CHAPTER 7 CONCRETE PLACEMENT & INSPECTION

Overview of slab replacement contact joint, and weakened-plane joint with dowel bar basket & bond breaker materials prior to the concrete pour

The following inspections procedures apply before, during, and after concrete placement.

PRE-POUR INSPECTION

Immediately prior to concrete placement, the bond breaker, dowel and tie bars (when specified), and expansion material must be inspected to ensure proper placement.

BOND BREAKER INSPECTION

Typically, plastic sheeting will be placed as the bond breaker over the existing base material. Ensure that it is placed flat, with a 150-mm overlap where necessary and with as few wrinkles as possible, with minimal overlapping of the same sheet.

Occasionally, a curing paper or coating may be applied, such as asphalt emulsion or pigmented curing compound. Verify that it has not been damaged since the installation and reapply if needed.

DOWEL BAR INSPECTION

Prior to concrete placement, check that all dowels are installed properly (when specified). All dowel bars must be placed parallel to the direction of slabs (longitudinal joint).

- For dowels set in the contact joints, each dowel should have an expansion cap located on the exposed end of the dowel bar, if a non-shrink mix (non PCC mix) will be placed. The expansion cap is not required for PCC mixes.
- For weakened plane dowel assemblies, verify that the dowels and dowel basket assemblies are fastened properly and aligned.

Transverse expansion joint material

Longitudinal expansion joint material

Failed attempt to fasten expansion material securely

EXPANSION MATERIAL INSPECTION

The expansion material must be cut to fit the holes for drill-and-bond dowel bars and tie bars. Additional expansion material may also be placed along the longitudinal joint if the adjacent slab will be replaced later.

CONCRETE PLACEMENT

Concrete placement

Poor construction practice. Concrete is beginning to set before final placement. Also, the concrete chute is being cleaned over the repair area.

DURING-POUR INSPECTION

CONCRETE PLACEMENT

As fresh concrete arrives on the job, the inspector should monitor the concrete temperature and watch for cement balls in the truck. Lumps of unmixed cement will affect the quality of the concrete by reducing the cement content of the remaining batch. If this occurs, reject the load. Usually, cement balling can usually be corrected by changing the batching sequence, such that cement does not come in contact with mix water directly in the drum.

The chute operator should distribute the concrete evenly to avoid the need for excessive shoveling. Attaining good concrete consolidation around dowel bars and along the patch perimeter is important to achieve long-term performance. Vertical penetrations of a standard spud vibrator will mobilize the fresh concrete adequately. Do not drag the vibrator through the mix because this may cause segregation.

WARNING:

RSC has a high slump, typically 200 mm or more. When poured on a slope, RSC can flow down the slope until it sets. High-slump RSC should be placed starting at the lowest point.

SPREADING, COMPACTING, AND SHAPING

Uniform concrete placement using the concrete truck chute

Concrete vibration without dragging the vibrator and hand finishing

SUMMARY OF SPREADING, COMPACTING, AND SHAPING

- Metal or wood side forms may be used. When wood side forms are used they should not be less than 40 mm thick.
- Side forms should remain in place until the pavement edge no longer requires the protection of forms. Side forms should be cleaned thoroughly and oiled prior to each use.
- RSC should be consolidated using high-frequency internal vibrators. Through proper application of vibration uniform consolidation should be achieved adjacent to the forms and across the full paving width.
- RSC should be placed, as nearly as possible, in its final position, and vibrators are not permitted for shifting of the mass of RSC.
- RSC should be spread and shaped by suitable powered finishing machines, supplemented by hand finishing as necessary. Methods of spreading, shaping, or consolidating that result in segregation, voids, or rock pockets should be discontinued. The contractor should use methods that will produce a dense homogeneous pavement conforming to the required cross-section.
- After the RSC has been mixed and placed, no additional water should be added to the plastic concrete. There are several approved retarding agents, which may be used to facilitate the finishing of the slab surface.

NOTE:

No cold joints are allowed. Make sure that there is enough RSC to pour the entire slab. If not enough RSC is on site to complete the slab, remove the concrete back to the previous transverse joint and place a construction joint.

CONCRETE SAMPLING AND TESTING

Sample preparation area

Concrete sampling

Preparation of concrete beams

Beams protected and placed on last constructed slab to cure

CONCRETE MATERIAL SAMPLING AND TESTING

The contractor may be required to hire a testing laboratory to conduct the required Caltrans tests. Caltrans staff will supervise the contactor sampling and testing.

During concrete placement, adequate amounts of concrete material should be obtained to conduct the required Caltrans tests (the sampling and testing procedures are summarized in appendix B). The sample material may be placed in a wheelbarrow. To ensure accurate testing results, representative samples should be obtained from the middle portion of the batch as soon as possible. Under no circumstances should the elapsed time between the first and final sampling of wet concrete exceed 15 minutes.

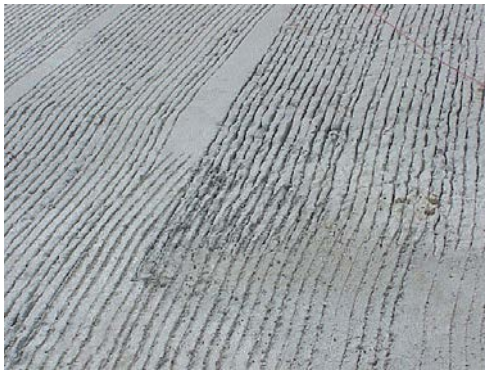
The material samples may be obtained from a stationary mixer, paving mixer, revolving drum truck mixer or agitator, open-top truck mixer, agitator, non-agitating equipment, or other types of open-top containers.

After a composite sample is obtained, the material should be placed in beam molds and allowed to set. The beams should be protected and placed on top of the last constructed curing slab to maintain the consistency of curing between the beam molds and the fresh concrete.

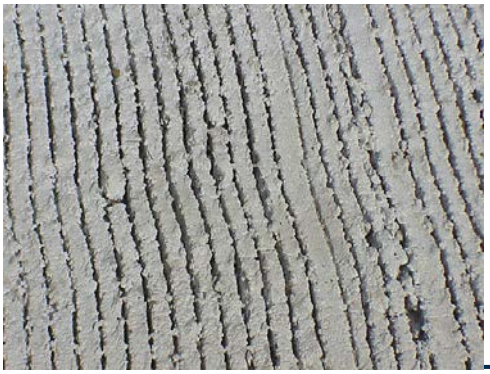
A Caltrans laboratory may conduct additional strength testing. These tests are used to determine payment to the contractor and acceptance of the pavement.

SURFACE TEXTURING

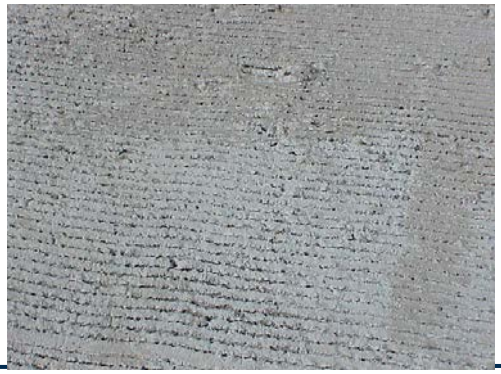
Tining should be applied parallel to the pavement centerline



Avoid overlapping the tining comb or digging too deep



Tining applied too early before the intial set can cause raveling of the concrete surface



Unsatisfactory workmanship resulting in rough surface

Improper tining techniques

AFTER CONCRETE PLACEMENT

Immediately after placement, surface texturing, saw cutting, and curing are critical to the final condition of the concrete surface.

SURFACE TEXTURING

Surface texturing by tining can begin immediately after the placement of the fresh concrete and must match the texture of the existing pavement surface. The texturing should be applied in one continuous pattern. The texture pattern should not overlap and should appear uniform over the entire pavement surface. See Caltrans Standard Specification 40-1.10, Final Finishing.

Power-operated cure

Hand cure should be used only when the work area is inaccessible to the power operated equipment

CURING

Curing of the fresh concrete is critical to the long-term performance of the replaced slab and must occur in a timely manner. Shortly after placement, the slab must be sprayed with curing compound or cured as recommended by the manufacturer of the hydraulic cement used in the RSC. Insulating layers, such as plastic sheeting, can be placed on the pavement surface to promote the hydration of the concrete resulting in faster strength development.

For high-early-strength mixes, the first few hours after placing the concrete are the most critical. Proper curing is essential to maintain a satisfactory moisture and temperature condition in the concrete after placement. As soon as possible, apply the curing compound and cover with plastic sheeting for proper curing.

SAWING TRANSVERSE JOINTS AND FINAL FINISH

Weakened plane joint being sawed

Late or shallow sawing can contribute to volunteer cracking

Planned PCC joint

Unplanned PCC joint caused by volunteer crack

SAWED WEAKENED PLANE JOINTS

Transverse joints in the replacement pavement should match the spacing and skew of the existing pavement. For slabs longer than 4.6 m, an intermediate sawed weakened plane joints should be provided at midslab. Sawed joints should be cut to the depth specified. If the sawcut depth is not specified, the joint should sawed t/3, where t is the slab depth. The sawcuts should be made to the minimum width, not to exceed 6 mm for joints that will not be sealed.

Sawing of weakened plane joints should be completed as soon as the concrete will support the saw. Refer to Caltrans Specification 40-1.08B(1), "Sawing Method." Sawing for joints to be sealed should conform to Caltrans Standard Plan A35C.

PROTECTING NEWLY PLACED SLABS

Newly placed slabs must be protected accordingly to Caltrans Specifications 7-1.16, "Contractor's Responsibility for the Work and Materials," and 90-8, "Protecting Concrete." To protect slabs from vehicles driving through them, the contractor should:

- Place "Wet Concrete" signs on barricades and place cones around the entire perimeter of the replaced slabs.
- Make sure that the cones and barricades are not placed on the new concrete slabs, as they will leave impressions and damage the surface finish.

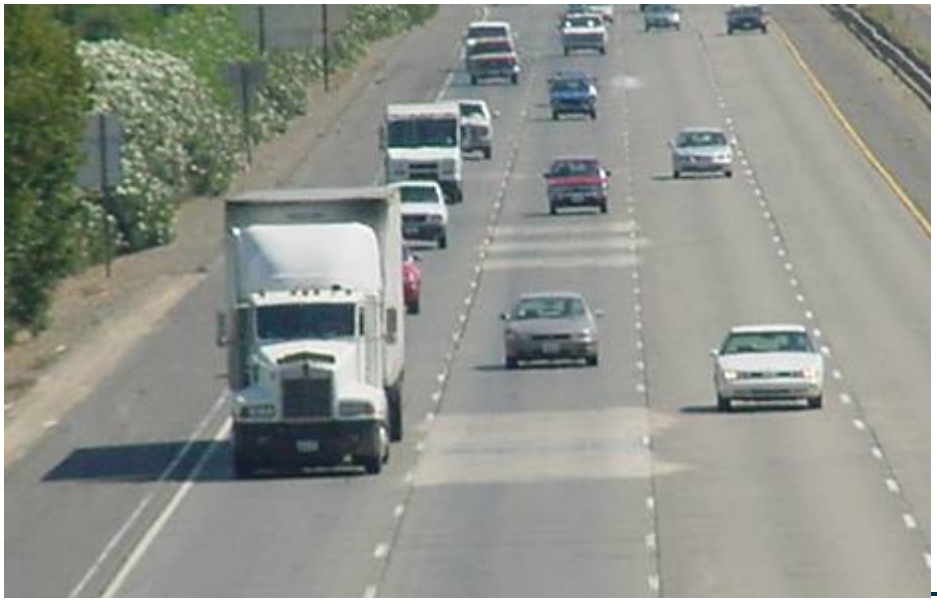
FINAL FINISHING

Tests to determine the coefficient of friction of the final textured surface will be made only if the engineer determines, by visual inspection, that the final texturing may not have produced the specified coefficient of friction.

Any tests to determine the coefficient of friction will be made after the pavement is opened to traffic, but not later than 5 days after concrete placement. Pavement areas having a coefficient of friction as determined in conformance with California Test 342 of less than 0.30 should be grooved in conformance with the Caltrans Standard Specifications.

Caltrans skid testing machine

CHAPTER 8 OPENING TO TRAFFIC



Opening to traffic

Before the replaced slab can be opened to traffic, the engineer must ensure that the repair area has gained specified strength and that the site has been cleaned up.

FLEXURAL STRENGTH TESTING

Variations in air temperature, humidity, wind speed, and mix temperature can have a great effect on strength development of RSC. The goal of curing the beams for flexural testing is to have the strength of the beams match the strength of the pavement. Following Caltrans test procedures will help ensure this.

It is important to remember that the Caltrans field laboratory will contact the designated inspector with the test results from the concrete flexural strength specimens. These flexural strength test results are not used as the criteria for opening to traffic. The Caltrans field laboratory flexural strength test results are used to determine pay factors for the contractor, as the contractor may choose to open the lanes to traffic at less than specified strength to avoid penalties associated with delays.

OPENING TO TRAFFIC (CONTINUED)

Slab replacement

CRITERIA FOR OPENING TO TRAFFIC

The opening to traffic strength is based on a minimum flexural strength of 2.8 MPa, as determined in accordance with CTM 523 (see Appendix B, page b.6).

If the slabs have not reached their flexural strength prior to opening the lanes to traffic, that portion of the job remaining should be considered temporary and must be replaced. The contractor will be required to return the next shift and replace the temporary slabs.

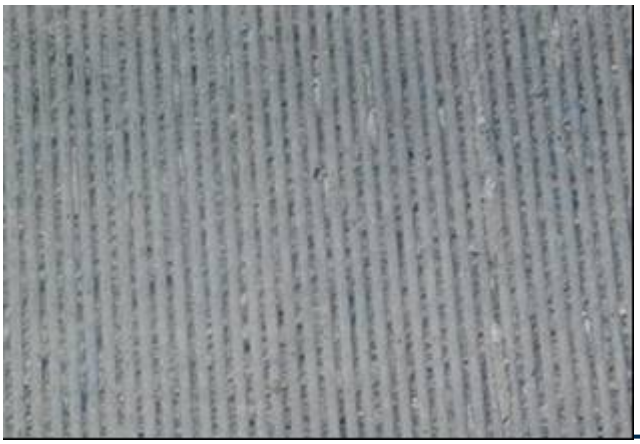
PAVEMENT DELINEATION REPAIR

Whenever pavement delineation is removed or damaged due to work involved within the project limits, the contractor should replace or repair the delineation to its original condition at the contractor's expense. Pavement delineation repairs should be made in conformance with the provisions in Section 84, "Traffic Stripes and Pavement Marking," and Section 85, "Pavement Markers," of the Caltrans Standard Specifications.

CLEAN-UP

The contractor must supply a sweeper at the end of concrete placement for each work period. Direct the sweeper to clean specific areas as necessary. If needed, have the sweeper clean around the area of the washout pit. Replace any pavement markers that were removed during the work shift. Touch up any traffic striping that was obscured or damaged during the shift.

CHAPTER 9 GRINDING & JOINT SEALING



Diamond-ground concrete

Diamond grinding should always follow slab replacement to reduce roughness and improve ride quality. Joint sealant, where specified, should be installed after completion of the slab replacements and after any required diamond grinding activities. Only the sawed joints shall be sealed.

NOTE TO DESIGNERS:

Be sure to include item to diamond grind!

DIAMOND GRINDING

Diamond grinding corrects irregularities by removing a thin layer of hardened concrete, using closely spaced diamond saw blades. The grinding operation normally removes between 4 and 6 mm per pass and results in a smooth, quiet, longitudinally grooved surface texture.

Ride quality measurements shall be used to determine when grinding is necessary. After slabs are replaced, measure the surface variance and joint differential. Variances greater than 2.5 mm affect ride quality. For slab replacements with a variance greater than 2.5 mm, diamond grinding is required.

Diamond grinding can extend serviceability, improve ride and skid resistance, and reduce pavement noise. Diamond grinding has been used as a PCC pavement rehabilitation strategy for the following purposes:

- Transverse joint and crack fault removal (primary reason)
- Removal of wheel path rutting caused by studded tires
- Removal of permanent slab warping or curling at joints (in very dry climates where significant warping has occurred)
- Texturing of polished concrete surface exhibiting inadequate friction
- Improve transverse slope
- Improve ride quality by removing faulting, surface roughness, and unevenness caused by slab replacement
- Reduce noise and provide a safe, long wearing surface texture

DIAMOND GRINDING (CONTINUED)

Acceptable diamond grinding

Note the vertical fins and irregular grooves

Unsatisfactory diamond grinding

Do not attempt to remove depressions that are deeper than 9 mm by diamond grinding. Profile measurements along the project in each lane are an excellent indicator of depressions and bumps.

The most effective approach for grinding is to grind the entire lane width, which requires several passes. The reason for grinding the entire lane width is to avoid creating multiple longitudinal steps in the pavement.

Using adjacent slabs as guides and forms while performing slab replacements may result in steps or bumps where none existed before and should not be allowed.

Once diamond grinding is completed, roughness profile measurements are an excellent way to verify that the desired pavement profile has been achieved. Remember to replace any removed lane markers prior to re-opening to traffic.

JOINT SEALS

The entrance of fines or incompressibles and surface water into the joints may contribute to faulting, joint spalling, excessive pressure against bridge abutments, and pavement blowups. This is especially critical on high-elevation routes where sanding is used during icing conditions, and also in sand-blown areas where fine sand is deposited on the road.

With recent developments in joint design and sealant materials, it is evident that joint sealing can be quite cost-effective, provided that careful attention is given to selection of materials and construction of the sealed joints.

Because of the factors mentioned above and to minimize the need for costly and disruptive repairs on heavily traveled urban freeways, sealing of all joints is required on new concrete pavements. However, when lanes are added for widening, the joints should not be sealed unless the transverse and longitudinal joints (and cracks) in adjacent lanes are also sealed. Where specified, sealant should be placed within 7 days of opening to traffic, so that incompressibles do not fill the joint.

JOINT CLEANING

The most critical phase of joint sealant installation is the cleaning of the joint. The concrete must be dry and curing complete. Following the sawing operation, the joint must be sandblasted. This operation should provide a visibly clean new surface along both sidewalls, which should be visible from a surface inspection of the joint.

Air blasting is an effective way to remove the fine material from the joint sidewall. The nozzles of some sand blasting equipment have been modified with deflectors to direct the sand against the sidewalls to provide a clean surface. Air blasting is not designed to remove old sealants and should never be performed in lieu of sealant removal.

Care is required to remove the laitance or cement dust produced by the sawing operation. This dust is not removed with water cleaning and prevents the sealant from bonding with the sidewall. It does not hurt the joint to flush it with water to assist in the removal of incompressibles, but washing is not sufficient to ensure good bonding.

The joint must be completely dry before proceeding with the sealant installation.

SEALANT INSTALLATION

When joints are to be sealed, the joint dimensions (shape factor) and preparation are critical to good performance and must be constructed per Caltrans Standard Plans (RSP A35C).

NOTES