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PJV

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**Discussion of “Evaluating the relationship between permeability and
moisture damage of asphalt concrete pavements” by Rafiqul A. Tarefder
and Mohiuddin Ahmad**

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Discussion of “Evaluating the relationship between permeability and moisture damage of asphalt concrete pavements” by Rafiqul A. Tarefder and Mohiuddin Ahmad

Contribution by P. J. Vardanega and T. J. Waters

The authors have presented a very interesting study (Tarefder and Ahmad, 2014) that presents in-situ field permeability data as well as laboratory permeability data on field core samples from asphalt concrete pavements. Field data is always pleasing to see and the authors should be congratulated for publishing it. We have some comments we would like to make and they are given below.

The pavements studied by the authors are multi-layered making the situation quite complex and, further, making it difficult to isolate the relevant factors affecting moisture damage. Figure 8c in the paper shows that TSR decreases with permeability. The question of whether TSR correlates with moisture damage will depend on several factors, in particular whether the water can drain away.

Permeability Level

In the abstract, the authors state that the average field permeability of the good pavements is 56×10^{-5} cm/s and that of the bad pavements is 87×10^{-5} cm/s. This is perhaps not much of a difference. As shown in Table 1 given in Vardanega and Waters (2011) and based on earlier work from one of the discussers (e.g., Waters, 1998) these two permeability levels would fall in the moderate permeability category. It is worth noting that in Figure 4 of the paper under discussion (Tarefder and Ahmad, 2014) the average field permeability of good-performing pavements is stated as 62.7×10^{-5} cm/s (moderate permeability – Table 1) while that of the

bad-performing pavements is stated as 298×10^{-5} cm/s (permeable– Table 1). This difference is more significant.

Field versus Laboratory Permeability

The authors conclude that '*field permeability is higher than laboratory permeability in most cases. These two parameters cannot be correlated, as field permeability has a lot of variables*'. This finding is generally supported by the results of the recent review presented in Vardanega (2014) while noting that there may be some correlation at lower values of permeability (e.g., as reported in Cooley et al. 2002).

Effective Particle Sizes

Waters (1998) (also reviewed in Reid et al. 2006), proposed the normalised voids concept that incorporates a grading parameter, the 50 percentile particle size, D50 (mm), with the percentage air voids, n :

$$NV = n (D50/4.75) \quad (1)$$

In the normalised voids approach, the permeability is directly related to the normalised voids rather than voids alone. This approach is an attempt to compensate for the effect of particle size, in particular the D50 particle size. Subsequently, Vardanega and Waters (2011) introduced the concept of a representative pore size and statistically demonstrated that other coarse fractions (effective particle sizes above D50) could also be related to asphalt concrete permeability. Therefore, a measure of effective particle size (e.g., D50), in combination with air voids, is generally found to be a good predictor of permeability.

Incorporating the D50 effective particle size, as well as air voids, will generally reduce the scatter of permeability data. In the paper under discussion (Tarefder and Ahmad, 2014), if the gradations are considerably different between the mixtures that comprise the pavement layers

(and gradations are available) the authors may be able to reduce the scatter on Figure 11 by applying either the normalised voids or representative pore size approaches.

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Table 1: Categorisation of permeability levels for asphalt concrete (from Vardanega and Waters, 2011)

Permeability (mm/s)	Category	Description
1×10^{-5} to 1×10^{-4}	A1	Very low permeability
1×10^{-4} to 1×10^{-3}	A2	Low permeability
1×10^{-3} to 1×10^{-2}	B	Moderate permeability: some water infiltrating under traffic
1×10^{-2} to 1×10^{-1}	C	Permeable: substantial water entering under traffic
1×10^{-1} to 1	D	Moderately free-draining: permeates freely under traffic or raindrop impact. Pumping of fines
1 to 10	E	Free draining