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| **DATE:** | February 28, 2011 |
| **TO:** | Tom Ulrich<br>Deputy Superintendent<br>Sleeping Bear Dunes National Lakeshore<br>9922 Front Street<br>Empire, MI 49630 |
| **FROM:** | Gill Williams, David Evans and Associates |
| **SUBJECT:** | Asphalt Pigment Information for Trails |
| **PROJECT:** | MSWN0000-0002 |
| **PROJECT NAME** | Sleeping Bear Dunes National Lakeshore |
| **COPIES:** | DPS, Jenni West |

## SLEEPING BEAR DUNES TRAIL MATERIALS COMPARISON

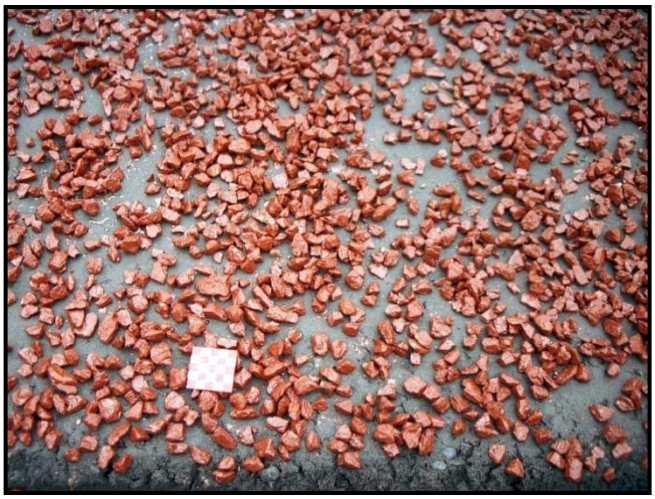
The project which this inquiry is serving is a trail project for the Sleeping Bear Dunes National Lakeshore. The anticipated trail is expected to be about 23 miles long and run into natural grass meadow and forest areas as well as parallel existing roadways. For the purposes of this inquiry the trail width will be assumed to be 12 feet. The trail at these dimensions will cover an area of 1,457,280 SF. Considering a 2-inch thick asphalt surface on top of 4 inches of crushed aggregate base at a cost of $1.80 per SF, the cost of paving this trail with standard black asphalt would run approximately $2.62 million.

## SURFACE COURSE TOP DRESSED WITH SUITABLE COLORED AGGREGATE AND HOT ROLLED

One means to pigment fresh asphalt is to top dress the fresh asphalt with graded aggregate of the desired color and hot roll the colored chips. This process would add about $0.50 per SF, adding $728,640 to the cost of the asphalt path. This process permanently fixes the pigmented chips into the surface layer. Some discoloration of the chips will occur as bitumen picked up by the roller will stain the chips. Time and traffic will wear the thin tar staining off the colored top dressing. Bicycle and pedestrian traffic would be less effective than motor vehicle traffic in this process.

The seeding aggregate may be pre pigmented to a desired color (as shown in photos) or natural aggregate of light colored granite, feldspar or other durable rock would also work. It is important to spread the seeding aggregate at a high rate to mute the appearance of the black asphalt base.

It should be noted that the finished surface will be rougher than standard top course asphalt with the irregularities of the aggregate exposed. For walkers and runners this is of no concern. Cyclists (especially those with skinny tire “racing” bikes) will notice the roughness in a harsher ride and slightly greater rolling resistance



Colored aggregate before hot rolling

Colored aggregate after hot rolling.
Note the dark staining on the aggregate

**ASPHACOLOR INTEGRAL COLOR AND TOPDRESSING SEALANT**

Two pigment systems are provided by Asphacolor Corporation. One is an integral color hot mix consisting of a dry concentrate that is added to the hot asphalt mix at the batch plant at a rate of between 50 and 80 pounds per ton of hot asphalt. This material is trucked to the project site and installed as any other asphalt with the same equipment and procedures. This material has smooth texture and because the coloration is integral to the mix, there is no surface pigmentation to wear through. The color for hot mix adds about $1.00 per square foot or an additional $1,457,280 to the project price.

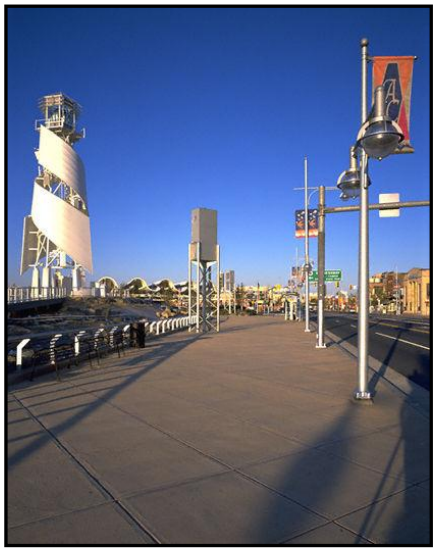
The other asphalt pigmentation option provided by Asphacolor is their Integral Color Dry Sealant Mix. This material is blended with asphalt emulsion seal coat at a rate of about 50 pounds of dry sealant mix per 20-38 gallons of asphalt emulsion seal coat. Silica sand is also used to enhance skid resistance and extend durability. Because this product is a surface dressing it is conceivable that the pigmentation could be worn through, but because the trail's primary users will be pedestrians and cyclists whose impact on the surface is slight, the likelihood of the pigmented seal coat wearing through would also be slight. The pigmented seal coat adds between $0.20 - $0.40 per square foot or an additional $437,184 to this project's cost.


Asphacolor hot mix colored asphalt pavement


Asphacolor seal coat pigmented asphalt

**PIGMENTED CONCRETE**

Concrete can provide a premium trail surface. Many coloring and finishing options exist for concrete. Concrete costs can run from between $4 and $7 per square foot so this material is more expensive than asphalt. Concrete requires joints to address shrinking and swelling. This can affect the ride quality for cyclists and provide a potential entrance to water that can freeze and crack the brittle material. Coloring concrete can be accomplished with the use of admixture pigments, acid etch stains, colored sealers and penetrating stains. A premium pigmented concrete trail could easily cost more than $7 million.



Admixture colored concrete

**CONCRETE UNIT PAVERS**

Interlocking concrete unit pavers come many different colors, many of which would blend nicely into natural settings. These pavers are resistant to frost heaving and provide a durable and easily reparable surface. Bicyclists would find the surface harsh as the many seams between pavers form a slightly irregular surface. Like concrete this material is somewhat expensive at a cost of $6 - $8 per SF.

Interlocking unit pavers can be installed with mechanical laying machines to reduce cost, but this material remains at the high end of pavement costs

**STABILIZED SOIL PAVEMENT**

Enviroseal Corporation has an acrylic liquid polymer soil modifier (M10+50) that modifies soils, crushed rock or recycled and crushed concrete with fines to a hardness and durability of asphalt. Using recycled concrete (with fines) as the wearing surface no base is required. The product is mixed with the crushed concrete by a machine with roto-tilling blades and immediately rolled with a - ton roller into the smoothed trail, and then the penetrating liquid polymer is reapplied. With this system recycled and native materials can be used. The material has a five year warranty. It is anticipated that a follow-up application of the polymer would be recommended at the five year mark. This material complies with ADA specifications and it is on the Qualified Products List (QPL) of the National Park Service. The estimate for the cost of the trail using this material is $1,463,000.


Stabilized and hardened soil roadway in Mexico on left, and stabilized and hardened crushed granite path in the Italian Alps on the right.

**RESIN BOUND GRAVEL**

Asphalt pavement can serve as a base for resin-bound gravels. The asphalt provides the stable base, and the relatively thin layer of gravel and polyurethane resin serve as the surface layer. Although this system is not uncommon in the United Kingdom its use in the United States is rare. Due to the disparate characters of the two materials and the extreme cold anticipated for the project site the likelihood of exfoliation of the surface layer is high. The cost of this treatment is prohibitively expensive at $1.60/SF in addition to the asphalt base.

Resin bonded aggregates on a stable base in garden setting.