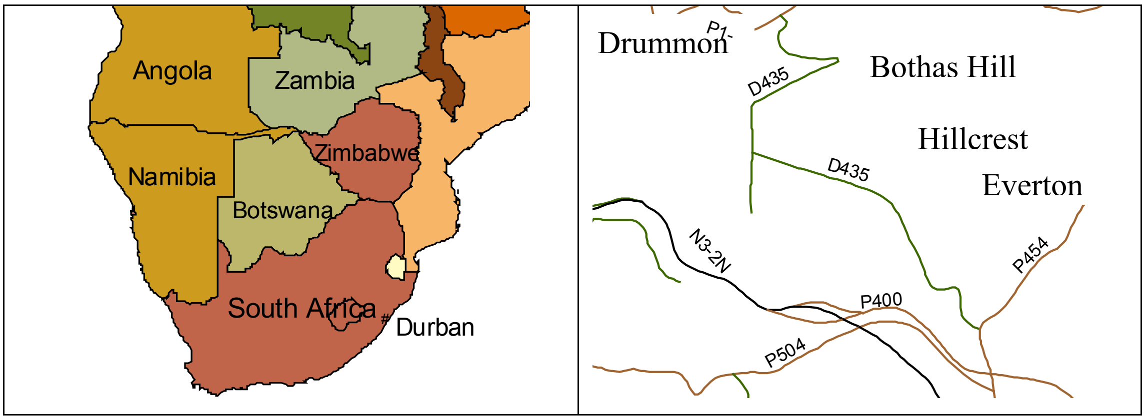

Figure 1: Location of test site.

3. Trial Sections

A total of 11 Otta seal trial sections, each 160m long, were constructed on D435 using various combinations of aggregates, prime and anti-striping agent. This paper is based on the characteristics and performance of 8 trial sections whose details are shown in Figure 2.

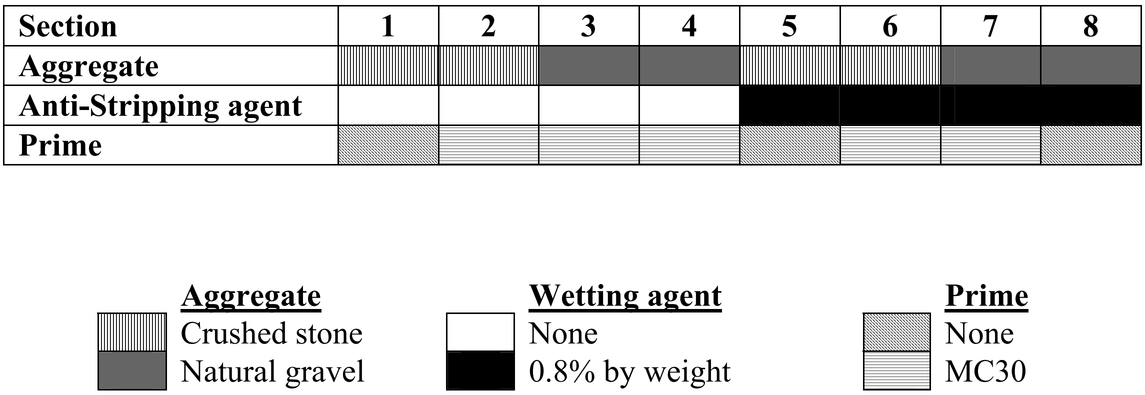

Figure 2: Characteristics of test sections.

Aggregates

Two types of aggregates were used, a crushed quartzite rock and a decomposed granite. The crushed rock aggregates had good physical properties but, as shown in Figure 3, had grading from marginal to out of specification for Otta seals. The crushed rock was gap graded forming an open texture with a fair proportion of oversized stones on the one end and significant proportions of fines on the other end.

The decomposed granite aggregates had lower crushing strength and grading that was also marginal to out of specification (Figure 4).

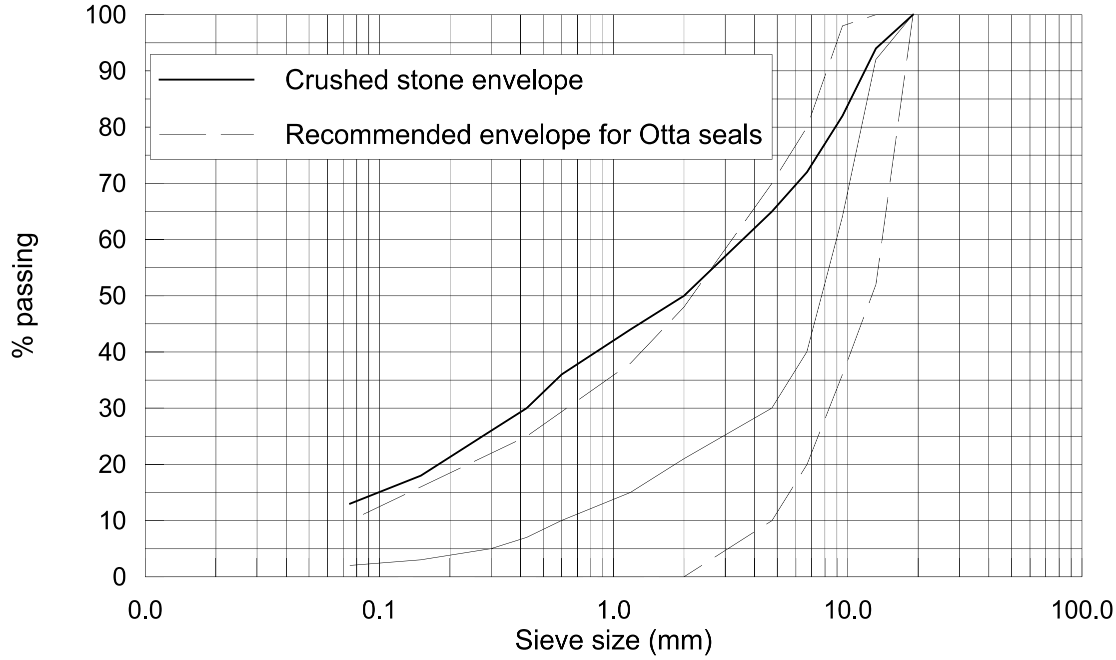

Figure 3: Grading envelope for crushed rock aggregates.

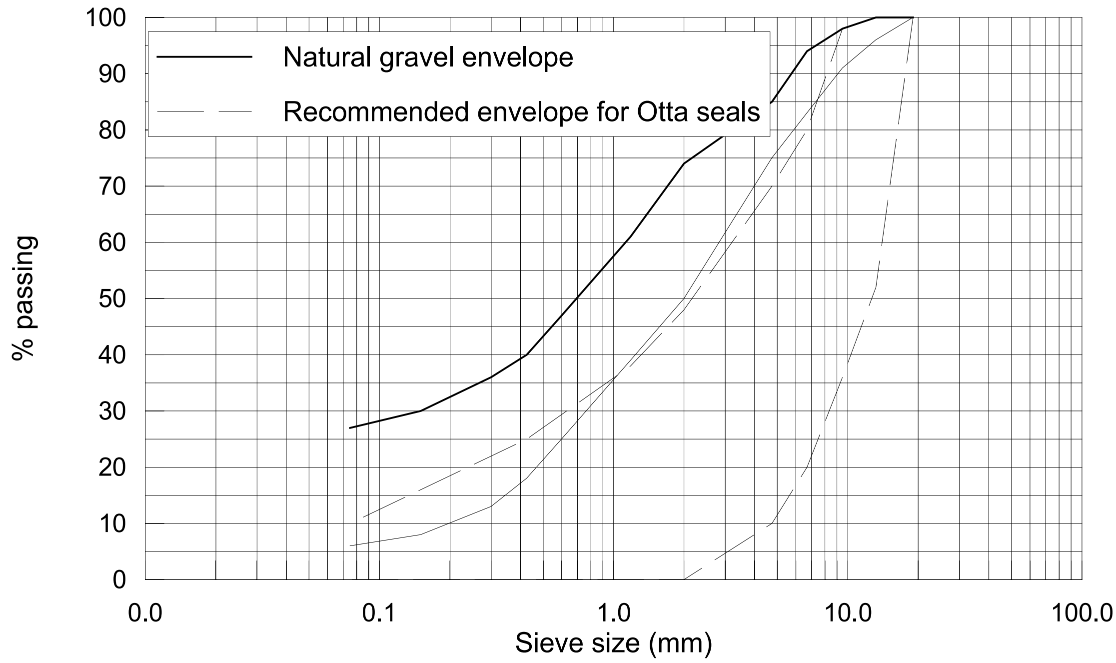

Figure 4: Grading envelope for natural gravel.

Binder

A150/200 penetration grade bitumen was used as binder. Spray rates varied between 1.6 to 1.9 l/m depending on the trial section. The binder was cut back on site using 8 percent of power paraffin in sections with the crushed stone aggregate and 11 percent in sections with the natural gravel aggregates.

Prime And Anti-Stripping Agent

Five out of the 8 test sections (Figure 2) were primed using MC 30 at a spray rate of 0.5 l/m^2. To improve adhesion between the binder and aggregates an anti-stripping agent, commercially known as duominc-T, was used on a number of sections shown in Figure 2. The stripping agent, when used, was blended into the bitumen distributor at the rate of 0.8 per cent by mass.

4. Performance of Trail Sections

The performance of the trial sections was monitored at regular time intervals by way of visual inspections. The results of the visual inspections are summarised below.

After One Week

The interaction between aggregate and binder in Otta seals is a gradual process. As a result, one week after construction there was still a large quantity of loose aggregate on the pavement and shoulders (Figure 5). Telltale signs of the kneading affect between the binder and aggregate could be seen along the crown and wheel paths. At this stage the only distinguishing feature separating the various trial sections was the difference in colour and texture of the aggregates used. The gap graded bluish grey crushed rock sections were clearly distinguishable from the denser, yellowish-brown decomposed granite sections.

Figure 5: Appearance of a crushed rock section one week after construction.

After One Month

The excess materials were broomed out of the pavement after about one month leaving a dark charcoal grey surface similar to asphalt premix. Curing was advancing well in most of the sections. Sections that had received higher spray rates and cutter content appeared to cure faster. However, they exhibited a potential to bleed in future.

Surface rutting and corrugations appeared in many parts of the road. Closer inspection revealed the unevenness to be associated with inadequate and non-uniform compaction of the base layer. The ruts and corrugations persisted over the life of the seal.

After Two Months

The binder had worked its way completely through the aggregate particle interstices displaying typical Otta seal characteristics (Figure 6). Trial sections consisting of the natural gravel where the higher binder application rate was used exhibited signs of bleeding. This was particularly true of Sections 7 and 8.

Figure 6: Characteristic premix look of Otta seal two months after construction.

A small proportion of oversized stones in the crushed stone aggregate were retained on the seal during application. These oversized stones could not be adequately bound in the seal and were whipped out by traffic resulting in blemishes on the surface. Some of the blemishes had cracked and developed into potholes.

After Six Months

Six months after construction the Otta seal had completely cured in all the test sections. The whole road had a uniform dark premix-like appearance with variable bleeding along the wheel paths (Figure 7). Natural gravel sections tended to bleed more than the crushed stone sections.

The surface defects and potholing that had appeared within the first two months had increased in both extent and severity necessitating emergency repairs.

Figure 7: Bleeding along the wheel paths after 6 months.

5. Conclusions

The following conclusions arose out of the observations on the performance of the Otta seal trial sections:

- The performance of both the crushed stone and natural granite aggregates was generally unsatisfactory. This can be attributed in part to grading, which was partly outside the recommended envelope.

- Binder application rates and amount of cutback appear to influence the performance of the Otta seal as evidenced by the excessive bleeding of the natural granite sections in which the amount of cutback was increased from 8 to 11 percent.

- There were no observed differences in performance that could be directly attributed to priming or lack of it. A primed base is generally not required in Otta seals except where the base material is calcareous or has a high adsorption rate.

- Rutting and corrugations can occur as a result of Otta seals following the contour of the base. Adequately compacting and finishing base layers can avoid these. The time interval between base preparation and seal construction should also be minimized.

Despite the shortcomings highlighted, Otta seals have the potential to become low cost surfacing alternatives especially where aggregates for conventional seals are unavailable or too expensive. More field trials involving a variety of aggregate types and grading need to be carried out in South Africa to broaden the knowledge base before concrete conclusions can be made.

6. References

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