

Set 1 Last 3 years ques solve

① What are classification of aggregates based on source, size and weight?

Based on source

i) Natural — Crushed stone,
Crushed boulders
gravels
shingles
sands etc.

ii) Artificial — Crushed brick
clay + pfa
synthetic etc.

Based on size

i) Coarse Aggregate, CA —
passing maximum size & retained on 4.75mm sieve

ii) Fine Aggregate, FA —
passing 4.75mm sieve & retained on 0.15/0.075mm sieve

iii) Silt & Clay or dust or fines or filler —
passing 0.075mm sieve

Based on Weight (Specific Gravity)

i) Normal Weight -

bulk unit weight, $1520-1680 \text{ kg/m}^3$ (95-105 pcf)

so that,

normal weight concrete (NWC) has a unit weight

2400 kg/m^3 (150 pcf)

ii) Light Weight -

bulk unit weight $< 1120 \text{ kg/m}^3$

iii) Heavy Weight -

bulk unit weight $> 2080 \text{ kg/m}^3$

② What are the properties of aggregates?

The most important properties of aggregates used for highway construction are —

- i) Particle size and gradation
- ii) Hardness or resistance to wear
- iii) Durability or resistance to weathering
- iv) Specific gravity or absorption
- v) Chemical stability
- vi) Particle shape and surface texture
- vii) Freedom from deleterious particles or substances

These properties are discussed below —

i) Particle size & gradation:

A key property of aggregates used for highway bases and surfaces is the distribution of particle sizes in the aggregate mix. The gradation of aggregates, that is, the blend of particle sizes in the mix, affects the density, strength and economy of the pavement structure.

ii) Hardness or Resistance to wear:

Materials used in highway pavements should be hard and resist wear due to the loading from compaction equipment, the polishing effects of traffic and the internal abrasive effects of repeated loadings.

The most commonly accepted measure of the hardness of aggregates is the Los Angeles abrasion test.

iii) Durability or Resistance to weathering:

The durability of aggregates is commonly measured by a soundness test. This test measures the resistance of aggregates to disintegration in a saturated solution of sodium or magnesium sulfate. It simulates the weathering of aggregates that occurs in nature.

iv) Specific Gravity & Absorption:

The specific gravity and absorption of aggregates are important properties that are required for the design of concrete and bituminous mixed.

The specific gravity of a solid is the ratio of its mass to that of an equal volume of distilled water at a specified temperature.

As aggregates may contain water-permeable voids, two measures of specific gravity of aggregates are used: apparent specific gravity and bulk specific gravity.

v) Chemical Stability:

Certain aggregates may be unsuitable for a particular highway construction application because of the chemical composition of the aggregate particles. In asphalt mixes, certain aggregates that have an excessive affinity for water may contribute to what is known as film stripping, leading to disintegration of asphalt concrete.

vi) Other properties of aggregates:

Specifications for aggregates used in highway construction commonly have requirements related to the particle shape, surface texture and cleanliness of the aggregates.

Specifications for aggregates used in bituminous mixes usually require that the aggregates be clean, tough, durable in nature and free of excess amounts of flat or elongated pieces, dust, clay balls and other objectionable material.

③ Why is aggregate grading and blending important for any aggregate construction in roads?

④ How do you get aggregates in a specified gradation for a particular project?

⑤ What are the tests for aggregates in the specification of asphaltic concrete for runway overlay of Hazrat Shahjalal International Airport (HSIA)?

- 1) Gradation (Combined aggregates)
- 2) Materials finer than 75 μm sieve
- 3) Clay Lumps
- 4) Flakiness Index
- 5) Water absorption for Coarse and Fine Aggregate
- 6) Bulk Specific Gravity of Coarse Aggregate
- 7) Specific Gravity of Fine Aggregate
- 8) Soundness of Aggregate by use of 5 cycles of Sodium Sulphate tests
- 9) Aggregate Crushing Value (ACV)
- 10) Aggregate Impact Value
- 11) Los Angeles Abrasion Value
- 12) Specific gravity of Mineral Filler
- 13) Sand Equivalent Value of Fine Aggregate.

⑥ Write down the specification requirement for asphalt/bituminous materials used in runway overlay mixes.

1) Penetration, 25°C , 100g, 5 sec

2) Flash Point, COC, $^{\circ}\text{C}$ (F)

3) Solubility in trichloroethylene, %

4) Retained Penetration after thin film oven test

5) Ductility 25°C , 5 cm/min, cm,
after thin film oven test

⑦ Write down the names of laboratory tests of bituminous materials used in road construction.

Purity of asphalt cement

Solubility in trichloroethylene

" " water

Consistency

Kinematic viscosity

Absolute viscosity

Penetration

Softening point (Ring & Ball method)

Ductility

Ductility

Volatility

Distillation of cutback asphaltic products

Loss on heating

Thin-film oven test

Flash point (Cleveland Open cup)

Flash point (Tag open cup)

Tests for emulsified asphalts

8) State the steps for refining crude Petroleum in order to get different varieties of asphaltic materials.

(b) Write down the total classification of asphaltic materials from straight run asphalt from refinery.

(a) Refining of crude petroleum is a very complex process producing a tremendous range of products from very simple hydrocarbon gas methane to the hardest bitumen with molecular weight of the order of several thousand.

Full range of asphaltic materials are obtained by—

1) Dehydration:

heating in the storage to remove water.

ii) Fractional Steam Distillation:

This is the main refining process after which the crude produces all oil varieties like - gasoline, kerosene, diesel, lubricating oil and residual asphalt or bitumen in liquid or semisolid state.

iii) Air rectification :

Air is passed through residual asphalt.

iv) Cutbacks :

Residual asphalt is mixed with light oil fractions.

v) Emulsification :

ⓑ Total classification of asphaltic materials from straight run asphalt from refinery is —

i) Air blown asphalt

ii) Penetration grade asphalt

Different grades depending on penetration/viscosity values

iii) Cutback bitumen

→ slow curing

→ medium curing

→ rapid curing

iv) Asphalt emulsion

→ Anionic

→ Cationic

9) What are the classification of bituminous material ?

i) Penetration grades of asphalt cement are -

Asphalt Cement grade	Penetration Range (100g, 5sec)
AC 40-50	40-50
AC 60-70	60-70
AC 85-100	85-100
AC 120-150	120-150
AC 200-300	200-300

ii) Grades of asphalt cement based on standard capillary viscometer test —

Asphalt Cement Grade	Viscosity, 140°F (60°C) (poise)
AC 2.5	250 ± 50
AC 5	500 ± 100
AC 10	1000 ± 200
AC 20	2000 ± 400
AC 30	3000 ± 600
AC 40	4000 ± 800

iii) Grades of asphalt cement based on viscosity tests made on the residue from a rolling thin film oven test —

Asphalt Cement grade	Viscosity, 140°F (60°C) (poise)
AC 10	1000 ± 250
AC 20	2000 ± 500
AC 40	4000 ± 1000
AC 80	8000 ± 2000
AC 160	16000 ± 4000

10) What are the types & grades of Emulsified Asphalt?

Emulsified asphalt is a mixture of asphalt binder and water, stabilized by emulsifiers. It is used for various applications in road construction, such as surface treatments, prime coats, and seal coats. The types and grades of emulsified asphalt are determined by their intended use and the specific requirements of the project.

Types of Emulsified Asphalt

Emulsified asphalt is classified into three main types based on their stability and application: Hot Emulsified Asphalt, Warm Emulsified Asphalt, and Cold Emulsified Asphalt. Each type is further divided into different grades based on their viscosity and intended use.

Hot Emulsified Asphalt

Hot emulsified asphalt is used for applications where the asphalt binder is applied at high temperatures. It is typically used for surface treatments and seal coats on existing pavement. The grades of hot emulsified asphalt are determined by their viscosity and the amount of water they contain.

Warm Emulsified Asphalt

Warm emulsified asphalt is used for applications where the asphalt binder is applied at moderate temperatures. It is typically used for surface treatments and seal coats on existing pavement.

⑪ What are the special tests for emulsified asphalt?

Emulsified asphalts are specified on the basis of the results of a complete series of tests, some of which are of a specialized nature.

Tests of the following categories are included:

- i) Composition
- ii) Consistency
- iii) Stability

i) Composition tests include water content,

in which 50g or 100g sample is mixed with an equal volume of water-immiscible solvent, distilled and the quantity of water determined by volume

Residue by distillation, in which the percentage of weight of residue is obtained by distillation of a 200-g sample in an iron still to 500°F (260°C)

Residue by evaporation, which is less frequently used.

ii) Consistency

is measured by use of the standard Saybolt viscometer with the sample at 77°F or 122°F (25°C or 50°C) using the Furol tip.

iii) Stability tests include

Demulsibility, in which a 100-g sample is mixed with a dilute solution of calcium chloride and the percentage by weight of asphalt that fails to pass a No. 14 wire cloth is determined.

Settlement, in which the difference in asphalt content of top and bottom samples is determined on a 500 mL sample after allowing it to stand for 5 days.

Cement mixing, in which the sample is diluted to 55 percent residue with water, mixed with cement and the percentage by weight of coagulated material that fails to pass a No. 14 sieve determined.

a sieve test, in which the percentage by weight that fails to pass the No. 20 sieve is determined.

a coating test, in which the ability of a sample to coat a specified stone is judged visually after mixing.

Miscibility with water, in which approximately 50 mL of sample is mixed with 150 mL of water and the visible coagulation after 2 hr observed.

Tests are also performed on the residue, including specific gravity, ash content, solubility in CS_2 , penetration and ductility.

12) What are the special qualities required for bitumen to be used in road construction of Bangladesh?

How are these qualities be achieved?

Qualities required for bitumen:

- i) It should be easily workable at low temperature.
- ii) Should have sufficient stiffness throughout the range of temperature.
- iii) Should have thermoplastic behavior.
- iv) Should have high adhesive or cementing capacity
- v) low rate of stripping
- vi) low temperature susceptibility
- vii) low tendency of age hardening

Techniques for achieving these qualities:

- i) Temperature susceptibility can be decreased by using polymer/bitumen blends.

ii) Improvement in softening point is possible by using Ethylene & Vinyl Acetate (EVA) co polymers.

iii) EVA also improves the resistance to deformation and gives an additional workability, which is useful during construction at relatively low temperature.

iv) Certain anti-stripping agents, such as heavy metal soaps, quarternary ammonium salts can be used to improve adhesive bond between stone and bitumen and to reduce the tendency for replacement by water.

v) For better durability of bitumen, Sulphur or air blowing can be used.

vi) For extending life under difficult conditions impervious dense mix with appropriate compaction can be used.

13) What are the requirements / Objectives of asphaltic concrete mix design?

An economical blend and gradation of aggregates and asphalt that yields a mix having -

- i) Sufficient asphalt to ensure durable pavement
- ii) Sufficient mix stability to prevent distortion or displacement
- iii) Sufficient voids to prevent bleeding and harmful moisture
- iv) Sufficient workability to ensure efficient placement.

14) What are the methods and general steps for determining optimum asphalt content?

Methods for

- i) Marshall Method
 - ii) Hveem Method
 - iii) Hubbard-Field Method
 - iv) BS 594 (UK) - involves Marshall for Rolled Asphalt
 - v) Lees Asphaltic Concrete
 - vi) Leeds Design Method (LDM)
- } USA

General Steps -

- Preparation of trial specimens
- Determination of density, stability, flow etc. of specimens
- Density-void analysis to find
 - voids in mineral aggregate (VMA)
 - voids in compacted mix (P_a)
 - voids filled with asphalt (VFA)
- Plotting of parameters for different asphalt content
- Determination of asphalt content at 4% air voids (P_a or $V\%$)
- Checking with 'Design Criteria'

15) What are the requirements of asphalt & aggregates in superpave mix design?

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Set 2 → { Marshall method
Hveem method
Math } Sheet 15, 16