

OTTA SEAL - A DIFFERENT APPROACH FOR ROAD SEALING

INTRODUCTION

The objective of this TECHnote is to increase road owners' understanding of the feasibility of using Otta seal for low traffic volume unsealed gravel roads.

The Otta seal is an alternative to gravel resheeting or upgrading roads to a conventional chip seal.

PROVIDE BASE GRAVEL STRUCTURAL SUPPORT

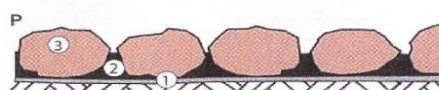
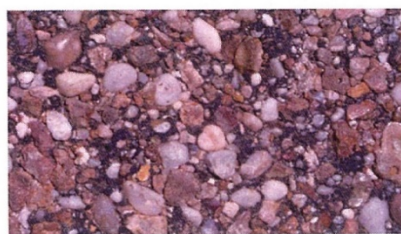
With all sealed pavements, whether it be conventional chip seal or Otta seal, it is necessary to make sure that the base gravel pavement is designed to provide structural support for the seal. Otta seal has greater deflection tolerance over weaker pavements.

WHAT IS AN OTTA SEAL?

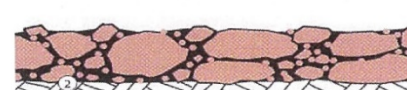
The Otta seal is a bituminous road surface treatment developed by the Norwegian Road Research Laboratory (NRRL) in the early 1960's. It derives its name from the location in Norway where it was developed – the Otta Valley.

In Australia and New Zealand, the binder has been nicknamed Norwegian Road Oil or NRO. Otta seal NRO binder can be a single seal and has a higher application rate than a conventional single seal. Compare this with the extra treatments for chip seals with prime seal, and 2 coat aggregate seal plus precoat emulsion on the aggregates.

In Victoria, Otta seals are referred to as GATT (Graded Total Aggregate Treatment) seals.



Single Chip seal



Single Otta seal

1. Prime 2. Binder 3. Stone

CHARACTERISTICS OF OTTA SEALS

- A primer seal is not required. Spray cutback binder hot bitumen MC800, MC3000, and cutback (up to 10% cutter)150/200 penetration grade bitumen readily supplied locally. Hot spray application rates range from 1.8 to 2.2 litres per square metre clay fines dependant.
- It is desirable before Otta sealing to dampen the prepared base gravel prior to spraying of the binder.
- Uses local natural pit road gravel (screened and separately stockpiled when the pavement gravel stockpile is created) range of 0.042 to 16 mm aggregate which includes up to 10% clay fines below 0.075 mm. This aggregate and clay material are spread on the road over the bitumen in a 16 mm layer or up to 19 mm if a double Otta seal is planned.
- The seal develops after initial rubber tyre rolling and is then left for a period of 2 months followed by sweeping of any residue gravel. Initially the Otta seal has the appearance of a gravel resheet however the seal becomes more visible over the next few months as the bitumen/clay mastic rises and joins with the larger stones in the gravel.
- The Otta seal aggregates need adhesion testing using an appropriate adhesion test, for example Riedel and Weber test. Use an adhesion agent if required.
- The gravel aggregate spreading rates for Otta seals vary between 0.013 to 0.020 cubic metre per square metre, and for sand spreading the rate is 0.010 to 0.012 cubic metre per square metre of road surface.
- After rolling and trafficking, the binder and fines work their way upwards through the aggregate interstices which results in a dense, durable matrix that relies on both mechanical interlock and bitumen binding for its strength - similar to a bitumen premix.
- Heavy trucking may require selection of a 32 mm double Otta seal for a 30-year life.



Abbreviations

NRO: Norwegian Road Oil

NRRL: Norwegian Road Research Laboratory

Relevant publications

Austrroads

AGPT Guide to pavement technology:

Part 3 Pavement surfacings

Part 5 Pavement evaluation and treatment design

Technical Paper 1

The Otta Seal Surfacing: Practical and economic alternative to traditional bituminous surface treatments

By Charles Overby, Norwegian Public Roads Administration

And Michael Pinard, Infra Africa Consultants, Botswana

Technical Paper 2

Innovation and Sustainable Road Services in Rural Setting

By Krishna Shrestha, Works Manager, Narrandera Shire Council, NSW

Relevant worksections

0054 Rural pavement design - unsealed

1140 Wearing course, base and subbase - unsealed

1141 Flexible pavement base and subbase

Method B11

Riedel and Weber Adhesion Test

Road Research Laboratory, England:

Bituminous Materials in Road Construction

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ADVANTAGES OF USING OTTA SEAL

Otta seals offer a number of important advantages over traditional surface treatments:

- **Flexibility:** The Otta seal is more flexible with greater deflection tolerance than a conventional seal. It can be used over lesser quality base gravel pavements with deflections in the order of 1.5 mm compared to 0.6 mm for conventional seals.
- **Longer economic life:** An unsealed road requires gravel resheeting every 8 to 12 years, whereas a single Otta seal for a similar price can last up to 15 years. A double Otta seal 32 mm thick can last up to 30 years subject to adequate base structural sufficiency. These are generalisations requiring local design assessments.
- **Less binder oxidation and associated maintenance:** Oxidation of bitumen in conventional chip seal's in low traffic volume roads is a major maintenance issue whereas Otta seal binder bitumen is enclosed as a mastic bitumen/clay mix and is less exposed to binder oxidation by comparison.
- **Lower material and transport costs:** Some Councils have high costs to transport hard rock commercial aggregates over long distances to the road sites for the conventional seals. This together with the extra commercial cost to purchase ex quarry, together with precoating costs can create a high initial cost for conventional seals. Otta seals supply the aggregates ex local gravel pits near the road sites however with an extra screening stage to remove finer clays and silts and aggregates above 16 mm.
- **Durability:** An Otta seal constructed with a dense, close textured grading tends to be far less susceptible to solar radiation and consequent hardening of the binder. The open graded conventional chip seal has binder more exposed to oxidation degrading.
- **Bleeding:** Bleeding of an Otta seal is more easily cured by surfacing with sand compared with conventional seals because of the relative soft binder used with the Otta seal. The soft binder tends to readily coat the fine sand particles in a manner that is not possible with the hard binders used in conventional seals.

IMMEDIATE POST CONSTRUCTION CARE

The immediate post-construction care of an Otta seal is important to its long-term performance and requires special attention. Such after-care includes additional rolling and brooming back of the aggregate that has been dislodged by traffic. This makes sure that the maximum number of aggregate particles are embedded into the soft binder. A newly constructed Otta seal may be observed as dusty and could produce "flying stones" for the first few weeks after construction.

USE OF OTTA SEALS IN AUSTRALIA

In 2018, Narrandera Shire Council in NSW allocated all their unsealed roads maintenance budget into Otta seals rather than persevering with gravel resheeting. They intended to convert all their unsealed roads to Otta seals with the long-term reduced expenditures on maintenance.

Due to the relatively flexible nature of the Otta seal, it is well suited as an overlay seal for roads that are extensively cracked or patched but are still structurally sound.

COST-EFFECTIVENESS

A life cycle cost comparison between a single 16 mm Otta seal and a double/double conventional 14 mm/7 mm seal reveals a considerable cost advantage to the 16 mm Otta seal due to:

- Lower aggregate construction cost due to localised pit source and no commercial supply cost. A variation in aggregate hardness is tolerated.
- No need for primer seal and easier rectification of bleeding for an Otta seal.
- Tolerance to overlay on lesser quality base gravel and higher deflections.
- Lower maintenance seal costs due to less oxidation of binder bitumen.
- No need for precoating of aggregates.

CONCLUSION

In the absence of empirical design studies, the base pavement for an Otta seal should be selected on the same basis as for a conventional chip seal. However, some arguments can be made for a discounted pavement design based on the greater resistance by an Otta seal to pavement damage caused by loading deflection.

Examples of the use of Otta seal in Australia



Otta seal stone grading variation



Otta seal (left) alongside chip seal



Otta seal – General view



Otta seal – Detail view



Boundaries of sprayed seal and otta seal