Sustainable Road Surfaces for Traffic Noise Control

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SILVIA PROJECT REPORT

Report on Recycling of Porous Asphalt in Comparison with Dense Asphalt

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Recycling of Porous Asphalt in Comparison with Dense Asphalt

The durability of the surface type comes into play when evaluating the cost factors such as material use and recycling. The general assessment for porous asphalt is that it is more expensive due to shorter life and the requirement for pressure or vacuum cleaning. Due to the expected shorter life, the ability to recycle substantial amounts of the material for porous asphalt becomes of more importance for the economic viability of porous asphalt vs. dense asphalt or concrete. The general assessment is that porous asphalt has a somewhat shorter lifetime and requires more maintenance to reduce clogging of the pores. There are however some positive impacts of a porous surface that should also be kept in mind. Additional economic impacts of porous asphalt over a dense surface are (Duval, 2002):

- Reduction of land space consumed by conventional storm water detention facilities
- Reduction of need for: curbs, gutters, inlets and storm sewers
- Improvement in wet weather skid resistance

This brief report will discuss to varying degrees the cleaning/maintenance of porous asphalt, the service life, and the recycling of materials in laying porous asphalt versus dense asphalt or concrete.

Cleaning/Maintenance

The maintenance of porous asphalt surfaces consists of structural maintenance, cleaning or unclogging, and winter maintenance.

Structural Maintenance

The most common mode of damage to a porous asphalt surface is loss of material, or ravelling. Minor repairs can be carried out to porous asphalt using conventional means, as long as care is taken to preserve the inherent drainage characteristics (Van der Zwan, 1990). Duval (2002) states that repairs can be made with standard dense graded mixes as long as they do not amount to more than 10% of the surface area.

Van Heystraeten and Moraux (1990) refer to a joint Dutch and Belgian working group investigating maintenance challenges associated with porous asphalt pavement. They refer to fog seal sprays, in-place recycling, "overlays in porous asphalt," and "cold-laid porous asphalt mixes" for local repairs, including potholes.

One additional problem is that local deficiencies need a repair area across the full lane width while with dense surfaces a very limited area can be repaired (Pracherstorfer and Litzka, 1994).

Figure 1 shows the perception of maintenance supervisors on the cost of repair of porous asphalt versus dense asphalt. As can be seen, the general perception is that the open graded or porous asphalt surfaces are more costly to repair on an area-specific basis than dense asphalt surfaces.

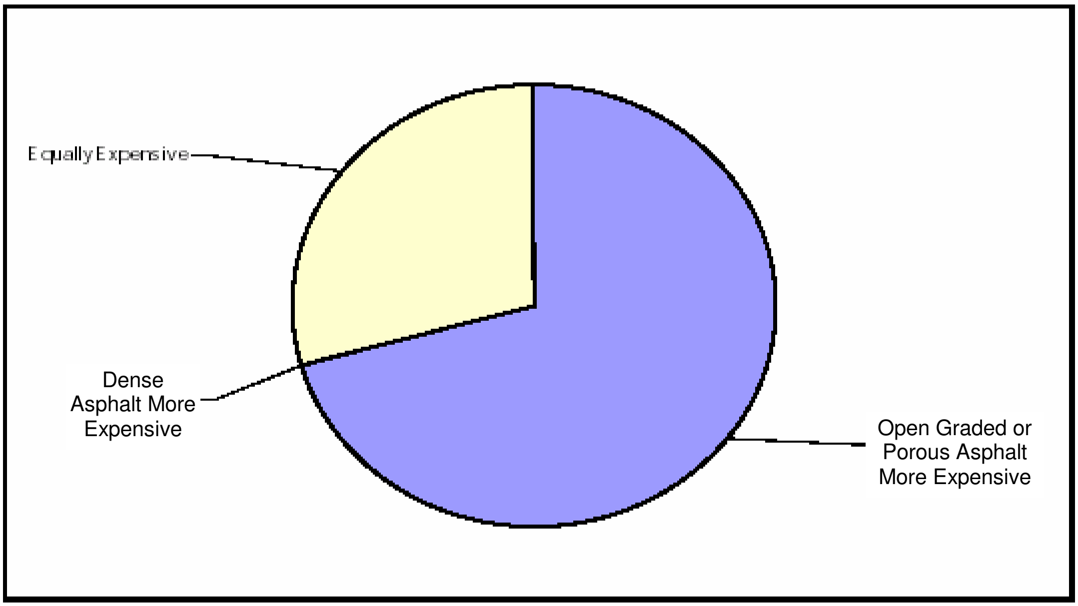


Figure 1: Maintenance Supervisor Perceptions of Cost of Repair of 400 m^2 Area (Rogge and Hunt, 1999)

Cleaning/Unclogging

Van Heystraeten and Moraux (1990) discuss the use of a suction sweeper with water jet for the cleaning of partially clogged pavement surfaces. PIARC (1993) has reported that attempts to restore drainage capacity by flushing the pavement with high-pressure water cleaning or vacuum sweeping machines have not been encouraging. Improvements have been limited to the surface and have only been temporary. Extensive investigations in Austria have shown that the results of cleaning were better the sooner the cleaning processes are applied (Litzka et al., 1999). It is expected that continuing developments in equipment technology may improve the performance of equipment for unclogging of porous road surfaces. The recommended schedule for vacuuming and sweeping is minimally four times annually (Duvall, 2002).

Winter Maintenance

It is noted in the literature that porous asphalts require more salt per unit area than conventional pavements and that in general, brines are ineffective and should not be used. There has been a tendency toward the use of electronic warning systems with porous pavements in France and the Netherlands (PIARC 1993).

A de-icing agent that will stay at the surface of porous pavements rather than disappear into the voids of the pavement is needed. One possibility is mixing Calcium Magnesium Acetate (CMA) with another material that will stay at the surface (Rogge and Hunt, 1999).

According to Austrian experiences the additional deficiencies with winter maintenance, e.g. higher frequency of salt application, are one of the main reasons for restrictions in the use of porous asphalt (Litzka, 2002).

Service Life

The most often cited mode of deterioration for porous asphalt is raveling. PIARC (1993) states that rutting or cracking hardly ever appears in porous asphalts, except for reflection cracks, and says that loss of material is one of the major reasons for road maintenance.

Ruiz et al. (1990) note that "the main problems have come in the form of particle losses in localized or large areas. This process usually occurs very quickly once the flow of traffic begins. This problem usually originates from laying the mixture cold, from too low a level of compaction, or from segregation of the binder. The solution has always been to mill and substitute the withdrawn material for another porous asphalt. In one case, the repair was made by laying one porous asphalt over another; so far, no problems have arisen."

Figure 2 shows the experience of maintenance supervisors regarding the state of open graded surfaces versus dense asphalt surfaces after 6 years (Rogge and Hunt, 1999).

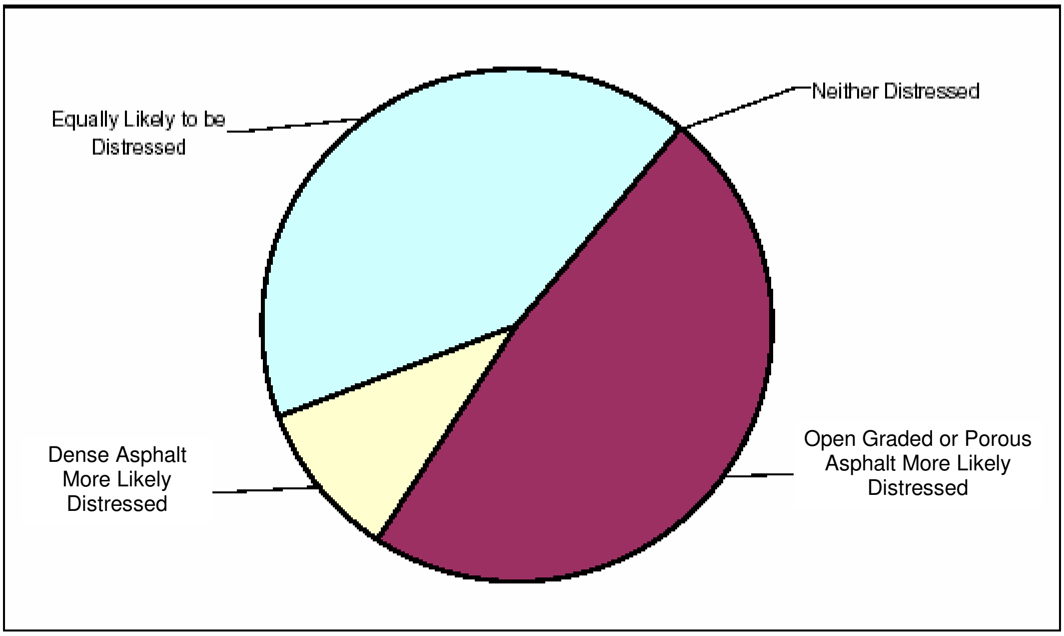


Figure 2: Maintenance Supervisor Perceptions of Six-Year-Old Pavement Distress (Rogge and Hunt, 1999)

It is stated by Tolman (1996) that the after a 5 to 10 year period of slow degradation, the speed of damaging increases on a porous asphalt surface. This has been mentioned as an important disadvantage for systematic pavement management planning in Austria (Pracherstorfer and Litzka, 1994, Litzka, 1997). In the Netherlands experience has shown that the approximate service life for porous asphalt wearing courses is 10 years versus 12 years for dense asphalt concrete (Van der Zwan, et al., 1990).

Recycling

Until recently, outworn porous asphalt has been replaced with a new layer, with no recycling (Brosseaud,1997). However, it has been shown in recent work that it is possible to recycle large shares of outworn porous asphalt (DWW 1998).

In comparison, standard dense asphalt is currently recycled at high rates. For example, in the U.S. over 80% of the total asphalt surface material removed during widening and resurfacing projects is recycled (Duval, 2002). This high rate is at least in part due to the development of the cold milling machine. This equipment provides the supply of recyclable material and is an integral part of the rehabilitation process (Acott, 2000). Cold-mix recycling for standard pavements is one of the various recycling methods available today. Cold-mix recycling can result in a stable pavement at a total expenditure of 40 to 50 percent less than that required by conventional construction methods(ARRA, 1991). Cold-mix asphalt recycling is defined as a process in which reclaimed asphalt pavement materials are combined with new asphalt and/or recycling agents to produce cold base mixtures. Because of the unique potential of conserving resource and energy, cold-mix recycling has become one of the most popular rehabilitation technique (USDOT, 1997). In contrast, hot mix recycling is the process in which reclaimed asphalt pavement materials are combined with new materials, sometimes along with a recycling agent, to produce hot mix asphalt mixtures. According to a European point of view this is reuse on the highest level of value.

Currently, the level of recycling of dense asphalt in Europe varies strongly between countries. In some countries in Europe the recycling rate of materials in the highway environment frequently reaches 100 percent. The following are examples of the recycling rate of asphalt in some European countries (Holtz and Eighmy, 2000):

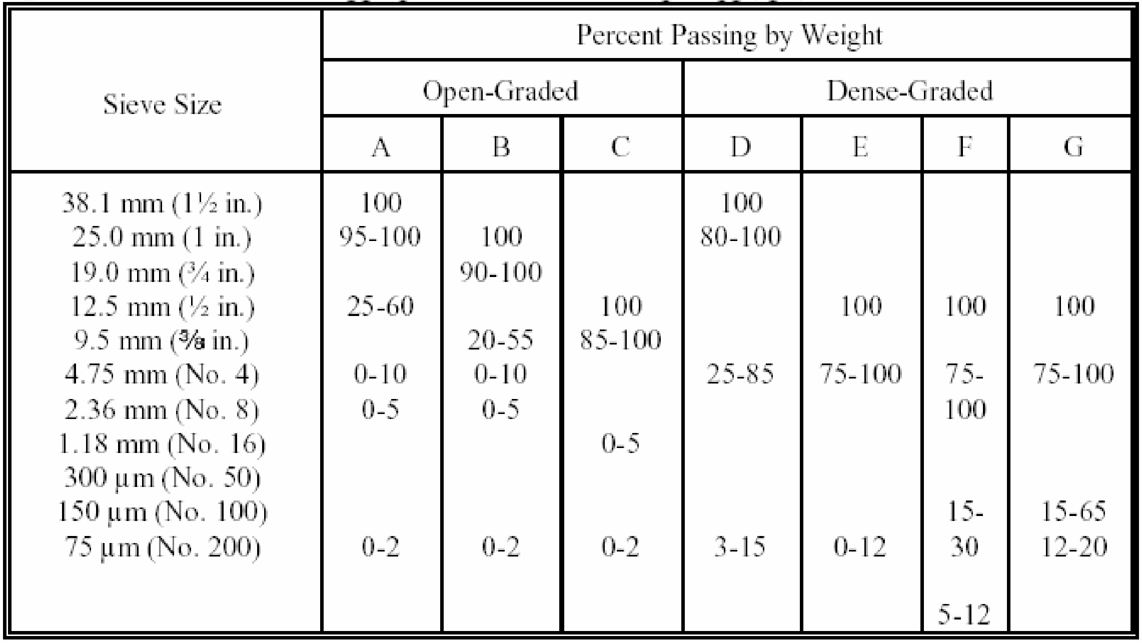
- Sweden: Reclaimed Asphalt Pavement = 95 percent, with 0.76 million metric tons used and 0.80 million metric tons produced
- Germany: Reclaimed Asphalt Pavement = 55 percent, with 6.6 million metric tons used and 12 million metric tons produced
- Denmark: Reclaimed Asphalt Pavement = 100 percent, with 0.48 million metric tons used and produced.
- Netherlands: Reclaimed Asphalt Pavement = 100 percent, with 0.1 million metric tons used and produced.

Also, when using concrete as the basis instead of dense asphalt, it has been shown by Wilcken and Fleischer (1999) that 100% recycling of road concrete is possible.

Because of their planned high usage of porous asphalts, the Dutch are placing an emphasis on recycling of porous pavements, both in-plant and in-place (Van der Kooij and Verburg, 1996). The most common porous asphalt recycling takes place in stationary plants using a hot-mix procedure (World Highways, 2004).

Duvall (2002) discusses the recycling of porous asphalt using a mill-and-replace procedure with a new porous mix. A comparison of the possible recycling rates as a function of aggregate size for cold milling is given in Table 1 (USDOT, 1997).

Table 1: Guidelines for Quantities of Recycled Asphalt Product and Virgin Asphalt in Open- and Dense-Graded Surfaces as a Function of Aggregate Size (USDOT, 1997)



Sieve Size	Percent Passing by Weight						
	Open-Graded			Dense-Graded			
	A	B	C	D	E	F	G
38.1 mm (1½ in.)	100			100			
25.0 mm (1 in.)	95-100	100		80-100			
19.0 mm (¾ in.)		90-100					
12.5 mm (½ in.)	25-60		100		100	100	100
9.5 mm (⅜ in.)		20-55	85-100				
4.75 mm (No. 4)	0-10	0-10		25-85	75-100	75-	75-100
2.36 mm (No. 8)	0-5	0-5				100	
1.18 mm (No. 16)			0-5				
300 µm (No. 50)							
150 µm (No. 100)						15-	15-65
75 µm (No. 200)	0-2	0-2	0-2	3-15	0-12	30	12-20
						5-12	

Additionally, a study in the UK on the recycling of material for porous pavements noted that inspection of site trials carried out in Holland has confirmed the technical feasibility of recycling Porous Asphalt (TRL, 1996).

Overview: Porous Asphalt Versus Dense Asphalt

Based on the information given in this report, the following conclusions can be drawn concerning the lifetime and recycling of porous asphalt versus dense asphalt.

1. Reduced durability of porous asphalt will tend to increase material use - and increase energy consumption in the paving and maintenance (sealing, repaving and salting/cleaning). The average estimated lifetime of porous asphalt is 10 years versus 12 years for dense asphalt concrete (Van der Zwan, et al., 1990).

2. Until recently, outworn porous asphalt has been replaced with a new layer, with no recycling (Brosseaud,1997). However, it has been shown in recent work that it is possible to recycle large shares of outworn porous asphalt (DWW 1998). Guidelines for recycling rates of open graded pavements show the possibility of generally 50 to 80% recycling (Table 1, USDOT, 1997).

3. In comparison, the average rate of recycling for dense asphalt in the U.S. and Europe is roughly 80% (Holtz and Eighmy, 2000, Duval, 2002).

4. It has also been shown (e.g., DWW, 1998, Wilcken and Fleischer, 1999), that recycling can be performed with different technologies - and one technology involves in situ recycling (as an alternative to recycling via a plant). The extent of recycling possible by these two methods would also be of interest, but unfortunately, these results were not obtainable in the scope of this research. It is expected that the difference in possible rate of recycling would be more dependent on the type of recycling (hot mix vs. cold mix) than on the technology of in situ versus plant recycling.

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