

Chip Sealing

What is Chipseal?

Chipseal (surface dressing) is a surface treatment in which an asphalt binder is sprayed onto a road surface and single-sized chippings are spread over and compacted. Thicker layers can be made by repeating the process, the most common techniques being:

Double Surface Treatment: Additional asphalt is sprayed and a second layer of chippings, usually smaller than the first, is applied.

Racked-In System: Increased asphalt is sprayed in the first layer and a second layer of smaller chippings applied without a second asphalt application.

Chipseals are applied to all classes of roadway, except that high-performance modified asphalts are used for higher trafficked or stressed areas. Chipseals are applied to unbound bases as a temporary riding surface, or to stabilized bases as a permanent riding surface. Chipseals are impermeable to water and will seal porous surfaces and provide a skid-resistant surface with good texture for water drainage. Chipseals can be applied to bleeding surfaces to restore skid resistance. Because of their flexible nature, chipseals give some resistance to reflective cracking and resist the effects of road movements.

Compared to microsurfacing, chipseals are noisier, although noise is less with smaller chippings or in double and racked-in systems. On the positive side, chipsealed shoulders can provide a 'rumble' warning to drivers straying off the pavement.

Why Emulsion Seals?

Emulsified asphalt has the following advantages over hot-sprayed or cutback binders:

- Fire hazard of cutback binders are avoided
- Fumes and burn hazards associated with hot-sprayed asphalt are avoided
- Emulsions can be used with damp aggregates
- Properly formulated emulsions do not require the use of antistripping agents because they have 'built-in adhesion'
- The residual asphalt properties are achieved quicker than cutback asphalts which may lose solvent slowly

Design of Chipseals

The aim of the design is to produce a mat of interlocked chippings with few loose chippings and without excess asphalt. Typical use levels of emulsion and aggregate for single layers are given in the following table. The actual application level of aggregate is best determined by a simple laboratory test and will depend on the specific gravity and shape of the chippings.

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Aggregate Size	Quantity of Aggregate (kg/m ²)	Quantity of Asphalt (liter/m ²)
19 to 9.5 mm	22-27	1.8-2.3
12.5 to 4.75 mm	14-16	1.4-2.0
9.5-2.36 mm	11-14	0.9-1.6
4.75-1.18 mm	8-11	0.7-0.9
Sand	5-8	0.5-0.7

Aggregates should be single sized as far as possible with cubical shape and with an abrasion resistance suitable for the traffic level. The chippings should be free of dust.

The level of asphalt can be calculated theoretically as the amount to fill 60-75% of the voids. The level may be reduced 10-20% for applications on bleeding surfaces and increased on porous surfaces. Trafficking is required to fully embed and align the chippings. On low trafficked roads a higher application rate of asphalt may be required.

In multi-layer chipseals, the size of the second aggregate layer is generally half the nominal size of the first layer. The total asphalt and chipping application rate in a double treatment is 10-20% less than implied by adding the figures in the table above for each layer and 60% of the total asphalt is used in the second spray.

In racked-in systems the aggregate in the second application is again about half the nominal size of the first layer. There is no second application of binder but the first spray is increased by about 10-20% compared to a single layer seal.

Emulsion Recipe

The key features of the emulsions for chipseal are setting rate and viscosity as well as the final cured properties of the binder such as adhesivity and cohesivity. The emulsion should be rapid-setting so that the chippings are tightly held soon after rolling and slow-speed trafficking. If aggregates are not clean or not single sized then a slightly slower-setting emulsion with some solvent content will be preferred.

The curing process in cold weather is helped by the use of a small amount (1-3%) of light solvent in the emulsion. Hot-applied (50-85°C) high asphalt content emulsions cure more quickly than cold-applied emulsions.

The viscosity of the emulsion should be high enough to resist flow on the roadway, which could result in puddling in depressions or run-off on cambers, but low enough at the spray

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temperature to allow good distribution. The choice of emulsifier can influence the viscosity of the emulsion (see the datasheet 'Selection of CRS emulsifiers for Viscosity Control').

Adhesion of emulsion to the chippings when fully cured is essential to the performance of the seal. Cationic emulsions generally have sufficient adhesion because the emulsifier acts as an adhesion agent. Anionic emulsions should be formulated with added adhesion agent.

Polymer-modified emulsions are needed for high speed traffic areas and may be required for areas where the roadway is exposed to extreme temperature range. Polymer can be incorporated into the emulsion either as a latex whose charge matches the emulsion grade or to the asphalt before emulsification.

Typical Recipes

Cationic Grades

	CRS-2	CRS-1
Asphalt	65-67	60-63
Naphtha	0-2	0-2
Redicote E-4819	0.18-0.25	0.20-0.25
HCl (33%)	0.10-0.15	0.10-0.15
Calcium chloride	0-0.1	0-0.1
Water	to 100	to 100

Anionic Grades

	HFRS-2	RS-1
Asphalt	63-67	57-63
Naphtha	0-2	0-2
Redicote E-62C	0.5-0.8	0.20-0.30
NaOH	0.2	0.1
Water	to 100	to 100

Application of Chipseals

The road surface must be swept. The distributor must be adjusted to apply the correct rate of emulsion and the spray pattern checked for evenness of distribution. Chippings should be applied at the correct rate (over-application means more loose chips and can impede the embedding process) and as soon after the emulsion spray as possible. Compaction is preferably by pneumatic-tired rollers, to avoid crushing aggregates. Traffic at controlled speed is beneficial to the formation of the chipseal matrix.

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In double layer chipseals, the first layer is only partially compacted before applying the smaller chips, which should be added shortly after the first layer. In raked-in seals the first layer should be fully compacted.

References

1. *A Basic Emulsion Manual*, MS 19, 3rd edition, AEMA, pp35-43.
2. *Bitumen Emulsions*, SFERB, 1991, pp118-148.
3. *Recommended Performance Guidelines*, 2nd edition, AEMA, pp7-16.
4. *Design Guide for Road Surface Dressing 3rd Edition*, Road Note 39, Transport Research Laboratory, U.K.

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