Chapter 6: Road Aggregates – Requirements and Types

Introduction

Aggregates form a significant component of road construction materials, making up about 70–80% of the volume of bituminous pavements and up to 90% in cement concrete pavements. The strength, durability, and performance of pavements are heavily influenced by the properties and types of aggregates used. Understanding their requirements and classifications is crucial for ensuring optimal pavement behavior under traffic loading and environmental conditions.

This chapter provides an in-depth exploration of the essential requirements of road aggregates, their classification, and the various types commonly used in highway construction.

6.1 Requirements of Road Aggregates

The suitability of aggregates for road construction is assessed based on specific engineering properties that determine their behavior under traffic loading, weathering, and construction conditions.

6.1.1 Strength

- **Definition**: The ability of aggregate particles to resist crushing under heavy traffic loads.
- **Tests Conducted**:
    - Aggregate Crushing Value (ACV)
    - Los Angeles Abrasion Test
    - Impact Value Test
- **Specifications**:
    - For wearing surfaces: ACV ≤ 30%
    - For bituminous macadam: ACV ≤ 35%
    - For base courses: ACV ≤ 40%

6.1.2 Hardness

- **Definition**: Resistance to abrasion and wear.
- **Test**: Los Angeles Abrasion Test
- **Typical Value**:
    - Max Abrasion Value for bituminous mix: 30–35%

6.1.3 Toughness

- **Definition**: Ability to resist impact and dynamic loads.
- **Test**: Aggregate Impact Value (AIV)
- **Standard**: AIV ≤ 30% for surfacing

6.1.4 Durability and Soundness

- **Definition**: Resistance to weathering, especially under freeze-thaw and wetting-drying cycles.
- **Test**: Sodium Sulfate/Magnesium Sulfate Soundness Test
- **Soundness Value**: Loss in weight should not exceed 12% for sodium sulfate and 18% for magnesium sulfate.

6.1.5 Shape of Particles

- **Importance**: Well-shaped aggregates offer better interlocking and compaction.
- **Types**: Angular, flaky, elongated, rounded
- **Tests**:
    - Flakiness Index (FI)
    - Elongation Index (EI)
- **Specifications**:
    - FI should be less than 15% for surface courses.

6.1.6 Adhesion with Bitumen

- **Requirement**: Aggregates must have good affinity to bitumen to resist stripping.
- **Test**: Static Immersion Test / Stripping Value Test
- **Improvement**: Anti-stripping agents or lime can be used to improve adhesion.

6.1.7 Water Absorption and Specific Gravity

- **Water Absorption**: Lower absorption indicates better performance; max 2%.
- **Specific Gravity**: Normally between 2.5 to 3.0 for road aggregates.
- **Importance**: Affects the mix design and quality control.

6.2 Types of Road Aggregates

Aggregates are classified based on their origin, size, shape, and geological formation. The selection depends on the pavement type, traffic intensity, and climatic conditions.

6.2.1 Based on Source

(a) Natural Aggregates

- **Definition**: Aggregates obtained directly from natural rock sources.
- **Examples**:
    - Gravel (river deposits)
    - Sand (natural sand)
    - Crushed Stone (granite, basalt, limestone)
- **Advantages**: Economical, widely available
- **Limitations**: May require washing and grading

(b) Artificial Aggregates

- **Definition**: Aggregates produced by industrial processes or modified from natural sources.
- **Examples**:
    - Crushed bricks
    - Slag aggregates (from steel industries)
    - Fly ash aggregates
- **Applications**: Low-traffic roads, secondary pavements

(c) Recycled Aggregates

- **Definition**: Aggregates obtained from demolished concrete, asphalt, or building waste.

- **Use**: Sustainable construction, sub-base, and base layers

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6.2.2 Based on Size

(a) Coarse Aggregates

- **Size**: Retained on 4.75 mm sieve
- **Use**: Base course, bituminous concrete, cement concrete pavements
- **Common Sizes**: 10 mm, 20 mm, 40 mm

(b) Fine Aggregates

- **Size**: Passing through 4.75 mm sieve and retained on 75 μm sieve
- **Use**: Filler, mortar, fine matrix in bituminous mixes

(c) Filler Materials

- **Size**: Passing 75 μm sieve
- **Examples**: Stone dust, cement, lime
- **Function**: Improves gradation, fills voids, improves cohesion

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6.2.3 Based on Shape

- **Rounded Aggregates**: Found in riverbeds; less friction, used in concrete.
- **Angular Aggregates**: Crushed rocks; excellent interlock, used in road construction.
- **Flaky Aggregates**: Thickness is small compared to length and breadth.
- **Elongated Aggregates**: Length is considerably higher than other dimensions.
- **Cubical Aggregates**: Preferred for superior interlocking and stability.

6.2.4 Based on Geological Origin

(a) Igneous Rocks

- **Examples**: Granite, basalt
- **Properties**: Hard, strong, durable
- **Use**: High-load pavements

(b) Sedimentary Rocks

- **Examples**: Limestone, sandstone
- **Properties**: Moderate strength and durability
- **Use**: Low to medium traffic roads

(c) Metamorphic Rocks

- **Examples**: Quartzite, gneiss
- **Properties**: Very hard and dense
- **Use**: Suitable for heavy traffic roads

6.3 Aggregate Gradation and Its Importance

6.3.1 Definition

Gradation refers to the distribution of particle sizes within the aggregate sample.

6.3.2 Importance

- Ensures proper compaction and strength
- Reduces voids
- Improves durability and stability

6.3.3 Gradation Types

- **Dense Graded**: Well-graded aggregates for maximum density
- **Open Graded**: High permeability, used in drainage layers
- **Gap Graded**: Eliminates certain intermediate sizes, used in stone matrix asphalt (SMA)

6.4 Specifications for Road Aggregates (IRC/MORTH)

The Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MORTH) specify criteria for aggregate properties in road construction. A few standard limits are:

Property	Surface Course	Base Course	Sub-base
Crushing Value (%)	≤ 30	≤ 40	≤ 50
Abrasion Value (%)	≤ 30	≤ 35	≤ 50
Impact Value (%)	≤ 30	≤ 35	≤ 40
Water Absorption (%)	≤ 2	≤ 2	≤ 2

Property	Surface Course	Base Course	Sub-base
Flakiness Index (%)	≤ 15	≤ 25	≤ 30

6.5 Aggregate Tests and Standards

6.5.1 Crushing Strength Test

- **Standard**: IS 2386 (Part 4)
- **Objective**: To assess resistance to crushing under compressive load.

6.5.2 Abrasion Test

- **Standard**: IS 2386 (Part 4) / ASTM C131
- **Objective**: To determine aggregate wear resistance.

6.5.3 Impact Value Test

- **Standard**: IS 2386 (Part 4)
- **Objective**: To determine aggregate's toughness under impact.

6.5.4 Soundness Test

- **Standard**: IS 2386 (Part 5)
- **Objective**: To check aggregate durability under weathering.

6.5.5 Shape Tests

- **Flakiness and Elongation**: IS 2386 (Part 1)
- **Purpose**: To classify aggregates based on geometric shape.

6.5.6 Water Absorption & Specific Gravity

- **Standard**: IS 2386 (Part 3)
- **Purpose**: To determine porosity and density-related properties.
