# CHAPTER 11 THIN ASPHALT OVERLAYS

## 11.1 OVERVIEW

Thin maintenance overlays (thin overlays) are defined as hot mix asphalt overlays 0.15' or less in thickness. This is applied as a maintenance treatment, either corrective or preventive.

Historically, three types have been used extensively by Caltrans, either alone or in combination with other treatments such as a Stress Absorbing Membrane Interlayer (SAMI). They include:

- Dense-Graded (Type A HMA) – Structure Layer
- Open-Graded Friction Courses (HMA-O, RHMA-O, and RHMA-O-HB) – Non-Structure Layer
- Gap-Graded Mixes (RHMA-G) – Structure Layer

The different mixes are defined based on their aggregate grading, binder content, and voids content. Figure 11-1 illustrates, in general, the differences in aggregate structure for these mix types.

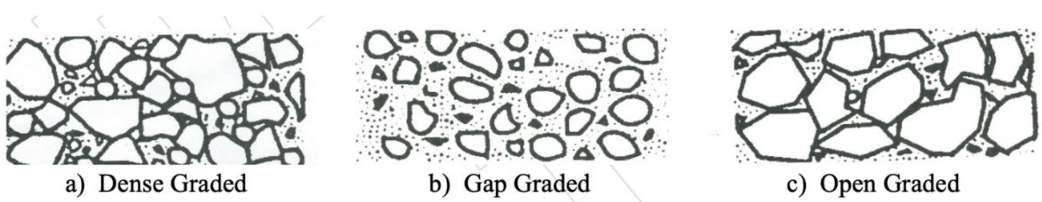



**Figure 11-1 Stone Matrices Created by Different Gradings (Austroads, 2000)**

This chapter describes each of these mix types in further detail and provides an overview of the design and construction of these mixtures.

## 11.2 DENSE-GRADED (TYPE A HMA) OVERLAYS

### *11.2.1 Mixes*

Type A HMA mixtures have an aggregate structure that is continuously graded (sized) from the largest to the smallest aggregate in the system. Aggregate gradations are specified in Section 39-2.02B(4)(b) of the Standard Specifications (Caltrans, 2025). The maximum stone size is limited to one third of the layer thickness.

The asphalt binder grade is selected based on the climate region and special conditions. Topic 632 – Asphalt Binder and Mix Specifications in the Highway Design Manual (Caltrans, 2022) discusses asphalt binder selection. Table 632.1, Asphalt Binder Performance Grade Selection, is a concise reference for asphalt binder selection. Refer to Topic 615 for determining the climate region. The District Materials Engineer should be consulted if a modified binder is considered. Typical special conditions justifying the use of a modified binder include climate region, elevation, and traffic loading.

### *11.2.2 Performance*

Type A HMA mixtures have relatively low air void contents and are designed as an abrasion resistant and functionally impermeable wearing course. Historically, these mixtures were the most commonly used mix type for overlaying asphalt or Portland cement concrete pavements. However, over the past 15 years, gap-graded mixtures (RHMA-G) have become the preferred type. The following paragraphs provide a brief overview of the distresses that occur as well as the factors influencing job selection, service lives, and costs.

#### **Distresses Addressed**

Type A HMA thin overlays should only be placed on structurally sound pavements. They offer little structural improvement and only moderate resistance to reflective cracking but can renew the surface in terms of functional performance (i.e., ride quality). They can be used to mitigate the following distresses present in an existing pavement:

- Raveling
- Oxidation
- Minor cracking
- Minor surface irregularities
- Skid problems
- Sealing against moisture intrusion (requires correct tack coating practices)

When used in association with a SAMI, or geosynthetic pavement interlayer, they may also address reflective cracking. In addition, modified asphalt binders can be used to address low temperature cracking and high traffic loading.

#### **Primary Distress Modes**

Type A HMA thin overlays exhibit the following distress modes:

- Permanent deformation due to heavy traffic and high temperatures
- Fatigue cracking due to repeated traffic loading
- Reflective cracking due to cracks in the existing pavement reflecting up

through the overlay
- Raveling due to a number of factors including oxidation and hardening of the binder, water damage, low binder content, and low compaction
- Stripping (water damage) caused by binder-aggregate incompatibility
- Delamination due to poor compaction and/or tack coat practices

Often, these can be addressed by selection of the correct binder and proper mix design. The principal failure modes are delamination, raveling and cracking due to poor compaction. Thin layers cool faster than thick layers reducing the time available for proper compaction. Thus, if a thin overlay is not compacted to the target air voids (8% or less), it will tend to be less cohesive and ravel or delaminate.

### *11.2.3 Project Selection*

Type A HMA thin overlays should only be used on sound pavements where minor defects may be present and all construction requirements can be met, especially compaction. Variables that affect project selection include:

- **Traffic Loading:** For low volume roads, variations in traffic need to be considered. Selection should be based on the worst-case scenario. For high volume roads, the principal failure modes are fatigue cracking and permanent deformation. To resist fatigue cracking a Type A HMA thin overlay can be used to extend the pavement life for 1-3 years for high volume roads and 3-5 years for low volume roads. Modified binders are best suited to resist fatigue cracking and will provide a longer life expectancy.

- **Existing Pavement Condition:** Use should only be on pavements that do not possess a significant amount of distress. For example, existing pavements with significant quantities of medium to high severity fatigue cracking are poor candidates. Conversely, pavements that possess distresses that affect the functional performance of the existing pavement (e.g., rideability, poor skid resistance, oxidation, etc.) are generally good candidates provided that a structural enhancement of the existing pavement is not required. Sometimes a Type A HMA thin overlay (with a SAMI) is placed over poor roads to prolong the period until rehabilitation or recycling is necessary.

- **Environment:** With proper mix design (i.e., appropriate asphalt binder type and content for a given aggregate type and gradation) these mixes have been successfully used in a range of climates. In all climates fatigue cracking can be the principle mode of failure. In hot climates permanent deformation (rutting) can be the principle mode of failure whereas in climates where large temperature swings occur thermal cracking can be the principal mode of failure. Use must consider the climate in which it will be placed in order to avoid distresses that commonly occur. The use of a modified binder helps to mitigate the aforementioned the effects of climate extremes.

**Service Life**

Type A HMA thin overlays have been shown to last between 4 and 6 years. The life is directly affected by the condition of the existing underlying pavement, the climate (environmental conditions), and the traffic loading. For example, a Type A HMA thin overlay placed on a pavement in poor condition would not be expected to last as long as one placed on a pavement in good condition. Similarly, if placed on a pavement in good condition but with heavy traffic, it would not be expected to last as long as one placed on the same pavement, but with much lighter traffic.

### *11.2.4 Design and Specifications*

The design of all thin overlay mixture types follows the Superpave Mix Design Method discussed in detail in Asphalt Institute publication MS-2.

Specifications for Type A HMA are in section 39-2.02 of the Caltrans Standard Specifications (2025).

Type A HMA must be comprised of materials capable of resisting degradation during construction as well as providing good long-term durability. Thus, the aggregates must be sufficiently hard to resist breakage during compaction and be sufficiently compatible with the binder so as to resist de-bonding of the binder in the presence of water (i.e., resist stripping). Other characteristics, such as particle shape, are also important. Similarly, the binder must be of sufficient quality to resist the effects of aging (i.e., oxidation and associated hardening). In this sense, it is desirable to have a relatively soft binder or to have a mixture with a relatively thick binder film. However, the binder must also be hard (stiff enough) and the binder film not too thick so as to resist permanent deformation. Thus, the performance-graded binder grade (e.g., PG 64-10, PG 64-16, etc.) considers and balances these conflicting requirements. Modified binders can be selected to assist in optimizing resistance to a particular distress mode.

Chapter 2 has more information on material requirements.

### *11.2.5 Construction*

**Production**

Aggregates, reclaimed asphalt pavement (RAP), and asphalt binder are mixed in either a batch or dryer-drum plant. Asphalt Institute Publication MS-22 discusses each type of plant and their operation in detail.

**Storage**

Storage in silos prior to hauling is common, in particular for large tonnage projects. High production dryer-drum plants also necessitate storage until loading. Storage in silos facilitates loading and hauling and results in more consistent and constant delivery to the project site which results in more uniform placement. Temperatures during storage must be those that result in the temperature of the mixture being within the range specified in the Standard Specifications. The necessary temperatures result in the mixture beginning the aging process during storage. Thus, storage time should be limited if possible. DGAC mixtures should not be stored in silos for more than 18 hours. However, this is not a requirement in the Standard Specifications.

**Hauling**

The effect of hauling and haul distances must be considered when considering any type of thin overlay. As previously mentioned, thin layers cool more rapidly than thicker layers. HMA material will cool during transport, thus the cooling is greater in proportion to the haul distance. Increasing production temperatures to compensate for cooling is not desirable as it will result in premature aging of the asphalt binder. Consideration should be given to requiring tarping the delivery vehicle, inclusion of a warm mix asphalt technology in the mixture, and use of a material transfer vehicle during placement to reduce the impact of cooling. Segregation may result from long haul distances as discussed below.

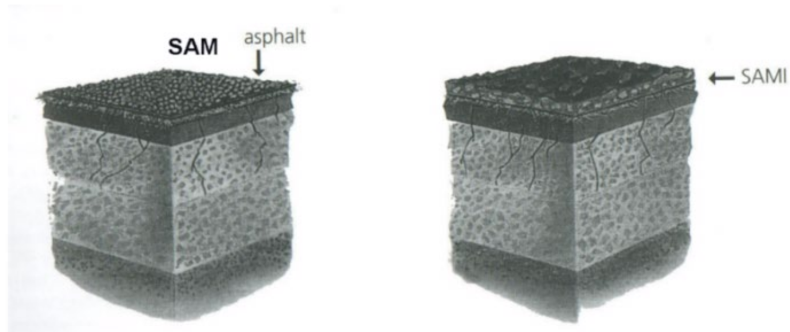
Standard hauling equipment (i.e., end dump vehicles, bottom dump vehicles, or live bottom dump vehicles) may be used. Tarping is advised to prevent any crusting of the mixture (i.e., hardening of the first few centimeters of the mixture exposed to ambient temperatures), especially in night and cool weather work with modified mixes, or when long haul distances are required. A non-petroleum-based release agent should be sprayed on the truck bed prior to loading. Diesel or other petroleum materials are not to be used as release agents as these will soften the mixture.

Segregation may occur, in particular if the haul distance is long, over rough roads, or both. This may also happen if the mix is not correctly loaded at the plant, is poorly designed, or not handled correctly. For larger jobs, use of a material transfer vehicle (MTV) should be required.

**Surface Preparation**

Surface preparation is critical for good performance of any thin overlay. Thin overlays should only be placed on sound pavements. This means that pavement failures must be repaired first. Cracks should be sealed several months in advance and any potholes or dig-out areas patched. Crack sealing and patching practices are covered in Chapters 4 and 5, respectively.

In some cases, an asphalt rubber binder chip seal also serves as a stress absorbing membrane (SAM) or stress absorbing membrane interlayer (SAMI) (Figure 11-2). A SAM or SAMI may be used over pavements with low severity fatigue cracking in small quantities (e.g., isolated areas). Refer to sections 37-2.04 and 37-2.05 of the Standard Specifications. A thin overlay may then be applied a year or more after a SAM or immediately following application of a SAMI.




a) Stress Absorbing Membrane Seal b) Stress Absorbing Membrane Interlayer

**Figure 11-2 SAM Seal and SAMI**

Surfaces should be thoroughly swept to remove debris that could prevent a good bond between the existing pavement and the overlay. Flushing with water may be needed where the pavement is exposed to agriculture product drippings.

### Tack Coat

Tack coats are applications of asphaltic emulsion or asphalt binder sprayed onto an existing pavement prior to an overlay being applied. The tack coat promotes adhesion between old and new pavement layers.

Refer to the Caltrans Tack Coat Manual. Surfaces must be clean before the tack coat is applied. If a good bond is not formed between the thin overlay and the existing pavement, it can de-bond resulting in a slippage failure or delamination. If too much tack coat is applied, it may bleed up through the layer, especially under heavy traffic.

Tack coat must be applied via a calibrated distributor truck with nozzles set at an angle of about 30 degrees to the spray bar. The height should allow a triple overlap (see Chapter 5). A tack coat must be applied in one application at the rate specified in section 39-2.01C(3)(f) of the Standard Specifications.

### Placement

Placement operations may be slightly different depending upon the type of haul vehicle used.

Placement operations using bottom dump trailers which deposit the material in windrows require close inspection. The mixture may be windrowed ahead of the paver and picked up with a pick-up device and deposited in the paver hopper. The length of the windrow must be as short as possible to ensure excessive cooling does not occur. If conditions are good (i.e., little or no wind and higher temperatures), this is usually about 250 ft (76 m) maximum. If conditions are poorer than this, the length of the windrow should be kept less than 250 ft (76 m). In addition, mixture that is left in the paver hopper too long and thus, allowed to cool below the minimum laydown temperature should not be combined with recently delivered, hot mixture.

Placement using a material transfer vehicle (MTV) is increasingly common, in particular for large tonnage projects. An MTV operation consists of a paving machine with a large chute or snorkel device fitted over the hopper, an MTV, and either end dump trucks or live bottom trucks or trailers. The delivery vehicle discharges into the hopper of the MTV. The MTV re-mixes the material and conveys it into the modified hopper of the paving machine. The re-mixing eliminates segregation and results in material with a more uniform temperature. During placement, the MTV and the paving machine do not come into contact which, along with the continuous forward progress, results in a smoother mat.

When paving operations are to be discontinued for an extended period (e.g., end of day), it is necessary to construct a transverse joint across the pavement being placed. This can be accomplished in a number of ways and the type of joint constructed depends primarily on whether or not traffic will be allowed to travel over the joint between the time the joint is constructed and paving operations resume. Refer to Chapter 8, section 8.5 of Asphalt Institute publication MS-22.

Longitudinal joints occur between adjacent travel lanes or between travel lanes and a paved shoulder.

During the paving operation of a lane of pavement, the material along the edge of the pavement (i.e., where the longitudinal joint will exist) normally has about a 60-degree incline relative to the surface of the existing pavement. Prior to placement of the adjacent lane of pavement (or shoulder), this material can be either cut back (using a saw or cutting wheel attached to a grader or front-end loader) by about 2 in (50 mm) to create a vertical face, or an overlapping joint can be constructed. Cutting back the joint helps to ensure that adequate density of the mixture exists at the longitudinal joint.

Whenever a joint is constructed by “cutting back the joint,” tack coat must be applied to the newly exposed face of the longitudinal joint.

Properly overlapping, raking, and compacting the longitudinal joint can typically also result in adequate joint density.

Refer to section 39-2.01C(4) of the Standard Specifications and Chapter 8, section 8.6 of Asphalt Institute publication MS-22.

**Rolling**

There are several stages of rolling. Because thin layers lose temperature rapidly, the rolling temperatures must be strictly monitored. The stages for compaction include initial breakdown using a vibratory steel drum roller (vibration may be on or off), intermediate (kneading compaction using a pneumatic roller or vibratory roller with the vibrator on), and finish using a static roller. Refer to section 39-2.01C(15) of the Standard Specifications and Chapter 9, section 9.7 of Asphalt Institute publication MS-22. Figure 11-3 shows rolling regimes.

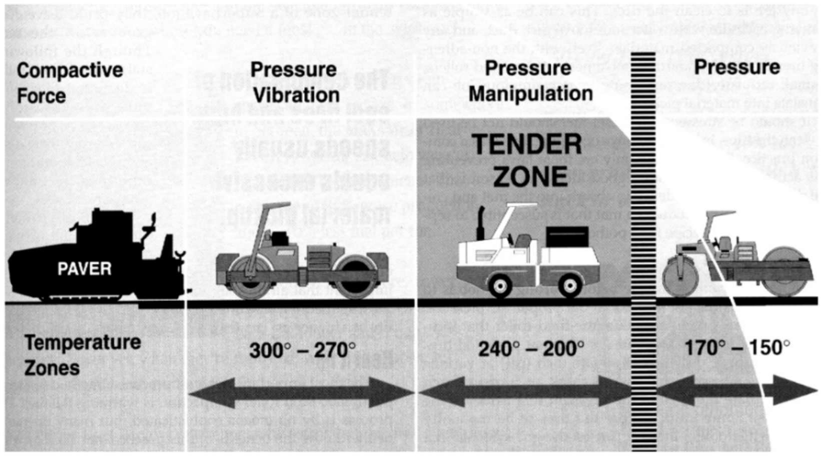



**Figure 11-3 Rolling Regimes (Lender, 2001)**

## 11.3 OPEN-GRADED FRICTION COURSES (OGFC)

### *11.3.1 OGFC Mixes*

Open Graded Friction Course (OGFC) is a surface course with an aggregate gradation that provides an open void structure as compared with Type A HMA. Air void content typically ranges between 15 to 25% resulting in a highly permeable mixture relative to Type A HMA (which normally is relatively impermeable). The porous nature of OGFC mixtures allows surface water to quickly drain away from the surface by flowing through the mixture. The principal benefit derived from OGFC mixtures is a significant reduction in splash and spray relative to Type A HMA mixtures and PCC pavements. Other benefits include a reduction in tire noise and an increase in the frictional characteristics relative to Type A HMA mixtures. The addition of modifiers such as polymers and asphalt rubber may be used to address different environmental and climatic conditions and allow for thicker films to improve durability.

### *11.3.2 Performance*

OGFC is designed as an abrasion resistant wearing course that can quickly drain water from the road surface. The following paragraphs provide a brief overview of the distresses that occur as well as the factors influencing project selection, service lives, and costs.

**Distresses/Conditions Addressed**

OGFC overlays can be used to mitigate the following distresses present in an existing pavement:

- Skid problems/Hydroplaning
- Splash and spray

- Noise problems
- Raveling
- Oxidation
- Minor surface irregularities (ride quality)
- Surface reflection problems
- Bleeding surfaces

RHMA-O will perform better than conventional OGFC mixes in slowing down reflective cracking. In addition, modified binders can be used to address low temperature cracking and reflective cracking. Also, because durability is a function of film thickness, the use of modifiers (e.g. asphalt rubber) that increase in service viscosity allow thicker films resulting in higher resistance to oxidation and raveling. The void structure also allows absorption of free surface asphalt to mitigate bleeding pavements.

**Primary Distress Modes**

OGFC overlays exhibit the following failure modes:

- Permanent deformation due to heavy traffic and high temperatures.
- Shear failures in high stress areas.
- Fatigue cracking due to repeated traffic loading.
- Reflection cracking due to cracks in the existing pavement reflecting up through the overlay.
- Raveling due to a number of factors including oxidation and hardening of the binder, water damage, low binder content, and low compaction.
- Stripping caused by binder-aggregate incompatibility.
- Delamination due to poor compaction and/or tack coat practices.
- Clogging of voids resulting in loss of permeability.
- Rich and dry spots due to drain down of binder during transport and application.
- Isolated areas of softened binder due to fuel/oil spills.

Often, these can be addressed by selection of the correct binder and proper mix design and project selection. OGFC overlays are not suitable for every project. The performance of OGFC overlays is based on maintaining the void structure.

### *11.3.3 Project Selection*

**Where Should OGFC be Used?**

In California, OGFC is generally used in new construction, major rehabilitation projects, and also in thin overlays. OGFC is used as a wearing course (i.e., surface treatment over dense graded asphalt concrete pavements and occasionally on Portland cement concrete (PCC) pavements). OGFC is generally used on the traveled way and extending 1 ft (0.3 m) on the shoulder. In maintenance applications, the distress mode of the existing pavement must be determined and addressed.

OGFC should only be placed on structurally sound pavements because it offers no structural improvement but can renew the surface in terms of functional performance (i.e., ride quality).

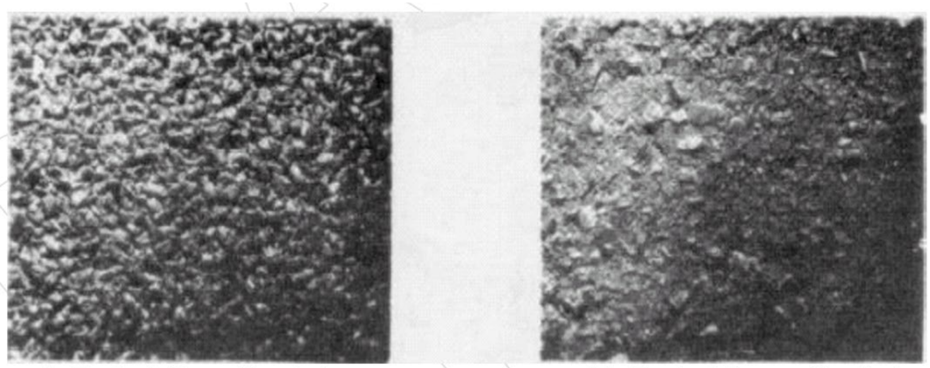
Reflective cracking is better addressed by utilizing rubberized OGFC with increased binder content (RHMA-O-HB).

**When Should OGFC be Used?**

OGFC is a desirable application for the surface layer of AC pavements where its benefits are important. This is especially the case whenever the traffic count is high, and the rainfall is moderate or high. Specifically, OGFC should be used when the following are issues:

- **Wet Weather Accidents:** When the Traffic Accident Surveillance and Analysis System (TASAS) Report reveals a high frequency of wet weather accidents or when the Traffic Safety Report recommends the use of OGFC to minimize wet weather accident occurrences.

- **Skid Resistance:** When frictional properties of the pavement surface are suspect, a skid test should be conducted to determine the existing coefficient of friction of the pavement surface (CT 342). Figure 11-4 shows typical surface textures of OGFC compared with Type A HMA.



a) Typical Open Graded b) Typical Dense Graded

**Figure 11-4 Typical Texture**

- **Wet-night Visibility:** When the TASAS Report reveals a high percentile confidence level for wet weather and nighttime accident occurrences. OGFC may also be considered for placement to reduce splash and spray due to rain and increase the visibility of pavement delineation. It can be placed on both asphalt and Portland cement concrete pavements.

- **Cross Slope:** When the cross slope is less than 2% and there are two or more lanes in one direction, OGFC may be especially helpful to assist in the draining of water from the pavement surface.

- **Noise:** OGFC is sometimes placed to reduce road noise. Caltrans has reported in a study on I-80 that traffic noise levels have decreased and continue to be lower than baseline conditions 35 months after the application of OGFC. The life expectancy of the noise benefit will vary with the mix and binder type.

- **Oxidation Reduction:** OGFC has been successfully used as a protection layer to prevent asphalt aging in the main structural layers.

- **Mitigation against Flushing and Bleeding:** When applied to a pavement provides void structure to accommodate any potential flushing or bleeding in the underlying pavement.

- **Mitigation of Cracking:** RHMA-O-HB can be used to mitigate cracking.

- **Structural Adequacy:** OGFC is not a structural layer, rather it is considered a sacrificial layer only.

**Where and When Should OGFC Not be Used?**

OGFC should not be used on:

- **Unstable Pavements:** Any pavement that exhibits substantial cracking, rutting, bleeding, or depressions.

- **Snow or Icy Areas:** In snow areas, where tire chains, studded tires, or snowplows will detrimentally affect the aggregate and binder, the result may lead to stripping of the aggregate and contribute to raveling and pavement deterioration.

- **Areas with Severe Turning Movements:** High shear areas are not recommended due to potential for scuffing. These areas may include parking areas, intersections, ramp terminals, or curbed sections.

- **Curb and Gutter/Dense Graded:** Adjacent to curb and gutter or Type A HMA where water may be held back and stored, thus creating a ‘bath’ that may cause striping or saturation of the structural section.

- **Muddy Areas:** Areas where mud may be tracked onto the pavement from un-surfaced side roads will fill the voids and **reduce** the surface water drainage characteristics of the OGFC.

- **Fuel or Oil Spill Areas**: Where dripping of oil or fuel from slow or stopped vehicles is likely.

- **Mill and Fill Areas:** Mill and fill areas as a bathtub effect may be created. If OGFC were to be used as the final course, a leveling course would be required first.

**Special Maintenance Requirements**

Normally, removal and replacement is used for repairing a failed or aged OGFC based on Caltrans. Permeability must be maintained to ensure water flow is unimpeded. Maintenance on roadways surfaced with OGFC should avoid any activities that may obstruct the lateral flow of water through the OGFC. These activities may include crack sealing or patching a small, failed area with Type A HMA thus creating a 'dam' where water may be retained or stored and contribute to further failure. When large areas of patching are involved, OGFC should be replaced with OGFC. Traffic striping may also inhibit lateral water flow if the striping materials are applied at a heavy rate or excessive amount of reflective beads are used.

Winter maintenance is not as great an issue as once thought. OGFC has different thermal and icing properties compared with Type A HMA. Thermal conductivity is up to 70% less according to the National Asphalt Pavement Association. It will thus act as an insulating layer and accumulate ice and frost faster than Type A HMA.

General maintenance of OGFC to prevent clogging is important in some areas. Water hoses, high-pressure cleaners, and specialized cleaning vehicles have been used successfully.

**Service Life**

OGFC overlays have been shown to last 2 to 10 years, but more commonly 4 to 6 years. The life is directly affected by the condition of the existing underlying pavement, the climate (environmental conditions), and the traffic loading. For example, an OGFC overlay placed on a pavement in poor condition would not be expected to last as long as one placed on a pavement in good condition. Similarly, an OGFC overlay placed on a pavement in good condition but with heavy traffic would not be expected to last as long as one placed on the same pavement but with much lighter traffic.

### *11.3.4 Design and Specifications*

Specifications for OGFC are in section 39-2.04 of the Caltrans Standard Specifications (2025).

The special requirements of OGFC mixtures are related to their specific properties. The void structure must remain intact to ensure that it remains permeable. As air can penetrate easily and promote aging, the void structure itself will promote accelerated aging compared with dense graded materials. For this reason, the binders used in OGFC mixtures must be more resistant to the effects of aging than those used for Type A HMA mixtures. Modified binders and asphalt rubber binders provide improved resistance to aging.

The texture of the mixture at the surface affects skid resistance. To achieve this, the aggregate must be hard and abrasion resistant and the mixture must be resistant to permanent deformation so that the open void structure remains intact. It has been found that coarser gradings give a more open void structure. These tend to give good stone on stone contact and deformation resistance and the voids are less susceptible to becoming clogged.

Asphalt rubber binder can be used to address low temperature cracking, reflective cracking and night paving. Polymer modified binders may be used to address low temperature cracking and to overcome problems of lower temperature paving conditions (e.g., night paving).

### *11.3.5 Construction*

**Production**

Production is similar to that for Type A HMA, except that if RHMA-O or R-HMA-O-HB are being produced, the plant must also have equipment for blending the crumb rubber modifier (CRM) and asphalt modifier with the paving asphalt and agitating the resulting asphalt binder.

Appropriate temperatures must be carefully controlled during the mixing process. Temperatures that are too high will promote drain down and ‘fat’ spots or ‘dry’ spots in the final surfacing. Temperatures that are too low may result in inadequate coating of the aggregate.

**Storage**

Storage is similar to Type A HMA, except, open graded mixes should not be stored for more than two hours. This is due to the potential for binder drain-down. This is not a requirement in the Standard Specifications.

**Hauling**

Hauling is similar to that for Type A HMA.

**Surface Preparation**

Surface preparation is similar to that for Type A HMA. Overlay of an existing OGFC OGAC surface will require removal of the existing OGFC OGAC prior to placing new OGFC OGAC. This will prevent water entrapment and poor bonding.

**Tack Coat**

Tack coat application is similar to that for Type A HMA. Refer to section 39-2.04C of the Standard Specifications.

**Placement**

Placement is similar to that for Type A HMA, except OGFC is more sensitive to temperature and the use of an MTV is required. Refer to section 39-2.04C of the Standard Specifications.

The guidelines shown in Table 11-1 apply to the placement of OGFC.

**Table 11-1 Guidelines**

| Anticipated Ambient Temperature | Guideline* |
|---|---|
| > 68ºF (20°C) | OGFC may be placed using windrow and pick up machines. The length of the windrow should be usually limited to 250 ft (76 m). There should be little or no wind. |
| 55ºF (13°C) – 68ºF (20°C) | OGFC should be placed by end-dumping into the paving machine, not by windrowing. Keep rollers within 49 ft (15 m) of paving machine. Tarp trucks for hauls > 30 minutes. Mix in hopper to be 194-248ºF (90-120°C). |
| 50ºF (10°C) – 55ºF (13°C) | In addition to above rules, polymer modified asphalt binder should be used. Asphalt rubber binders may also be used. Maximum mixing temperature can be raised to 325ºF (163°C). Mix temperature in hopper to be 275ºF (135°C). |
| < 50ºF (10°C) | OGFC should not be placed. |

**Ensure all Standard Specifications and SSPs are followed.*

Wind is an important factor. Cold wind may reduce the surface temperature quickly making compaction difficult. On very cool and windy days placement may need to be suspended. Transverse joints are more difficult to make in OGFC due to these mixtures being more difficult to work by hand as compared with dense graded mixtures. Handwork should be minimized. For this reason, transverse butt joints should be constructed, or joints should be avoided by continuous paving. Longitudinal joints are made in a similar manner to those for Type A HMA.

### Rolling

The rollers used for OGFC mixtures are solely steel drum operated in static mode (pneumatic rubber-tired rollers are not used because they will close up the voids in the surface by kneading action and the mix may stick to the tires). Rollers should not "hang over" an unsupported edge, as this will tend to collapse the void structure creating a flattened and sealed edge. Refer to section 39-2.04C of the Standard Specifications.

### Post Treatment

If traffic can be kept off the mix, no treatment is required. However, in most cases, sanding is carried out on rubberized mixes to prevent initial traffic pick up. Clean sand is spread using a sand spreader after rolling is complete. Refer to section 39-2.04C of the Standard Specifications.

## 11.4 GAP-GRADED (RHMA-G) OVERLAYS

Gap graded mixtures are solely Rubberized Hot Mix Asphalt – Gap Graded (RHMA-G).

### *11.4.1 RHMA-G Mixes*

The purpose of gap grading is to provide improved stone-to-stone contact by reducing the fine aggregate content so as to provide a strong aggregate skeleton that creates space for more engineered binder than a dense graded mix can hold. Gap grading is also a good way to increase the VMA of a mixture.

A gap-graded mixture consists of an aggregate grading that has a missing fraction. The gap (missing fraction) is used to accommodate the higher asphalt rubber binder content relative to that of Type A HMA. This results in stone-on-stone contact for deformation resistance and the extra binder improves fatigue and reflection cracking resistance. The crumb rubber modifier (CRM) increases the viscosity of the binder allowing high binder contents without bleeding. The increase in voids allows the mix to accommodate the larger particulate rubber present. Aggregate gradations are specified in Section 39-2.03B(4)(b) of the Standard Specifications (Caltrans, 2025). The maximum stone size is limited to one third of the layer thickness. Properly designed and constructed RHMA-G mixtures have low permeability and have good durability characteristics (due to high binder content).

### *11.4.2 Performance*

**Distresses/Conditions Addressed**

RHMA-G thin overlays should be placed on structurally sound pavements. They can be used to mitigate the following distresses present in an existing pavement:

- Raveling,
- Oxidation,
- Reflection cracking,
- Minor surface irregularities, and
- Flushing Surfaces
- Skid Problems

Although not as free draining as open graded mixes, some improvement is noted in skid related problems (i.e., hydroplaning and spray and splash) and noise reduction.

**Primary Distress Modes**

RHMA-G thin overlays can exhibit the following distress modes:

- Permanent deformation due to heavy traffic and high temperatures
- Shear failures in high stress areas
- Fatigue cracking due to repeated traffic loading
- Reflection cracking due to cracks in the existing pavement reflecting up

through the overlay
- Raveling due to a number of factors including oxidation and hardening of the binder, water damage, low binder content, and low compaction
- Stripping caused by binder to aggregate incompatibility
- Delamination, due to poor compaction and/or tack coat practice

Often, these can be addressed by proper mix design and job selection. In California, only asphalt rubber modified binders are used in these mixes.

### *11.4.3 Project Selection*

**Where Should RHMA-G be Used?**

RHMA-G mixes are used as a surface treatment over Type A HMA pavements and occasionally on Portland cement concrete pavements. RHMA-G should be placed over structurally sound pavements and may be used in new construction and rehabilitation projects. These mixes are generally used on the traveled way and should be placed across the entire roadbed, from outside edge of shoulder to outside edge of shoulder to provide uniform frictional properties and proper drainage.

**Where Should RHMA-G Not be Used?**

RHMA-G mixes should not be used on unsound pavement exhibiting substantial cracking, rutting, bleeding, or depressions. RHMA-G should not be considered for use on bridge decks as a surface course unless approved by Headquarters Division of Structures.

**Service Life**

Caltrans has not performed any LCCA on these mixes. Regardless, service life should be expected to exceed that of Type A HMA in similar applications.

### *11.4.4 Design and Specifications*

Specifications for RHMA-G are in section 39-2.03 of the Standard Specifications (Caltrans 2025).

### *11.4.5 Construction*

**Production**

Production is similar to that for Type A HMA, except that the plant must also have portable equipment for blending the crumb rubber modifier (CRM) and asphalt modifier with the paving asphalt and agitating the resulting asphalt binder attached. It uses a slightly higher temperature range during production.

### Storage

Storage is similar to that for Type A HMA.

### Hauling

Hauling is similar to that for Type A HMA, except RHMA-G mixes are more temperature sensitive.

### Surface Preparation

Surface preparation is similar to that for Type A HMA.

### Tack Coat

Tack coat application is similar to that for Type A HMA.

### Placement

Placement is similar to that for Type A HMA, except RHMA-G is more sensitive to temperature and the use of an MTV is required. Refer to section 39-2.03C of the Standard Specifications.

Transverse joints are more difficult to construct in RHMA-G mixtures due to the lower workability by hand of such mixes as compared to Type A HMA mixtures. Handwork should be avoided if possible, however, if required handwork should be done as soon as possible. For this reason, transverse joints should be constructed as a butt joint or avoided by continuous paving.

### Rolling

Vibratory steel drum rollers should be used on RHMA-G mixtures. Pneumatic rubber-tired rollers are not allowed as the mix will stick to the tires. Refer to section 39-2.03C of the Standard Specifications.

RHMA-G mixtures often require more compacting effort than Type A HMA mixes, and vibratory compaction is generally required for breakdown rolling. The breakdown roller should follow as closely behind the paver as practicable. If the mix is tender, then the roller should lay back only the minimum time necessary for rolling. Breakdown rolling should achieve 92 to 96% of the required compaction. This will ensure that adequate compaction is achieved with the subsequent intermediate roller passes. Finish rolling is mostly for aesthetics. If density has not already been achieved at this stage, additional compaction will likely not increase density due to low mix temperature.

### Post-Laydown Treatments

If traffic can be kept off the mix, no treatment is required. Otherwise, sand is applied after final rolling to avoid pick up by early traffic. Refer to section 39-2.03C of the Standard

Specifications (Caltrans 2025). Sweeping may be required after initial trafficking to remove the sand. This is generally done the next day.

## 11.5 TROUBLESHOOTING AND FIELD CONSIDERATIONS

### *11.5.1 Troubleshooting Guide*

This section provides information to assist maintenance personnel with troubleshooting problems associated with placing any of the thin HMA overlays. Table 11-2 presents a troubleshooting guide that associates common problems with their potential causes, whereas Table 11-3 lists some commonly encountered problems and their recommended solutions.

**Table 11-2 Troubleshooting Guide**

| Cause | Wavy Surface - Short Waves/Ripples | Wavy Surface - Long Waves | Tearing of Mat - Full Width | Tearing of Mat - Center Streak | Tearing of Mat - Outside Streaks | Mat Texture - Nonuniform | Screed Marks | Screed Not Responding to Correction | Auger Shadows | Poor Pre-compaction | Poor Longitudinal Joint | Poor Transverse Joint | Transverse Cracking (Checking) | Mat Shoving Under Roller | Bleeding or Fat Spots in Mat | Roller Marks | Poor Mix Compaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fluctuating Head of Material | ✔ | ✔ | | | | ✔ | | | | | ✔ | | | | | | |
| Feeder Screws Overloaded | ✔ | ✔ | | | | ✔ | | | ✔ | | | | | | | | |
| Finisher Speed Too Fast | ✔ | | | | ✔ | | | | | | | | | | | | |
| Too Much Lead Crown in Screed | | | | | ✔ | | | | | | | | | | | | |
| Too Little Lead Crown in Screed | | | | ✔ | | | | | | | | | | | | | |
| Overcorrecting Thickness Control Screws | ✔ | | | | | | | | | | ✔ | | | | | | |
| Excessive Play in Screed Mechanical Connection | ✔ | ✔ | | | | | ✔ | ✔ | | | | ✔ | | | | | |
| Screed Riding on Lift Cylinders | ✔ | ✔ | | | | ✔ | | ✔ | | ✔ | ✔ | ✔ | | | | | |
| Screed Plates Worn Out or Warped | | | ✔ | ✔ | ✔ | ✔ | | | | | | | | | | | |
| Screed Plates Not Tight | ✔ | | | | | ✔ | | ✔ | | | | ✔ | | | | | |
| Cold Screed | | | ✔ | ✔ | ✔ | ✔ | | | | | | | | | | | |
| Moldboard on Strike off Too Low | | | | | ✔ | | | | | | | | | | | | |
| Running Hopper Empty Between Loads | | ✔ | | | | ✔ | | | | | | | | | | | |
| Feeder Gates Set Incorrectly | | ✔ | | ✔ | ✔ | | | | | | | | | | | | |
| Kicker Screws Worn Out or Mounted Incorrectly | | | | ✔ | | | | | | | | | | | | | |
| Incorrect Nulling of Screed | | | | | | | | | | | | ✔ | | | | | |
| Screed Starting Blocks Too Short | | | | | | | | | | | | ✔ | | | | | |
| Screed Extensions Installed Incorrectly | | | | | ✔ | ✔ | | | | | | | | | | | |
| Vibrators Running Too Slow | | | | | | ✔ | | | | ✔ | | | | | | | |

## Table 11-2 Troubleshooting Guide (Continued)

| Cause | Wavy Surface - Short Waves/Ripples | Wavy Surface - Long Waves | Tearing of Mat - Full Width | Tearing of Mat - Center Streak | Tearing of Mat - Outside Streaks | Mat Texture - Nonuniform | Screed Marks | Screed Not Responding to Correction | Auger Shadows | Poor Pre-compaction | Poor Longitudinal Joint | Poor Transverse Joint | Transverse Cracking (Checking) | Mat Shoving Under Roller | Bleeding or Fat Spots in Mat | Roller Marks | Poor Mix Compaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade Control Mounted Incorrectly | ✔ | ✔ | | | | | | ✔ | | | ✔ | | | | | | |
| Grade Control Hunting (Sensitivity Too High) | ✔ | | | | | | | | | | ✔ | | | | | | |
| Grade Control Wand Bouncing on Reference | ✔ | | | | | | | | | | ✔ | | | | | | |
| Grade Reference Inadequate | ✔ | ✔ | | | | | | | | | | | | | | | |
| Sitting Long Period Between Loads | | ✔ | | | | ✔ | | | | | | | | | | | |
| Improper Joint Overlap | | | | | | | | | | | ✔ | | | | | | |
| Improper Mat Thickness for Max. Agg. Size | | | ✔ | | | ✔ | | ✔ | | ✔ | | | | | | | |
| Trucks Bumping Finisher | | ✔ | | | | | ✔ | | | | | | | | | | |
| Truck Holding Brakes | | ✔ | | | | | ✔ | | | | | | | | | | |
| Improper Base Preparation | ✔ | ✔ | | | | ✔ | | | | ✔ | | | ✔ | ✔ | | ✔ | ✔ |
| Improper Rolling Operation | ✔ | | | | | | | | | | ✔ | ✔ | ✔ | ✔ | | ✔ | ✔ |
| Reversing or Turning Too Fast of Rollers | | ✔ | | | | | | | | | | | | ✔ | | ✔ | ✔ |
| Parking Roller on Hot Mat | | ✔ | | | | | | | | | | | | | | ✔ | ✔ |
| Improper Mix Design (Agg) | ✔ | | ✔ | | | ✔ | | | ✔ | | | | ✔ | ✔ | ✔ | | ✔ |
| Improper Mix Design (Asphalt) | ✔ | | ✔ | | | ✔ | | | ✔ | | | | ✔ | ✔ | ✔ | | ✔ |
| Mix Segregation | ✔ | ✔ | ✔ | | | ✔ | | | ✔ | | | | | | | | |
| Moisture in Mix | | | ✔ | | | | | | | | | | ✔ | ✔ | ✔ | | ✔ |
| Variation of Mix Temperature | ✔ | ✔ | ✔ | | | ✔ | | ✔ | | | | | ✔ | ✔ | ✔ | ✔ | ✔ |
| Cold Mix Temperature | | | ✔ | ✔ | ✔ | ✔ | | ✔ | | ✔ | ✔ | ✔ | | | | | ✔ |

*1. Find problem above*
*2. Checks indicate causes related to paver*

*Note: Many times, a problem can be caused by more than one item, therefore, it is important that each cause listed is eliminated to assure solving the problem.*

**Table 11-3 Common Problems and Related Solutions**

| Problem | Causes and Solutions |
|---|---|
| **Surface Waves** | **Causes**<br>• A fluctuating head of material in front of the paver screed causing it to rise and fall usually causes surface waves.<br>• Worn or badly set screeds can cause surface waves.<br>• A mix that is too stiff or that has cooled too much before compaction will cause surface waves.<br>• Long waves can be caused by adjusting the screed too often and not allowing an adjustment to fully take effect before changing it again.<br>• Dump trucks bumping the paver when delivering a load of mix can cause long waves.<br>**Solutions**<br>• The solution for avoiding surface waves is to control the material amount, temperature, and screed correctly.<br>• Pave continuously with a pick-up machine where possible. |
| **Wash Boarding** | **Causes**<br>• Wash boarding is caused by improper use of vibratory rollers, either in amplitude setting or in speed of roller.<br>**Solutions**<br>• Use higher roller amplitudes for thicker layers and lower amplitudes for thinner layers.<br>• Slow down the roller. |
| **Tearing** | **Causes**<br>• Poor paver operation, or the mix being too cold and/or too stiff causes tear marks.<br>**Solutions**<br>• Tear marks can be avoided by adjusting the degree of crown and ensuring the mix temperature is correct. |

**Table 11-3 Common Problems and Related Solutions (Continued)**

| Problem | Causes and Solutions |
|---|---|
| **Non-Uniform Texture-Segregation** | **Causes**<br>• The mixture separating in the hopper or in transportation causes segregation.<br>• Poor paver set up.<br>• Low mix temperature or poor grading or mix design.<br>• Prone to occur in thin overlays.<br>• Weak base layer.<br>**Solutions**<br>• Ensure thickness is at least twice, preferably three times that of largest stone size, mix design is correct, and the paver is properly set up.<br>• Ensure mix temperature is correct. |
| **Screed Marks** | **Causes**<br>• Transverse screed marks occur when the paver stops and starts and longitudinal screed marks occur when extensions are used on the screed.<br>• Poor paver set up or worn or dirty screeds.<br>• Low mix temperature or poor grading or mix design.<br>**Solutions**<br>• Set paver and screed correctly. Use windrowing to ensure paver does not stop.<br>• Ensure the mix is in specification. |
| **Surface Shadows** | **Causes**<br>• Caused by overloading augers in the paver.<br>• May be caused by low mix temperature or poor grading or mix design.<br>**Solutions**<br>• Adjust the distance between the screed and the tractor of the paver.<br>• Ensure that the level of mix is near the center of the auger shaft. The augers should NOT be totally covered with mix. |

**Table 11-3 Common Problems and Related Solutions (Continued)**

| Problem | Causes and Solutions |
| --- | --- |
| **Roller Checking and Roller Marks** | **Causes**<br>• Deflection under the roller (i.e., mix too hot) or mix design is poor.<br>• Too much asphalt in the mix, too much middle size sand in the gradation (No. 16 - No. 30 [1.18mm - 600 μm sieve]).<br>**Solutions**<br>• Wait until the mix cools further or adjust the mix design. |
| **Bleeding and Fat Spots** | **Causes**<br>• High mix temperature or poor grading or mix design.<br>• Too much asphalt in the mix or amount of fines too low in the grading.<br>• Mix design not taking the correct traffic level into account.<br>• Moisture in the mix or on the pavement.<br>• Extremely high applications of tack coat.<br>• Existing bleeding surface.<br>**Solutions**<br>• Solve by ensuring aggregates are dry during the mixing process, that pavement is not bleeding, that pavement is dry, and that mix is correctly designed for traffic and aggregate. |
| **Shoving** | **Causes**<br>• Caused by excess asphalt in the mix.<br>• Improper roller operation such as sudden reversal.<br>• Rolling before the mat is stable enough.<br>• Roller going too fast.<br>**Solutions**<br>• Ensure mix is at correct temperature.<br>• Ensure roller is not going too fast.<br>• Check and correct mix design if necessary.<br>• Consider use of modified binders. |

**Table 11-3 Common Problems and Related Solutions (Continued)**

| Problem | Causes And Solutions |
|---|---|
| **Delamination** | **Causes**<br>• Insufficient tack coat.<br>• Mix is too cold during compaction.<br>• Existing surface being too cold for paving.<br>• Dirty surface on which an overlay is being placed.<br>**Solutions**<br>• Ensure paving temperatures are correct.<br>• Ensure the surface is substantially free of debris. |
| **Poor Joints** | **Causes**<br>• Paver operating at different elevations when paving adjacent lanes.<br>• Poor joint practice, especially in compaction of thin layers.<br>**Solutions**<br>• Make sure joints are correctly formed and compacted at the correct temperature. |
| **Raveling** | **Causes**<br>• Insufficient asphalt in the mix.<br>• Poor compaction.<br>**Solutions**<br>• Ensure mix design conforms to the specification.<br>• Ensure compaction is carried out at correct temperatures. |

### *11.5.2 Field Considerations*

The following field considerations are a guide for the important aspects of performing a maintenance overlay project. Table 11-4 lists items that should be considered in order to promote a successful job outcome. As thoroughly as possible, the answers to these questions should be determined before, during, and after application. The staff to do this work will vary by job type and size. Some topics may need attention from several staff members. The field maintenance personnel should at least be acquainted with its contents. The intention of the tables is not to form a report, but to bring attention to important aspects and components of the project process. Some information is product specific and contained in the relevant standard specifications, special standard provisions, or special provisions.

### Table 11-4 Field Considerations

| | Preliminary Responsibilities |
|---|---|
| **Project Review** | • Is the project a good candidate for a thin overlay?<br>• How much rutting is present, depth and extent?<br>• Other profile problems observed?<br>• How severe and what type of cracking exists?<br>• Is crack sealing needed?<br>• Is the pavement surface waterproof?<br>• How much bleeding or flushing exists?<br>• Is pavement raveling or oxidized?<br>• What is the traffic level?<br>• Is the base sound and well drained?<br>• Is a drainage layer required?<br>• Is pavement strengthening required? Use a structural overlay if it is.<br>• Review project for bid/plan quantities. |
| **Document Review** | • Application specifications and special provisions.<br>• Mix design information.<br>• Traffic control plan (TCP). |
| **Materials Checks** | • A full mix design has been done for the mixture?<br>• The mix is produced by an approved source?<br>• Has the tack coat emulsion been sampled and submitted for testing?<br>• Aggregates meet all specifications and are not from a source known to have stripping problems? If so, what anti stripping treatment is to be used?<br>• Aggregate is clean and free of deleterious materials and correct grading?<br>• Is the tack coat emulsion properly prepared (diluted) before use?<br>• Is the mix checked at the plant for temperature compliance and have samples been taken? |

**Table 11-4 Field Considerations (Continued)**

| | Inspection Responsibilities |
|---|---|
| **Surface Preparation** | • Is the surface clean and dry? Has it been swept?<br>• Have any areas with oily residue been scrubbed from the pavement?<br>• Have all pavement distresses been repaired?<br>• Has the existing surface been inspected for drainage problems?<br>• Have all utilities been raised or masked? |
| | **Equipment Inspection Considerations** |
| **Broom** | • The bristles are the proper length?<br>• The broom can be adjusted vertically to avoid excess pressure? |
| **Tack Coater** | • Is the machine fully functional?<br>• Has the machine been calibrated to accurately spray the correct level of tack coat?<br>• Are all spray tips clean and not blocked?<br>• Are nozzles angled correctly (approximately 30°)?<br>• Is the spray bar at the correct height? Is there a double or triple overlap of spray fan? |
| **Paving Machine** | • Is the machine fully functional?<br>• Is the paver clean and are the wings operating correctly?<br>• Are flow gates clear, set at the right height, and functioning properly?<br>• Are the conveyors functioning?<br>• Are the augers clean and functioning?<br>• Is the flow system (manual or automatic) operational?<br>• Are material levels in the paver auger chamber set correctly?<br>• Do the screed heaters work?<br>• Is the screed clean and properly set? Is the angle of attack correct?<br>• Is the automatic leveling system working and correctly set?<br>• Is the paver speed correct for correct thickness and angle of attack?<br>• Are the screed strike offs clean and providing a uniform mat?<br>• In continuous jobs, is the pickup machine working correctly?<br>• Is a materials transfer device being used? Is it working correctly?<br>• Are the mixing and heating facilities fully operational? |

**Table 11-4 Field Considerations (Continued)**

| | Equipment Inspection Considerations |
|---|---|
| **Rollers** | • What types of rollers will be used on the project for break down and finish rolling?<br>• Tandem or vibratory rollers - are they fully functional? CT 109?<br>• Pneumatic roller - is it fully functional and do roller tire pressures comply with the manufacturer's specification?<br>• Do the roller tire size, rating, and pressures comply with manufacturer's recommendations?<br>• Ensure the tire pressure is the same on all tires.<br>• All tires should have a smooth surface. |
| **Dump Trucks** | • What types of dump trucks are being used?<br>• Are bottom dump trucks providing a clean and well-shaped windrow?<br>• Do rear dump trucks have correct hitch for the paver? |
| **Weather Requirements** | • Have air and surface temperatures been checked at the coolest location on the project?<br>• Do air and surface temperatures meet specification requirements? |
| **Determining Application Rates** | • Have Agency guidelines and requirements been followed?<br>• Is rut filling or a leveling course required? If so, have material quantities been calculated or estimated to properly reprofile roadway?<br>• Has a full mix design been done?<br>• Are tack coat application rates correct for the pavement surface? More emulsion may be required on roads with porous surfaces and less for those with flushed surfaces. |
| **Calibration of Equipment** | • Are machines calibrated?<br>• Who carried out the calibration and what documentation has been provided? |

**Table 11-4 Field Considerations (Continued)**

| | Equipment Inspection Considerations |
|---|---|
| **Traffic Control** | • The signs and devices used match the traffic control plan.<br>• Flaggers do not hold the traffic for extended periods of time.<br>• Unsafe conditions, if any, are reported to the RE.<br>• The pilot car leads traffic slowly–24 mph (40 kph) or less–over fresh overlays.<br>• Signs are removed or covered when they no long apply. |
| | **Project Inspection Responsibilities** |
| **Tack Coat Application** | • What is the emulsion temperature?<br>• Wind, humidity, and temperature can affect set time and affect distribution.<br>• Has tack coater application spray bar been checked for height, blocked nozzles?<br>• Has application rate been checked?<br>• Has the emulsion been diluted correctly?<br>• Is the grade and ambient temperature satisfactory?<br>• Is the application even and covering the entire pavement?<br>• Is the emulsion allowed to turn black before paving?<br>• Is the application in accordance with Caltrans guidelines?<br>• Do the paver wheels pick up the tack coat during paving? |
| **Laydown of Dense Graded Mix** | • Has a test strip been successfully laid and compacted?<br>• Is the ambient and grade temperature correct?<br>• Is the mix temperature correct?<br>• Is the paver going at a uniform speed?<br>• If continuous application is used with windrowing? Is the mixture the correct temperature?<br>• If back dump trucks are used, are changeovers smooth causing no bumping of the paver?<br>• Are the hopper, augers, and screed operating correctly?<br>• Is the screed set at the correct height?<br>• Is the mat being tamped uniformly and is the mat a uniform thickness?<br>• Are height adjustments minimal?<br>• Are height adjustments allowed sufficient times to be effective?<br>• Is the mat uniform looking?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist? |

**Table 11-4 Field Considerations (Continued)**

| | Project Inspection Responsibilities |
|---|---|
| **Laydown of RAC Type G Mix** | • Has a test strip been successfully laid and compacted?<br>• Is the ambient and grade temperature correct?<br>• Is there evidence of significant drain down of the mix?<br>• Is the mix temperature correct?<br>• Is the paver going at a uniform speed?<br>• Are the paver wings kept open to avoid segregated mix being laid?<br>• If back dump trucks are used, are changeovers smooth causing no bumping of the paver?<br>• Are the hopper, augers, and screed operating correctly?<br>• Is the screed set at the correct height?<br>• Is the mat being tamped uniformly and is the mat a uniform thickness?<br>• Are height adjustments minimal?<br>• Are height adjustments allowed sufficient times to be effective?<br>• Is the mat uniform looking?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist?<br>• Does the material have a dull or shiny look? |
| **Laydown of Open Graded Mix** | • Has a test strip been successfully laid and compacted?<br>• Is the ambient and grade temperature correct?<br>• Is the mix temperature correct?<br>• Is there evidence of drain down?<br>• Is the paver going at a uniform speed?<br>• If continuous application is used with windrowing, is the mixture the correct temperature?<br>• If back dump trucks are used, are changeovers smooth causing no bumping of the paver?<br>• Are the hopper, augers, and screed operating correctly?<br>• Is the screed set at the correct height?<br>• Is the mat being tamped uniformly and is the mat a uniform thickness?<br>• Are height adjustments minimal?<br>• Is adjustments allowed time to be effective?<br>• Is the mat uniform looking?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist? |

## Table 11-4 Field Considerations (Continued)

| | Project Inspection Responsibilities |
|---|---|
| **Rolling Dense Graded Mix** | • Has a roller pattern been established?<br>• Have the number of passes required for breakdown rolling been established?<br>• Is the surface temperature of the mat correct at beginning of rolling?<br>• Is the roller being operated at the correct speed? Does the mat check under the roller?<br>• Ensure that no aggregate is crushed under breakdown rolling.<br>• Is water being used to cool the mat?<br>• Is finish rolling required?<br>• How many passes?<br>• Is the mat uniform looking?<br>• Does mat meet density requirements?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist? |
| **Rolling RAC Type G Mix** | • Has a roller pattern been established?<br>• Have the number of passes required for breakdown rolling been established?<br>• Is the surface temperature of the mat correct at beginning of rolling?<br>• Is the roller being operated at the correct speed?<br>• Does the mat check under the roller? If so, wait a little longer for cooling.<br>• Is water being used to cool the mat?<br>• How many passes?<br>• Is the mat uniform looking?<br>• Has density been met?<br>• Does the mix pick up?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist? |

**Table 11-4 Field Considerations (Continued)**

| | Project Inspection Responsibilities |
|---|---|
| **Rolling Open Graded Mix** | • Has a roller pattern been established?<br>• Have the number of passes required for breakdown rolling been established?<br>• Is the surface temperature of the mat correct at beginning of rolling?<br>• Is the roller being operated at the correct speed?<br>• Does the mat check under the roller? If so, wait a little longer for cooling.<br>• Is the mat uniform looking?<br>• Has density been met?<br>• Does the mix pick up?<br>• Are edge lines and joint overlaps neat and straight?<br>• Is the job stopped if problems persist? |
| **Truck Operation** | • Trucks are staggered across the fresh tack coat to avoid driving over the same area.<br>• Trucks travel slowly on the fresh mix.<br>• Stops and turns are made gradually.<br>• Truck operators avoid driving over mat.<br>• Trucks should stagger their wheel paths when backing over a previous pass. |
| **Longitudinal Joints** | • Is echelon paving used?<br>• Are joints overlapped or cut back?<br>• Has a notch device been used?<br>• Is compaction at joints satisfactory?<br>• If left open to traffic, are edges of runs feathered to prevent fall off of traffic?<br>• Are joints flat and smooth?<br>• How far does the end gate of the paver overlap the previous lane?<br>• Minimal raking of the longitudinal joint should be done.<br>• Compaction should be from the hot side of the joint.<br>• Are the joints straight and compact?<br>• Ensure no gaps! |

**Table 11-4 Field Considerations (Continued)**

| | Project Inspection Responsibilities |
|---|---|
| **Transverse Joints** | • Transverse joints should be minimal and are used at the end of paving or when problems occur in laying.<br>• Butt joints require a vertical face to be constructed by hand. Is this done?<br>• Is it done quickly to avoid mix cooling?<br>• Compaction is done upstream of the joint, are runoff boards provided for the roller?<br>• Tapered joints are used if traffic is to be carried over a transverse joint.<br>• Is the mat uniform up to the joint?<br>• Is treated paper or sand used on the edge for a temporary joint to form a ramp?<br>• Is a ramp constructed just with mix?<br>• When paving is recommended, is the ramp or taper removed cleanly?<br>• Is raking used excessively to form the joint?<br>• Is the joint compacted transversely?<br>• If there are restrictions, is the joint compacted longitudinally?<br>• Is the joint tight and well compacted and close to being indiscernible? |
| **Brooming (if required)** | • Brooming begins after the mixture is available for traffic.<br>• Follow-up brooming should be done if raveling is high or if traffic is high. |
| **Opening the Mix to Traffic** | • The traffic travels slowly–24 mph (40 kph) or less–over the fresh mat.<br>• Remove all construction related signs when opening to normal traffic. |
| **Clean Up** | • All loose aggregates should be removed from travel way.<br>• Remove spills from all areas including curbs, sidewalks, and radius applications. |

## 11.6 REFERENCES

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*Note: Caltrans manuals referenced above may have later editions than those cited. Refer to the latest editions of these references for the most current information.*