Chip seal is the application of an asphalt binder to a pavement surface which is covered by a layer of one-sized, preferably crushed, cubical, aggregate.

**Benefits**
- Seal and protect age-oxidized surfaces
- Provide durable, high-friction wearing surfaces
- All-weather performance, used in multiple climate zones in U.S.
- Seal and resist reflection of small surface cracks
- Provide a waterproofing layer at the surface which protects the underlying pavement structure
- Cost-effective preventive maintenance and pavement preservation, extends life of pavements

**Limitations**
- Predominately for Low and Medium Volume Roads
- Susceptible to Snow Plow Damage
- Limited Construction Season
- Less margin for construction error-
- Loose Chips and Bleeding
- Consumer Acceptability
Design and Material Selection

Four Basic Steps
- Pavement Survey
- Mix design
- Binder Selection & Application Rate
- Aggregate Selection & Application Rate

Pavement Condition Survey
- Thermal Cracking
- Reflective Cracking
- Fatigue Cracking
- Base Failure
- Bleeding and Rutting

Mix Design & Job Mix Formula
- Job mix formula determined by
  - Pavement surface condition
  - ADT of roadway or highway
  - Gradation and type of aggregate
  - Emulsion Type
    - Anionic or Cationic
    - Modified or Non-Modified
  - Weather conditions
    - Temperature
    - Humidity
    - Wind
    - Sunlight
    - Rain Forecast

Pavement Conditions for Success
- Structurally Sound
- Defects Patched and Cured
- Surface must be clean and free of loose stone and debris
- Surface must be dry
- Pavement temperatures
- No Impending Rain forecast for 24Hrs
**Single Chip Seal**

Pavements with bituminous surface
- Light cracking
- Moderate cracking with crack fill
- Light to moderate raveling
- Polishing
- Light to moderate flushing
- Good ride quality & structural soundness

**Double Chip Seal**

Pavements with bituminous surface
- Moderate cracking
- Severe cracking with crack fill
- Moderate to severe raveling
- Light to moderate Bleeding or Flushing
- Good ride quality & Structural Soundness

**Binder Selection**

- **Rapid-Setting Emulsion**
  - Can be used with Damp Aggregates
  - Low or no VOC- Environmentally Friendly!
  - Modified or Non-Modified
  - Anionic or Cationic
- **Asphalt Cement**
  - Requires Hot Spray at Elevated Temperatures
  - Pre-coated Stone
- **Solvent Cutbacks**
  - Flammable and Combustible Liquids
  - VOC Emissions

**What is an Asphalt Emulsion?**

“An Asphalt Emulsion is a chemically-stabilized dispersion of fine asphalt particles throughout a continuous phase of water as a carrier”
Why Emulsions are Better

Aggregate Effect

Opposites Attract!

Emulsion Penetrates Cracks & Surface Voids.
- Asphalt emulsion has the ability to flow into the voids of the existing surface.
- Hot applied ACs, asphalt cement, cool quickly and are unable to flow into the surface voids.

Cationic or Anionic?

Emulsion Aggregate Interaction Process

- Stone Particle
- Emulsion Attraction
- Asphalt Particles Buildup on Surface
- Asphalt Particles Get Tighter Together
- FLOCCULATION
Emulsion Aggregate Interaction Process

Continued Flocculation

Coagulation

Film Cure Occurs thru evaporation of residual water and solvents

Emulsion Breaking

From This

Brown

To This

Black

Why Asphalt / Aggregate Choice is Important to a Successful Job?

“Degree of Job Success is not measured By the number of Broken Windshields!”

Aggregate Selection

• One Sized Aggregate (Recommended Size Chart)
• Cubic Particle Shape (Crushed Stone)
• Sound Material, resistant to abrasion and degradation
• May use pre-coated (mainly for hot spray asphalt binder)
• Follow ASTM D1139 for Soundness Guidelines
• Choice will determine type of asphalt emulsion used

SFERB Emulsion Book

From This

To This

Emulsion Breaking

Brown

Black
ASTM D1139 Specifications

- LA Abrasion (ASTM C131) <40%
- Percent Fractured Faces (ASTM D5821) >60%
  - 2 faces minimum
- Sodium Sulfate Soundness (ASTM C88) <12%
- Magnesium Sulfate Soundness <18%
- Flat or Elongated Pieces (ASTM D4791) <10%
- Deleterious Materials (ASTM C142) <3%
- Density - Aggregate Specific Requirement

Application Rates

- ASTM D1369 Guidelines
- AI/AEMA MS-19 Handbook Guidelines

Adjustments?

- Surface Conditions
- Traffic Volumes / Types
- Type and Specific Gravity of Aggregates
- Aggregate Size
- Pre-coating
- Local Experience
- Laboratory Determinations – Pan Test
9 Step Construction Process

- Set traffic control and prepare surface removing debris and loose stone with power broom
- Adjust spray bar to correct height and nozzles to proper angles
- Calibrate distributor and chip spreader
- Spray test strip, strap distributor to determine volume available
- Spray binder at correct volume to pavement surface
- Spread aggregate immediately behind
- Roll immediately with pneumatic rollers
- Allow to cure
- Sweep excess aggregate

Computer Controlled Asphalt Distributor

Today

Operators Bar Control
Material Metering and Control System

Asphalt Distributor

- Hydrostatic controls maintain material application rate regardless of ground speed
- Spray widths from 1 to 24 feet, without stopping
- Eliminates matching pump output to ground speed
- Proper bar height and nozzle angle minimizes longitudinal seams

Some Things Never Change!

Two Mule Power Distributor

Same Basic Design
Proper Bar Adjustments

- Fan Pattern and Angle Overlap
  - Pneumatic tire rollers follow directly behind spreader
  - Control speed to avoid chip displacement
  - One to five passes may be used, two to four sufficient to embed chips properly with correct orientation on surface
  - Last pass in direction of traffic

Chip Spreader

- Maintain correct speed to prevent rolling
- Proper adjustment of gates imperative

Rollers
Proper Rolling Results

- Clean pavement prior to and after chip seal
- Pickup-type sweepers used in areas where materials cannot be moved onto an aggregate shoulder.

Doing Things Right

- Average least dimension 0.5 in.
  - Asphalt 0.39 gal/yd²
  - Cover aggregate 49 lb/yd²

- Average least dimension 0.2 in.
  - Asphalt 0.16 gal/yd²
  - Cover aggregate 20 lb/yd²

Fig. 2 illustrating the effect of aggregate particle shape on material quantities. Both aggregates are 0.5 inch as measured by sieve analysis. One is cubic, the other is flat and elongated. Voids filled is 70% for both aggregates.

Effects of Improper Gradation

- Improper aggregate gradation
- Poorly graded aggregate
- Uneven distribution of aggregates
Preparation

- Patches and Cold Mix Leveling need proper cure times
- If necessary, Fog Seal may be used to seal patch areas
- Crack fill carefully, excessive filler can be a problem
- Smooth patches result in smoother ride
- Ideal to perform prep work previous season

Address Base Failures

Address Rutting

Troubleshooting

- Streaking
- Flushing/Bleeding
- Aggregate Loss
- Joint Raveling
- Ride Quality
Streaking

Longitudinal Streaking
Usually results from Poor Spray Pattern or faulty gate control in spreader box.

Transverse Streaking
Usually from irregular progress of Chip Spreader or chatter in spreader box.

Flushing, Bleeding, & Fat Spots

- Wheel Path Bleeding
- Start / Stop Bleeding
- Fat Spot Bleeding
- Edge Bleeding & Runoff
Common Preventions

- Level Rutting
- Start Stop Strips
- Pickup Droppings & Slop

Control Application
- Rate
- Temperature
- Emulsion Viscosity
- And Aggregate Moisture

Polymer Modifiers?

- RS-2P, HFRS-2P, CRS-2P are common grades
- Use SBS, SBR, or EVA as common modifiers
- Provide increased cohesion for better early chip retention
- Higher softening points lower potential for bleeding
- Provide higher degree of crack retardation
- Must be carefully selected and formulated by Supplier
- Stability can be an issue if not formulated properly

Quality Chip Seals

- Recent Chip Seal
- Two-Year old Chip Seal

QUESTIONS?