

CITY OF COLUMBUS, OHIO

**SUPPLEMENT 1037
METHOD OF TEST FOR DETERMINATION
OF PERCENT VOIDS IN THE MINERAL AGGREGATE (VMA)
IN COMPACTED ASPHALT CONCRETE MIXTURES**

October 31, 2011

1037.01 SCOPE. This method covers the procedure for the determination of voids in the mineral aggregate (VMA) in a compacted mixture.

1037.02 DEFINITION. VMA is defined as the intergranular void space between the aggregate particles in a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume.

1037.03 SUMMARY OF METHOD. Determination of VMA is based on bulk specific gravity of the aggregate and is expressed as a percentage of the bulk volume of the compacted paving mixture. VMA is calculated by subtracting the volume of the aggregate determined by its bulk specific gravity from the bulk volume of the compacted paving mixture.

1037.04 CALCULATIONS. Determining VMA in mixtures containing:

- 1. 100% NEW MATERIAL** (for mixtures incorporating recycled material, see 2. following).

$$\text{VMA} = 100 - \frac{G_{mb}P_s}{G_{sb}}$$

where

VMA = Voids in mineral aggregate (percent of bulk volume)
G_{mb} = bulk specific gravity of compacted mixture (ASTM D 2726)
P_s = aggregate, percent by total weight of mixture
G_{sb} = bulk specific gravity of total aggregate
G_{sb} = $\frac{P_1 + P_2 + \dots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots + \frac{P_n}{G_n}}$

where

P₁, P₂, ..., P_n = percentage by weight of aggregates 1, 2, ..., n
G₁, G₂, ..., G_n = bulk specific gravities of 1, 2, ..., n (AASHTO T 84 and T 85)

- 2. Recycled materials.**

$$\text{VMA} = 100 - \frac{G_{mb}P_s}{G_{sb}}$$

Where:

VMA = voids in mineral aggregate (percent of bulk volume)

$$\begin{aligned}
G_{mb} &= \text{bulk specific gravity of compacted mixture (ASTM D 2726)} \\
P_s &= \text{aggregate, percent by total weight of mixture} \\
G_{sb} &= \text{bulk specific gravity of total aggregate} \\
G_{sb} &= \frac{P_1 + P_2 + \dots + P_n + P_{RAP}}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots + \frac{P_n}{G_n} + \frac{P_{RAP}}{G_{seRAP}}}
\end{aligned}$$

where

$$\begin{aligned}
P_1, P_2, \dots, P_n &= \text{percentage by weight of aggregates 1, 2, \dots, n} \\
G_1, G_2, \dots, G_n &= \text{bulk specific gravities of 1, 2, \dots, n (AASHTO T 84 and T 85)} \\
P_{RAP} &= \text{percentage by weight of recycled aggregate} \\
G_{seRAP} &= \text{effective specific gravity of the recycled aggregate}
\end{aligned}$$

$$G_{seRAP} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}}$$

where

$$\begin{aligned}
P_b &= \text{asphalt content of recycled material, percent by total weight} \\
G_{mm} &= \text{theoretical maximum specific gravity of recycled material (ASTM D 2041)} \\
G_b &= \text{specific gravity of the asphalt in recycled material}
\end{aligned}$$