MATTEST
Engineering Services

Quality care is only fair...

Bituminious Testing

Website : mattestlab.com

E-mail : rvmattest@gmail.com

Vishal Raiyani
(M.Tech)

CONTENTS

SPECIFIC GRAVITY TEST FOR BITUMEN

STANDARD: I.S. 1202-1978 (RA 2009)

- This standard covers the methods for the determination of specific gravity of asphalt, bitumen, bituminous products, road tar, coal tar, coal tar pitch, creosote and anthracene oil.

DEFINATION

- Specific gravity is the ratio of the mass of a given volume of the substance to the mass of an equal Volume of water.

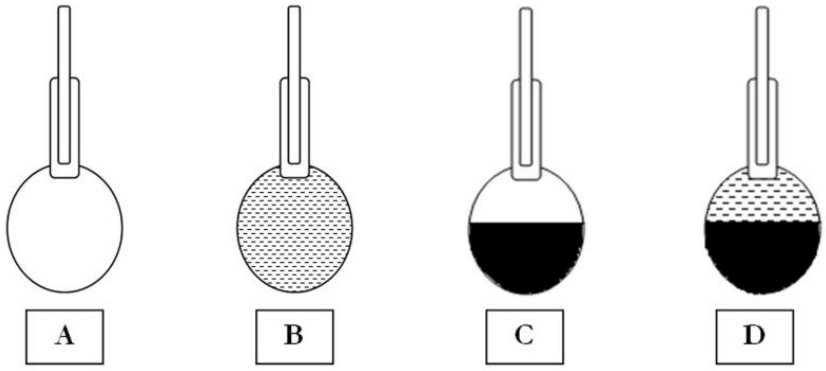
APPARATUS

1. Specific Gravity Bottle (50 ML)
2. Constant Temperature Bath
3. 0 - 44^0 C Thermometer
4. Balance of capacity 500grams and sensitivity 0.01gm.

PROCEDURE

1. Clean, dry and weigh the specific gravity bottle together with the stopper (A).
2. Fill it with freshly boiled and cooled distilled *water* and insert the stopper firmly.
3. Keep the bottle up to its neck for not less than half an hour in a beaker of distilled water at
   a temperature of 27.0 ± 0.1°C or any other temperature at which specific gravity is to be determined.
4. Wipe all surplus moisture from the surface with a clean, dry cloth and weigh it.
5. Bring the bituminous material to the fluid condition by gentle application of heat, care being taken to prevent loss by evaporation.
6. When the material is sufficiently fluid, pour the bituminous material in to the clean, dry specific gravity bottle to fill at least half.
7. Slightly warm the bottle before filling the material.
8. Keep the material away from touching the sides above the final level of bottle and avoid the inclusion of air bubbles.
9. The use of small funnel will prevent contamination of the neck of the bottle.

10. To permit escape of entangled air bubbles, allow the partly filled bottle to stand for half an hour at a suitable temperature, then cool to the specified temperature and weigh with the stopper (C).
11. Fill the specific gravity bottle containing the asphalt with freshly boiled and cooled distilled water placing the stopper loosely in the specific gravity bottle.
12. Do not allow any air bubble to remain in the specific gravity bottle.
13. Place the specific gravity bottle in the water bath and press the stopper firmly in place.
14. Allow the specific gravity bottle to remain in the water bath maintained at a temperature of 27.0 ± 0.1°C for a period of not less than 30 minutes.
15. Remove the specific gravity bottle from the water bath, wipe all surplus moisture from the surface with a clean with a clean dry cloth and weigh it along with the stopper (D).



CALCULATIONS

$$\textbf{Specific Gravity} = \frac{\textbf{(C-A)}}{\textbf{(B-A) - (D-C)}}$$

A = weight of specific gravity bottle.

B = weight of specific gravity bottle filled with distilled water.

C = weight of specific gravity bottle about half filled with the bituminous material.

D = weight of specific gravity bottle about half filled with the material and the rest with Distilled water.

REPORT

- Express the ratio of mass of a given volume of the bituminous material to the mass of an equal volume of water.

PRECAUTIONS:

- Only freshly boiled and cooled distilled water shall be used.
- At no time of weighing shall the temperature of the apparatus be allowed to exceed the specified temperature.

DUCTILITY TEST OF BITUMEN

STANDARD: I.S. 1208-1978 (RA 2009)

- This standard covers the method of determination of ductility of distillation residue of cutback bitumen, blown type bitumen and other bituminous products.

DEFINATION

- The ductility of bituminous material is the distance in centimetres to which it will elongate before breaking when a briquette specimen of the materials is pulled a specified speed and at specified temperature.

APPARATUS

1. Ductility Mould made of brass.
2. Thermostatically Water Bath of 10 Liter Capacity
3. Ductility testing Machine
4. Thermometer 250^{0}C capaple of reading up to 0.01^0 C.

PROCEDURE

1. Unless otherwise specified this test shall be conducted at a temperatures of 27 ± 0.5^{0}C and at a rate of pull of 50 ± 2.5mm/min.
2. Melt the bitumen to be tested to a temperature of 75 to 100^{0}C above its approximate softening point till it becomes fluid.

3. Assemble the mould on the brass plate and coated on all the sides with a mixture glycerine and dextrin of equal parts to avoid sticking of the material.
4. Fill the mould until it is more than level full.
5. In filling the mould, pour the material in a thin stream back & forth from end to end of the mould.
6. Leave it to cool room temperature for 30 to 40 minutes and then place it in water bath maintained at a specified temperature for 30 minutes.
7. Cut off bitumen by means of hot straight edged putty knife level full.
8. Place the brass plate and mould with briquette specimen, in the water-bath and keep at the specified temperature for about 85 to 95 minutes.
9. Remove the briquette from the plate; detach sidepieces and the briquette immediately.
10. While the test is being conducted, make sure that the water in the tank of the testing machine covers the specimen above by at least 25 mm and is maintained continuously within ± 0.5^0C of specified temperature.
11. Attach rings at each end of the clips to hooks in the testing machine and pull the two clips apart horizontally at a uniform speed as specified until the briquette ruptures.
12. At least three determinations shall be made for each test.

REPORT

- Report the average of three normal tests s ductility of the sample, provided that, the three determinations be within ± 5% of their mean value.
- If the values of three determinations do not lie within ± 5% of their mean but the two higher values are within ± 5% of their mean, then recored the mean of two higher values as the test result.

PRECISION

- The duplicate test results should not differ by more than the values given below

Repeatability	Reproducibility
10% of mean	20% of mean

PRECAUTION

- In filling the mould care shall be taken to see that no air bubbles shall be formed, and not to disarrange the parts and thus distorting the briquette.
- **SPECIFIED DUCTILITY FOR DIFFERENT GRADE BITUMEN: (AT 27 DEG. C)**

TYPE OF BITUMEN	DUCTILITY AT 27°C.
BITUMEN 30/40	50
BITUMEN 60/70	75
BITUMEN 80/100	75

PENETRATION TEST OF BITUMEN

STANDARD: I.S. 1203-1978 (RA 2009)

- This standard covers the method for the determination of penetration of asphaltic bitumen and fluxed native asphalt and blown type bitumen.

DEFINATION

- Penetration of a bituminous material is the distance in tenths of a millimetre that standard needle will penetrate vertically into a sample under standard condition of temperature, load & time.

APPARATUS

1. Penetrometers
2. Time Measuring Device
3. Thermometer
4. Water Bath
5. Needle
6. Container
7. Transfer Dish
8. Time Device

PROCEDURE

1. Soften the material to a pouring consistency at a temperature not more than 60 ^{0}C for tars and pitches and not more than 90 ^{0}C for bitumen above the approximate respective softening points.
2. Stir it thoroughly until it is homogeneous and free from air bubbles and water.
3. Pour the melt in to the container to a depth of at least 10mm in excess of the expected penetration.
4. Protect the sample from dust and allow it to cool in atmosphere at a temperature between 15 to 30 ^{0}C for 11/2 to 2 hours for 45mm deep container and 1 to 11/2 hours for 35mm deep container.
5. Unless otherwise specified carry out testing at a temperature of 25 ± 0.1 ^{0}C.

6. Place it along with the transfer dish in the water bath 25 ± 0.1 ^{0}C and allow it remain for 11/2 to 2 hours for 45mm deep container and 1 to 11/2 hours for 35mm deep container.
7. Fill the transfer dish with water from the water bath to a depth sufficient to cover the mould completely.
8. Remove the transfer dish along with the mould from water bath after specified period of time and put it upon the stand of penetration apparatus.
9. Adjust the needle (previously washed, cleaned well with benzene and dried) just to make contact with the surface of the sample.
10. The sum of weights of the needle, carrier and super imposed weights i.e. the total moving weight shall be 100 ± 0.25 grams.
11. Bring the pointer to zero.
12. Release the needle for five seconds and measure the distance penetrated.
13. Make at least three determinations at points on the surface of the sample not less than 10mm apart and not less than 10mm from the side of the dish.
14. After each test, return the sample and transfer dish to the water bath and wash the needle with benzene and dry.
15. In case of material of penetration greater than 225 make three determinations on each of two identical test specimens using a separate needle for each determination, leaving the needle in the sample on completion of each determination to avoid disturbance of the specimen.

REPORT

- Express the depth of penetration of the needle in tenths of mm.
- The value of penetration reported shall be the mean of not less than three determinations whose values do not differ by more than the difference given below.

Penetration	Maximum difference
0 to 49	2
50 to 149	4
150 to 249	6
250 and above	8

PRECISION:

- The duplicate results should not differ by more than the following.

Penetration	Repeatability	Reproducibility
Below 50	1 Unit	4 Unit
Above 50	3% of their mean	8% of their mean

PRECAUTIONS

- If the sample contains extraneous matter, it should be sieve through I.S. Sieve 30.
- To avoid over heating at the bottom of the container, use of an air oven or sand bath is recommended.
- While the needle is penetrating into the sample, if there is any movement of the container, that determination shall be discarded.

SOFTENING POINT TEST OF BITUMEN

STANDARD: I.S. 1205-1978 (RA 2008)

- This standard covers the method for the determination of softening point of asphaltic bitumen and fluxed native asphalt, road tar, coal tar pitch and blown type bitumen.

DEFINITION

- Softening point is the temperature at which the substance attains a particular degree of softening under specified conditions of test.

APPARATUS

1. Standard Ring and Ball Apparatus.
2. Brass Rings.
3. Thermometer.
4. Water Bath
5. Steel Balls.
6. Stirrer
7. Ball Guide
8. Beaker

PROCEDURE

1. Heat the material to a temperature between 75°C and 100 °C above its softening point,

2. Stir until it is completely fluid and free from air bubbles and water, and filter if necessary, through IS sieve 30.
3. Place the rings; previously heated to a temperature approximately to that of molten material on a metal plate, which has been coated with a mixture of equal parts of glycerin and dextrin.
4. Fill the mould with sufficient melt to give excess above the level of the ring.
5. Remove the excess material with a warmed sharp knife after cooling in air for 30 minutes.
6. Assemble the apparatus with the rings, thermometer and ball guides in position.
7. Fill the bath to a height of 50 mm above the upper surface of the rings with the freshly boiled distilled water or pure glycerin at a temperature of 5 ^{0}C.
8. The water bath liquid shall be freshly boiled distilled water when testing materials having softening points below 80^{0}C and pure glycerin for material having softening points above 80 ^{0}C.
9. There shall be exactly 25mm difference between the bottom of the rings and the top surface of the bottom plate of the support, if any, and the bottom of the bath.
10. Maintain the bath at a temperature of 5 ^{0}C for 15 minutes after which place the balls previously cooled to a temperature of 5 ^{0}C by forceps in each ball guide.
11. Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5 ± 0.5 ^{0}C per minute until the material softens and allow the balls to pass through the ring.
12. Record the temperature shown by the thermometer for each ring and ball at the instant the sample surrounding the ball touches the bottom plate of the support, if any or the bottom of the bath.
13. Record the temperature shown by the thermometer for each ring and ball at the instant the sample surrounding the ball touches the bottom plate of the support, if any or the bottom of the bath.

REPORT

- Report to the nearest 0.5 ^{0}C the mean of the temperature recorded in duplicate as the softening point.

PRECISION

- Test results shall not differ from the mean by the following.

Softening Point	Repeatability	Reproducibility
40 to 60	1.00	5.50
61 to 80	1.50	5.50
81 to 100	2.00	5.50
101 to 120	2.50	5.50
121 to 140	3.00	5.50

PRECATUTIONS

1. The stirrer shall be so placed that the moulds are not disturbed when the stirrer is in operation.
2. The prescribed rate of heating shall be rigidly adhered to for ensuring accuracy of results.
3. The rate of temperature rise shall not be averaged over the period of the test.

ABSOLUTE VISCOSITY TEST OF BITUMEN

STANDARD: IS: 1206-(Part II) 1978 (RA 2009)

- This standard covers the determination of absolute viscosity of bitumen and cut-backs by vacuum capillary viscometers at any specified temperature. It is applicable to materials having a viscosity range of 42 to 200000 Poises.

APPARATUS

1. Constant Temperature Bath –
2. Silicone Bath Oil suitable up to 150 C
3. Vacuum System
4. Thermometer for Bath–Mercury in glass, range 37.8 to 82 C & graduations of 0.2 C.
5. Timing Device – A stop watch or stop clock capable of reading up to ½ second.
6. Cannon-Manning Vacuum Viscometers- With manufacturers' calibration certificate, viscometer holder and silicone cork. Size 12 and Size 13 (one each) [Size 12 is suitable for testing VG-10 and Size 13 is suitable for testing VG-20, VG-30, and VG-40 bitumen.]

PROCEDURE

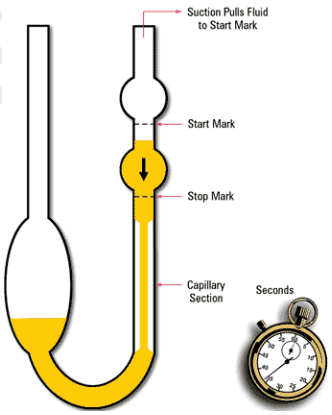
- Heat the bitumen sample to a temperature not more than 90 C above its approx.
- Softening point until is has become sufficiently fluid (like motor oil) to pour easily.
- Transfer about 20 ml into a suitable container and maintain at a temperature of 135 ± 5.5 C stirring occasionally to allow entrapped air to

escape. Pour the hot bitumen in the Canning-Manning vacuum viscometer through the larger diameter filling tube A so that bitumen is within ± 2 mm of the fill line E.

- Place the charged viscometer in an oven or bath maintained at 135 ± 5.5 C for a period of 10 ± 2 minutes to allow larger air bubbles to escape.

TESTING

- Maintain the test bath temperature at 60 ± 0.1 C.
- Place the charged viscometer vertically in the test bath with the help of a holder so that that the uppermost timing mark is at least 2 cm below the surface of the bath liquid.
- Establish a vacuum of 30 ± 0.05 cm of mercury in the vacuum system and connect to the viscometer with the valve closed. After the viscometer has been in the bath for 30 ± 5 min, open the valve and allow the bitumen to flow in the viscometer.
- Measure the time required (to within ± 0.5 sec) for the leading edge of the meniscus to pass between successive pairs of timing marks. Report the first flow time which exceeds 60 sec between a pair of timing marks, noting the identification of the pair of the timing marks.



CALCULATION

- Calculate and report the absolute viscosity in poises to three significant figures as follows:

Absolute Viscosity in poises = K t

Where, K = Calibration factor in poise per second supplied with the viscometer tube for the pair of timing marks where the flow time exceeded 60 seconds.

t = flow time in second

KINEMATIC VISCOSITY TEST OF BITUMEN

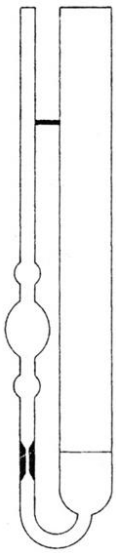
STANDARD: I.S. 1206 (Part III) -1978 (RA 2009)

- This standard (Part III) covers the method for the determination of kinematic viscosity of paving grade and cut-back bitumen and distillation residues of cut-backs. It is applicable to the materials having a viscosity range of 30-100000 cSt.

DEFINITION

- Kinematic viscosity is defined as the quotient of the absolute or dynamic viscosity divided by the density of the liquid both at the same temperature.

APPARATUS



1. Constant Temperature Bath
2. Silicone Bath Oil suitable up to 150 C, Vacuum
3. Thermometer for Bath – Mercury in glass, range 37.8 to 82 C, and graduations of 0.2 C.
4. Timing Device – A stop watch or stop clock capable of reading up to ½ second.
5. Cannon-Manning Vacuum Viscometers- With manufacturers' calibration certificate, viscometer holder and silicone cork. Size 12 and Size 13 (one each) [Size 12 is suitable for testing VG-10 and Size 13 is suitable for testing VG-20, VG-30, and VG-40 bitumen.]

PROCEDURE

1. Heat the sample to a temperature not more than 60°C for tars and pitches and not more than 90% for bitumen above the corresponding approximate softening point temperature respectively until it attains pouring consistency.
2. Stir it thoroughly and transfer approximately 20 ml in a 30 ml container. Local over-heating and entrapped air should be avoided.
3. Mount the BS U-tube viscometer in the constant temperature bath keeping tube ***L*** vertical.
4. Pour sample through tube N to a point just above filling mark G, allow the sample to flow freely through capillary R, taking care that the liquid column

remains unbroken until the lower mark H and then arrest its flow by closing the timing tube with a cork or rubber stopper in tube ***L.***

5. Add more liquid, if necessary to ~bring the upper meniscus slightly above mark G.
6. After allowing the sample to attain bath temperature and any air bubble to rise to the surface (usually about 20-30 min is required), gently loosen the stopper allowing the sample to flow until it is approximately at the lower filling mark ***H*** and press back the stopper to arrest flow.
7. Remove the except sample above filling mark G by inserting the special pipette until its cork rests on top of the tube N and apply gentle suction until air is d:-awn through.
8. The upper meniscus shall coincide with mark G.
9. Allow the viscometer to remain in -the constant temperature bath for a sufficient time to ensure that the sample reaches temperature equilibrium.
10. It takes about 20 min at 38°C, 25 min at 100°C and 30 min at 135°C. Remove the stopper in the tube N and ***L*** respectively and allow the sample to flow by gravity.
11. Measure to the nearest O-1 sec. the time required for the leading edge of the meniscus to pass from timing mark E to timing mark I;. If this efflux time is less than~60 s, select a viscometer of smaller capillary diameter and repeat the operation.
12. Upon completion of the test, clean the viscometer thoroughly by several mixing with an appropriate solvent completely miscible with the sample followed by a completely volatile solvent. Dry the tube by passing slow stream of filtered dry air through the capillary until the last trace of solvent is removed.

CALCULATION

- Calculate the kinematic viscosity up to three significant figures with the help of following equation:

Kinematic viscosity cSt = Ct

Where, C = calibration constant of the viscometer in centi-stokes per second, and

t = efflux time in second.

BINDER CONTENT TEST

STANDARD: ASTM: D 2172 (RA 2011)

This Standard Covers the Quantitative Determination of Bitumen in Hot – Mixed Paving Mixtures of Pavement Sample.

APPARATUS

- Extraction Apparatus Bitumen Extractor (Hand Operated).
- Electronics Balance
- Spatula.
- Tri-chloro Ethylene
- Transfer Tray / Bowl.
- Filter Paper

PROCEDURE

1. Weigh Bowl + Filter Disc…… (1)
2. Weigh Mix Sample…… (2)
3. Weigh Bowl + Filter Disc + Sample…… (3)
4. Weigh Bowl + Filter Disc + Dry Sample (After Extraction)…. (4)
5. Weight of Dry Mix…… (4) – (1)
6. Weight of Bitumen…… (3) – (4)

BINDER CONTENT (%)

1. By Wt. of Total Mix …… $\frac{(3) - (4)}{(2)}$ X 100

2. By Weight of Aggregate …… $\frac{(3) - (4)}{(4) - (1)}$ X 100

UTILITY

- This is a Quality Control Check Test. The Value Obtained Shall Be Compared With The Designed Value of Binder Content.

MARSHALL TEST

STANDARD: ASTM D 6927 (RA 2006)

- This standard covers the determination of Bulk density Stability and voids in bituminous mixes.

APPARATUS

1. Mould Assembly
2. Compaction Pedestal
3. Sample Extractor
4. Breaking Head Loading Machine Flow Meter

PROCEDURE

- In the Marshall method each compacted test specimen is subjected to the following tests and analysis in the order listed below:
    1. Bulk density determination,
    2. Stability and flow test,
    3. Density and voids analysis.
- At least three samples are prepared for each binder contents are selected.

PREPARATION OF TEST SPECIMEN

1. The coarse aggregates, fine aggregates and the filler material should be proportioned and mixed in such a way that final mix after blending has the gradation within the specified range.

2. The aggregates and filler are mixed together in the desired proportion as per design requirements and fulfilling the specified gradation. The required quantity of the mix is taken as to produce a compacted bituminous mix specimen of thickness 63.5 mm approximately.
3. Approximately 1200 gm of aggregate and filler are taken and heated to a temperature of 175°c to 190°c. The compaction mould assembly and rammer kept pre – heated to a temperature of 100 ° c to 145°c. The bitumen is heated to temp. of 121 to 138° c and the required quantity of first trial percentage of bitumen (say 3.5% by weight of mineral agg.) is added to the heated aggregate and thoroughly mixed using a mechanical mixer or by hand mixing with trowel.
4. The mixing temp. For 80/110 grade bitumen may be around 154°c and that for 60/70 grade about 160°c. The mix is placed in a mould and compacted by rammer, with 50 blows on either side. The compacting temp may be about 138°c for 80/100 grade bitumen and 149°c for 60/70 grade.
5. The compacted specimen should have a thickness of 63.5 mm. The weight of the aggregate taken may by suitably altered to obtain a thickness of 63.5±3.0 mm. At least two specimens, but preferably three or four specimens should be prepared at each trial bitumen content which may be varied at 0.5 percent increments up to about 7.5 or 8.0 percent.

TEST

Specific Gravity of the Compacted Specimen

- The sp. Gravity values of the different agg., filler and bitumen used are determined first. The theoretical sp. Gravity Gt of the mix is given by:

$$G_t = 100 / ((W_1 / G_1) + (W_2 / G_2) + (W_3 / G_3) + (W_4 / G_4))$$

Where, W_1 = percent by weight of coarse agg.

W_2 = percent by weight of fine agg.

W_3 = percent by weight of filler

W_4 = percent by weight of bitumen in total mix.

G_1, G_2, G_3, are apparent sp. Gravity values of the coarse agg., fine agg. And filler respectively and G4 is the sp. Gravity of bitumen.

DENSITY AND VOIDS ANALYSIS

- Soon after the compacted bituminous mix specimens have cooled to room temp, the weight, average thickness and diameter of the specimen are noted.
- The sp. are also weighed in air and then in water. The bulk density value Gb of the specimen, if calculated from the weight and volume.
- The voids analysis are made as given below:

Vv % = 100 (Gt – Gb) / Gt

Vb % = (Gb X W4) / G4

VMA % = Vv + Vb

VFB % = 100 X Vb / VMA

Where, Vv = Air voids in the mix, %,
Vb = Volume of bitumen,
VMA = Voids in mineral agg. %,
VFB = Voids Filled with bitumen, %.

MARSHALL STABILITY AND FLOW VALUES

- The sp. To be tested are kept immersed under water in a thermostatically controlled water bath maintained at 60° c ± 1° c for 30 to 40 minutes.
- The sp. Are taken out one by one, placed Marshall test head and the Marshall st. values (max. load carried in kg, before failure) and the flow value(the deformation the specimen under goes during loading in 0.25 mm units) are noted.
- The corrected Marshall st. values of each sp. Is determined by applying the appropriate correction factor, if the average height of the sp. Is not exactly 63.5 mm.

DETERMINATION OF OPTIMUM BITUMEN CONTENT

- Five graphs are plotted with values of bitumen content against the values:

1. Density Gb, gm / cm3.
2. Marshall Stability, S Kg.
3. Voids in total mix, Vv %.
4. Flow Value , F (0.25 mm units)
5. Voids filled with bitumen, VFB %.

- Let the bitumen content corresponding to maximum density be B1, corresponding to maximum stability be B2 and that corresponding to the sp. Voids content Vv(4.0 % in the case of dense AC mix.) be B3. Then the optimum bitumen content for mix design is given by :

$$\mathbf{Bo = (B1 + B2 + B3) / 3}$$

- The value of flow and VFB are found from the graphs, corresponding to bitumen content Bo. All the design values of Marshall Stability, flow, voids, and VFB are checked at the optimum bitumen content Bo. With the sp. Design requirements of the mix.

CALCULATION

Percent Air Voids :

Vv = (Gt – Gb)X100/Gt

Where, Gb = Bulk Density

Gt = theoretically sp. Gravity mix.

Gt = 100 / ((W1/G1) + (W2/G2)+(W3/G3)+(W4/G4))

Percent of Voids in Mineral Aggregate

VMA = Vv + Vb

Where, Vb = Gb X W4 / G4

Percent of Voids field with Bitumen of Tar VFB = 100 x Vb / VMA