

# Otta Seal Surfacing of Aggregate Roads

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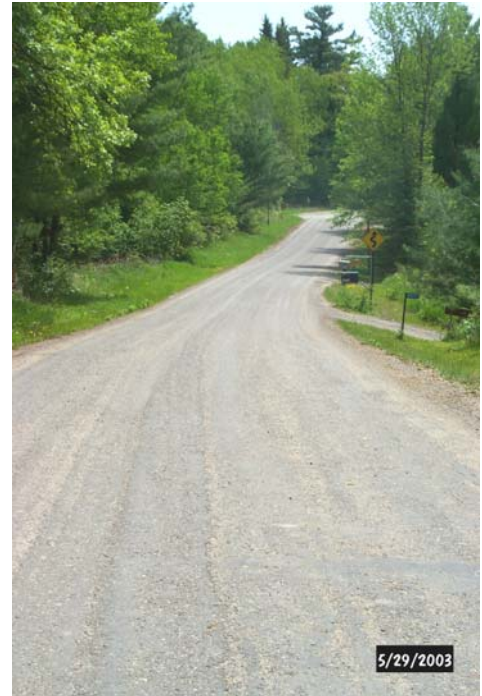
2003, 2008

**Description:** An Otta seal is an asphalt surface treatment constructed by placing a graded aggregate on top of a thick application of relatively soft bituminous binding agent. Minnesota has used emulsified asphalt exclusively (HFMS-2s); it could be constructed with cutback asphalt if desired. The binder works its way into the aggregate with rolling and traffic. In comparison to other surface treatments, material and construction specifications are not as strict. Local aggregates that would not meet the requirements for high quality paving aggregate are often used in Otta seals.

**Traffic Range:** Very Low to High (AADT < 2000) for a double Otta seal.

**Base/Subbase Requirements:** Otta seals are constructed over an aggregate base course. Since Otta seals do not add structural capacity to the roadway, the base/subbase must be designed to support the anticipated traffic loading. Subgrade and base materials should be compacted and graded to provide a stable working surface prior to Otta seal placement. A prime coat is usually not used above the aggregate base prior to Otta seal application.

**Materials:** An Otta seal is constructed of a graded aggregate on top of a thick application of relatively soft bituminous binding agent. The bituminous binding is typically an emulsified asphalt (e.g. HFMS-2s). Bituminous binder application rates vary from about 1.9 liter/m<sup>2</sup> (0.45 gal/yd<sup>2</sup>) to 2.4 liter/m<sup>2</sup> (0.56 gal/yd<sup>2</sup>) for emulsified asphalt, depending on aggregate gradation and type. In comparison to other surface treatments, material and construction specifications are not as strict. Local aggregates that would not meet the requirements for high quality paving aggregate are often used in Otta seals. Natural gravels are acceptable. The maximum aggregate size in the graded aggregate is generally 13 to 25 mm (0.50 to 1 in.). The graded aggregate can be crushed or uncrushed and contain up to 10% fines. Quantities of aggregate are usually around 50 lb/yd<sup>2</sup>. Otta seal design is empirical in nature and trial sections are recommended to determine the appropriate material application rates.



Otta Seal Const. 2007, Olmsted County CR58

**Equipment:** Equipment required for Otta seal construction includes: asphalt distributor, chip spreader, pneumatic-tired roller, and mechanical broom.

**Placement Process:** The bituminous binding agent is sprayed onto the prepared working surface by the distributor; then, the graded aggregate is spread onto the surface using an aggregate spreader. After the aggregate is placed, the surface is rolled with a pneumatic-tired roller to embed, realign the aggregate chips in the binder, and begin drawing the binder through the aggregate to the surface. Due to the fines in the aggregate, two or three days of compaction, either by rollers or traffic, is required for the binder to coat all the aggregate particles. During the first few weeks, aggregates dislodged from the surfacing by traffic should be swept back into the wheelpaths. After about three weeks, the surface should be swept by a mechanical broom to remove all loose aggregate from the surfacing. The second layer of a double seal is constructed in a similar manner two to three months after the first layer is constructed. With attention to details a second application can be applied 1 day after the first application. However, two to three months is recommended.

**Lane Closure Requirements:** The roadway lane being constructed is closed during construction, so adequate traffic control is needed. The Otta seal surface can be opened to traffic as soon as it is constructed.

**Reliability and Performance History:** Otta seals were developed in Norway in the 1960s. They have been used frequently in Norway, Sweden, Iceland, and Botswana, and to a less extent in several other countries. Otta seal performance has been good in countries that are familiar with this type of surfacing. Otta seal design is empirical in nature and trial sections are often construction to determine the proper material application rates.

**Life Expectancy:** Life expectancy varies depending on construction materials used, environmental conditions, and traffic volumes. Reported serviceable lives for double Otta seals range from 8 to 15 years.

**Ride Quality:** Otta seals can provide minor improvements to ride quality, but will not mitigate significant defects (rutting, depressions, etc.) in the application surface. On a proper prepared application surface, a good ride quality can be achieved after construction. Ride quality deteriorates over the serviceable life.

**Ability to Recycle/Reuse:** Otta seals can be pulverized and reused as an unbound or stabilized material.

**Appearance:** Immediately after placement, the Otta seal's appearance is similar to a gravel road and is influenced by the aggregate color. With time and traffic, the black bituminous binding agent works its way up through the aggregate, creating a surface appearance similar to cold mix asphalt concrete.

**Supply+Install Price (in 2003 dollars):** \$24,000 to 34,000/mile (28 foot width)

## EXAMPLE PROJECTS

Cass County Roads 25 & 171 and many other township roads, Cass County, MN; MN Highway 74, north of Whitewater State Park, Elba MN; Fillmore County Road 20, Lanesboro, MN.

**Other Comments:** Otta seals have been used as an impermeable surfacing for moisture-susceptible gravel roads with low bearing capacity (i.e. roads during spring thaw period). The Otta seal shields the





base material from moisture infiltration and is flexible enough to withstand the relatively large deflections associated with low bearing capacity roads without exhibiting significant distress. If there is permanent deformation of the base, the Otta will not knead back together.

Because Otta seals can provide a high-quality road surfacing, there is a tendency for higher road usage and speeding that may be beyond the geometrics of the existing roadway.

## Otta Seal – 2008 Review John Pantelis, Minnesota Department of Transportation

**Description:** A field review of Otta Seal Projects was conducted to evaluate the performance of projects completed since 2001. These sections had been in place for some time with little or no review of aging or repairs.

**Review:** CR168 was in good shape. It appeared to have 1-in. aggregate. Typical 50+ foot thermal cracks were noted, surface had no fine aggregate, and snow packing was seen in shaded areas.



**Otta Seal constructed 2003, Cass County CR168.**

**Review:** Unmarked Road NE of CR168 was in good / fair shape. Potholes on the centerline were repaired and new were present, some wheel tracking and delamination present. Intersections into housing developments were upgraded with HMA. Otta Seal intersections were somewhat rough.



**Otta Seal constructed 2003, NE of Cass County CR168.**

**Review:** CR171 was in good condition and was treated with a chip seal. The chip seal gave the Otta Seal a clean finish. Longitudinal cracks were evident along swampy areas.



**Otta Seal constructed 2001, Cass County CR171.**



**Review:** CR25 was in good and was also treated with a chip seal. CR25 has a large dairy farm which features truck traffic with sizable loads. Road & chip look in good shape. Northern intersection repaired / replaced with HMA to correct previous pushing problem.



**Otta Seal constructed 2001, Cass County CR25 – Dairy Farm.**

**Cass Co. Birch Lake Sections:** Due to the low traffic & light use over the winter months, the northern sections were not plowed well enough to review. All had heavy packed snow, which aids in plowing in your typical aggregate road structures. Two areas were listed to be either Bad or So-So conditions, but viewed. Terrain in these areas varied. Some areas were Y intersections with other roads, others were swampy, hilly, and some lacked proper drainage for good performance.

**Review:** 116 & 117 were in good shape and were also treated with a chip seal. Road & chip looked in good shape. Intersections with turning or crossing farm equipment looked in good shape.





**Otta Seal Const. 2002, Cass County  
CR25 – Dairy Farm**

### **SELECT RESOURCES**

- Johnson, Greg (2003). "Minnesota's Experience with Thin Bituminous Treatments for Low-Volume Roads," Transportation Research Record 1819, TRB, National Research Council, Washington, D.C., pp. 333-337.
- Norwegian Public Roads Administration (1999). "A Guide to the Use of Otta Seals," PIARC XXIst World Road Congress, Kuala Lumpur, Malaysia.
- Thurmann-Moe, T., and Ruistuen, H. (1983). "Graded Gravel Seal (Otta Surfacing)," Transportation Research Record 898, TRB, National Research Council, Washington, D.C., 333-335.



### **NEED MORE INFORMATION ON OTTA SEAL SURFACING OR THE MINNESOTA ROAD RESEARCH PROJECT (MN/ROAD)?**

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