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## Otta Seal

Category : Technical Information/On-carriageway/

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### BACKGROUND

An Otta seal is a thin bituminous seal comprising graded gravel or crushed aggregate containing all sizes and either a cut-back or soft penetration grade bitumen. Otta seals should be considered when;

- a road is to be constructed in a remote area where only natural gravels occur;
- workmanship may be of indifferent quality;
- flexibility and durability are required to tolerate low quality, low bearing capacity pavements; or
- there is a low maintenance capability.

### GENERAL DESCRIPTION

An Otta seal comprises of a layer of binder followed by a layer of aggregate that is rolled into the binder using a pneumatic tyred roller or loaded trucks. It is different to surface dressing in that an 'all in' graded gravel or crushed aggregate is used instead of single sized chippings. It depends for its success on the binder being squeezed up through the aggregate by the action of extensive rolling. Due to the fines in the aggregate, 2 to 3 days or longer of pneumatic-tyred compaction (rollers or traffic) are required to fully coat all the particles. An Otta seal may be applied in a single or double layer. Evidence on the performance of these types of seal constructed by conventional plant methods has shown them satisfactory for over 12 years on roads carrying up to 300 vehicles per day.

Binder and aggregate design is by judgement and must be established through trials. Inadequate trials can give poor results and a loss of confidence in the construction technique. A wide range of aggregate sources and types can be used.

### DESIGN ASPECTS

#### Aggregate

The grading of the aggregate material is based on the the level of traffic expected. Recommended grading envelopes are given in Table 1. Generally for roads carrying light traffic (less than 100 vehicles per day), a 'coarse' grading should be chosen while a 'dense' grading should be applied to roads carrying greater than 100 vehicles per day.



Table 1

Sieve (mm)	Dense grading	Medium grading	Coarse grading
	Percentage passing <sup>1</sup>		
19.0	100	100	100
16.0	93 - 100	84 - 100	80 - 100
13.2	84 - 100	68 - 94	52 - 82
9.5	70 - 98	44 - 73	36 - 58
6.7	54 - 80	29 - 54	20 - 40
4.75	44 - 70	19 - 42	10 - 30
2.00	20 - 48	3 - 18	0 - 8
1.180	15 - 38	1 - 14	0 - 5
0.425	7 - 25	0 - 6	0 - 2
0.075	3 - 10	0 - 2	0 - 1

The amount of fines (<0.075 mm) should not exceed 10 per cent. A higher fines content than this may result in construction problems through the finer particles being coated before the larger ones which can result in a less durable surfacing.

Plasticity Index of the aggregate must not exceed 10. No requirement for Flakiness Index is required for natural gravel or a mixture of crushed rock and natural gravel in Otta seals. If crushed rock material is used on its own then the Flakiness Index must not exceed 30.

The Flakiness Index is determined on the following fractions;

9.5 – 13.2 mm, 6.7 – 9.5 mm and 4.75 – 6.7 mm.

The aggregate strength requirements are shown in Table 2 and spread rates in Table 3.



Table 2

Aggregate strength requirements	Vehicles per day	
	<100	>100
Minimum Dry 10% FACT	90 kN	110 kN
Minimum Wet/Dry strength ratio	0.60	0.75

Table 3

Aggregate spread rate m <sup>3</sup> /m <sup>2</sup>		
Dense grading	Medium grading	Coarse grading
0.016 – 0.020	0.013 – 0.016	0.013 – 0.016

### Binder

The viscosities of binders used in construction should reflect the grading of aggregate employed and the level of traffic at the time of construction. Normally MC 800, MC 3000 or 150/200 penetration grade bitumen are used. Table 4 shows the recommended binders for Otta seals with different aggregate gradings and traffic levels.

Table 4

Annual Average Daily Traffic	Aggregate grading		
	Dense	Medium	Coarse
More than 1000	MC 3000 MC 800 below 15°C	150/200 pen.	Not suitable for Otta seal
100 – 1000	MC 3000 MC 800 below 15°C	150/200 pen.	150/200 pen.
Less than 100	MC 800	MC 3000	150/200 pen.

Spray rates are not calculated by design and must be chosen empirically through road trials. The range of spray rates for different levels of traffic that can be employed during trials is given below.

- Average annual daily traffic <100                      1.8 - 2.2 l/m<sup>2</sup>
- Average annual daily traffic 100 – 500                1.8 - 2.0 l/m<sup>2</sup>
- Average annual daily traffic >500                      1.6 - 1.8 l/m<sup>2</sup>



Best results are achieved by spraying the bituminous binder with a self propelled or tractor drawn bitumen distributor. However application by hand lance, if skilfully carried out, can achieve satisfactory work on small-scale work.



Binder distributor

## CONSTRUCTION ASPECTS

It is because of the broad range of materials that may be used and the empirical nature of the design of this type of seal that it is imperative that pre-construction trials be carried out. This strategy will enable any special local conditions concerning the available aggregates and binders to become apparent to the engineer so he can adjust the nominal design.

### Preparation for otta sealing

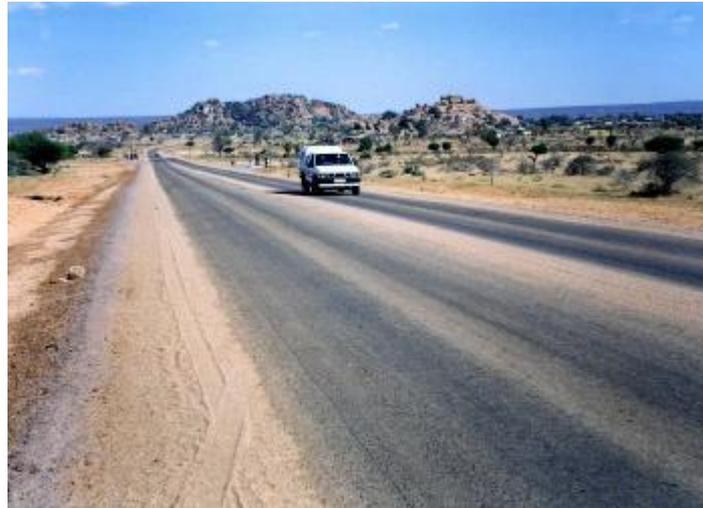
An Otta seal will not add to the structural strength of the road and therefore the surface to be treated must previously have been prepared to withstand the expected traffic levels. Preparation of the roadbase may include regravelling, reshaping and compaction. Immediately prior to the construction of the Otta seal the roadbase must be broomed free of sand and excess dust, mud or any other material that might hinder bonding between the seal and roadbase. Priming of the roadbase of non-calcareous material is not normally required. Calcareous material does require priming due to its capacity to absorb high amounts of bitumen. MC 30 or MC 70 is normally used for priming and are applied at spray rates between 0.8 and 1.2 l/m<sup>2</sup>.



Stockpiles of aggregate must be inspected to see if screening is needed to remove excess fines or over large particles. The spreading of aggregate can be carried out with conventional mechanical methods or by more labour intensive methods. If aggregate is to be spread by hand then small stockpiles must be placed in sufficient quantities on either side of the road to be treated at approximately every 10 metres. The aggregate must be placed so as not to interfere with the binder spraying operation.

### **Otta sealing construction**

1. The area of road to be treated must be marked out by some means such as with string or small stones. This will ensure the correct placement of binder and no overspray onto adjoining vergeside areas.
2. Controls must be put in place to prevent traffic encroaching within the area of construction.
3. The binder distributor should be loaded with sufficient binder to complete the work area and be at the correct temperature for spraying.
4. Cut-off sheets of paper or other material must be placed across the road at the start and end of the length of road to be sprayed. This produces a tidy appearance.
5. Check the speed of the distributor will be driven will produce the design binder spray rate.
6. Check the aggregate has been placed correctly and the workforce are ready to spread the aggregate after the distributor run.
7. Check equipment for rolling is positioned ready for rolling.
8. It is recommended the distributor makes a spray run of 100 metres to allow for immediate covering of the binder with aggregate. Rolling will be able to begin within 10 minutes of the binder being applied.
9. Spreading of the aggregate must begin immediately after the spraying of binder has begun. The binder must be covered with aggregate as soon as possible.
10. The supervisor must check no areas are left uncovered or too little aggregate is spread. Aggregate must not be left in heaps and a drag broom pulled manually or by tractor can help ensure an even distribution before rolling begins.
11. 12 tonne pneumatic-tyred rollers must be used in the construction of Otta seals although it is possible to use loaded trucks in their place. The section of treated road may be reopened to traffic after 3 passes of the rollers but on the day of construction, the surface treated must receive a minimum total of 15 passes.
12. Traffic must be restricted in speed to 30 kilometres per hour for two to three weeks after construction to minimise the hazard of loose excess aggregate being thrown up into the air.
13. During this initial period, aggregate that has been displaced by the action of traffic should be broomed back into the wheelpaths. After 2 to 3 weeks the excess aggregate should be swept away and the traffic speed restriction can be lifted.
14. If a second layer is to be constructed to make a double Otta seal, then a minimum of 2 to 3 months should pass before construction takes place.



Completed Otta seal

An important aspect of Otta seal construction that can not be over stressed is the need for extensive rolling by pneumatic rollers for two to three days or longer after construction. The action of rolling ensures the binder is forced upwards, coating the aggregate, and thereby initiating the process, continued by subsequent trafficking, of forming a premix like appearance to the surface.

## **REFERENCE DATA AND FURTHER INFORMATION**

The Design, Construction and Maintenance of Otta Seals, Guideline No.1. Roads Department, Ministry of Works, Transport and Communications. Republic of Botswana, June 1999.

A Guide to the Use of Otta Seals, Publication No. 93, Norwegian Public Roads Administration, Directorate of Public Roads, Road Technology Department, International Division, Oslo, August 1999.