COLD-IN-PLACE RECYCLING WITH FOAMED ASPHALT*

*Also known as Cold-In-Place Recycling, Expanded Asphalt Method (CIR-EAM), Cold Foam In-Place Recycling (CFIPR), and Full-Depth Reclamation Using Foamed Asphalt (FDR-FA)

Caltrans approved Nonstandard Special Provision (NSSP) for foamed asphalt

A Binding Agent Offering lots of Potential

Cold recycling with foamed bitumen has become an established technology worldwide and is now increasingly moving into the focus of road authorities and construction companies for use in the rehabilitation and new construction of road pavements.

Cold recycling with foamed bitumen produces flexible and highly durable base layers that become a key component of the pavement foundation for the final asphalt overlay to be built at reduced layer thickness.

The perfectly engineered process provides:

- exceptionally high durability of layers
- economic viability
- saving of natural resources
- reduction of CO_2 emissions
- reduction of construction times

Producing Foamed Asphalt

Foamed asphalt is produced by foaming standard paving asphalt. In the process, small amounts of water and air are injected into the hot asphalt at high pressure, which results in the asphalt foaming and expanding to around 20 times its original volume. The bitumen foam is then injected into a mixer via injection nozzles. It is eminently suitable for mixing with cold and moist construction materials.

The new material – frequently produced using reclaimed asphalt pavement (RAP) – is called BSM (bitumen-stabilized material).

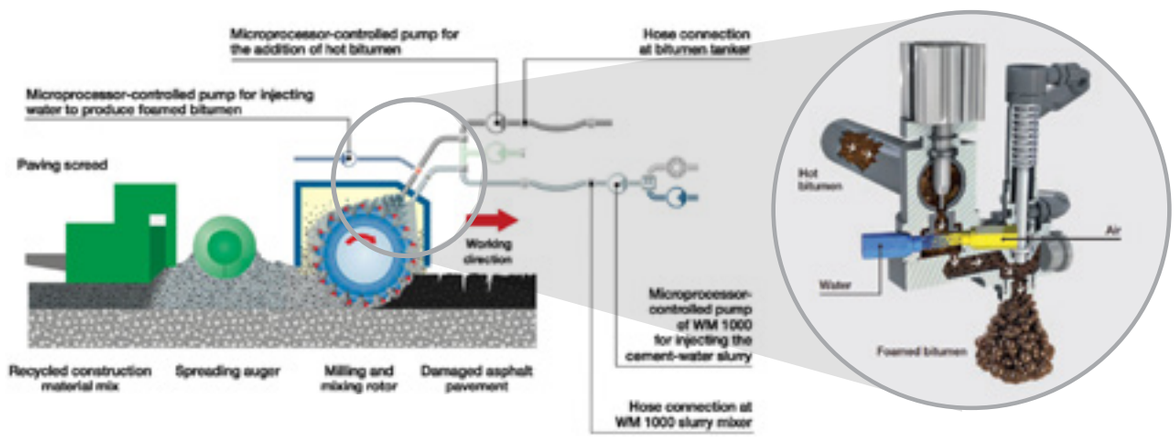
Material Structure

Cold mixes produced with foamed bitumen behave like a construction material with constant inter-particle friction but significantly increased cohesion (adhesion force) and strength. This type of material is also called BSM (bitumen-stabilized material).

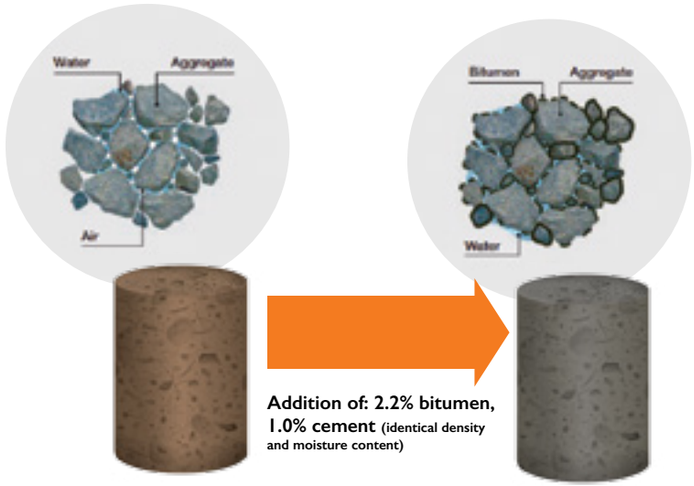
BSM mixes do not involve coating of the aggregate but homogeneous mixing of the bitumen binder and aggregate. Typical bitumen quantities range between 1.5% by mass and 2.5% by mass of the mixed material. After final compaction, the material is characterized by good flexible properties and high bearing capacity. It has a proven track record around the globe.

CIR EQUIPMENT

The equipment to install CIR, since its beginnings some thirty years ago, has evolved into technologically automated machinery.



SHEAR PROPERTIES OF BSM



Aggregate crushed as per grading curve	Bitumen-stabilized material
Cohesion: 30 kPa (4 psi) 55 kPa (8 psi)	**Cohesion:** 200 kPa (30 psi) 300 kPa (45 psi)
Angle of Friction: 43° to 51°	**Angle of Friction:** 40° to 49°

TO REHABILITATE 1 LANE-MILE OF HIGHWAY AT 3" DEPTH

Mill and fill	Cold-In-Place Recycling (EAM)
83 truckloads	2 truckloads
45 truckloads to haul off millings	38 truckloads to haul in new AC
	2 truckloads to import PG 64-10 Oil

Structural Section Design

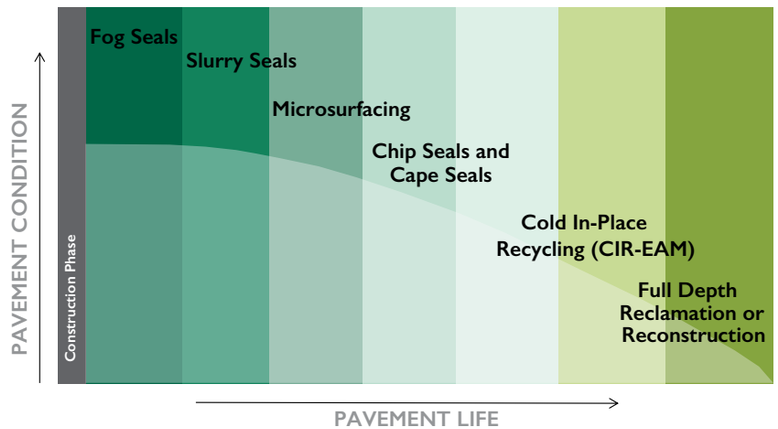
AASHTO '93 is the preferred method for foamed asphalt CIR section design. Considerable research is available recommending structural coefficients of 0.30 to 0.35 per inch of foamed asphalt, and AASHTO '93 allows more flexibility in selecting desired reliability and estimating variability, allowing designs to be more carefully tailored to each situation and taking full advantage of the proven strength of the material.

The Caltrans design method can be used, but tends to be conservative because of the limited information available to establish a gravel factor for foamed asphalt. Available information suggests a gravel factor of 1.7 is reasonable, and that higher values may be appropriate.

The structural contribution of foamed asphalt is dependent upon the existing materials, mix design, and construction practices. Sample specifications can be found in the cited references.

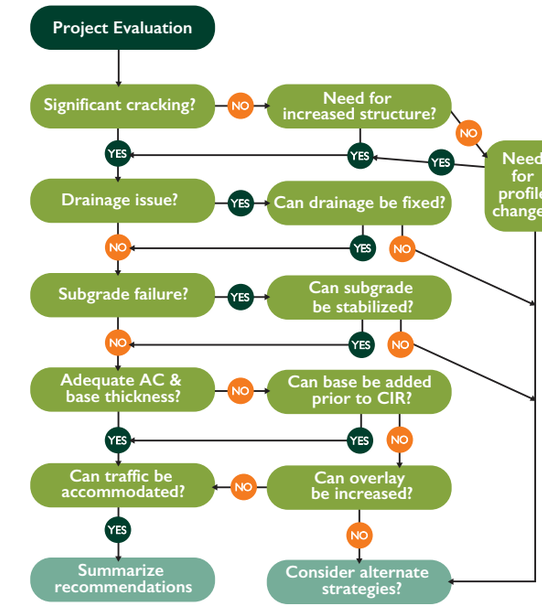
Regardless of the design method, it is important that the existing subgrade be evaluated for R-value, that traffic, especially heavy vehicle traffic, be estimated carefully, and the existing section be investigated adequately to ensure a successful project. Foamed asphalt CIR is generally restricted to thicknesses of 3 to 6 inches.

PAVEMENT PRESERVATION AND REHABILITATION STRATEGIES

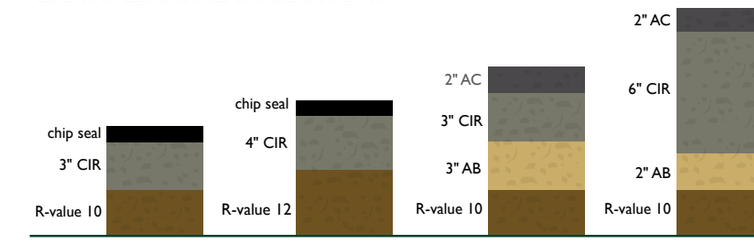


Because of the high strengths available with foamed asphalt, it can be cost effectively applied earlier in a pavement's life, helping maintain high levels of serviceability.

SIMPLIFIED FOAMED ASPHALT CIR DECISION TREE

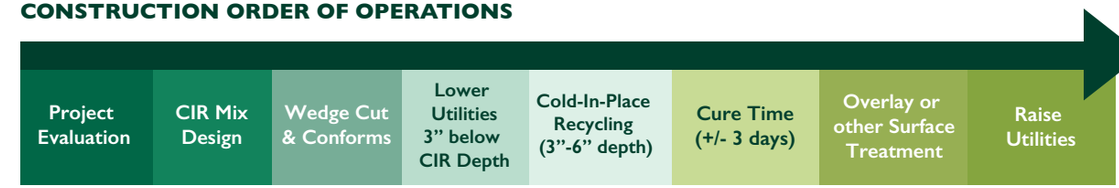


EXAMPLE CIR-EAM SECTIONS



AC = asphalt surface course CIR = CIR w/ foamed asphalt ESAL = Equivalent Single Axle Load (18,000 lb)

CONSTRUCTION ORDER OF OPERATIONS



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