Section 40 Concrete Pavement

Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 40 Concrete Pavement

4-4001 General

This section covers concrete pavement including:

- Preparation of concrete pavement subgrade
- Production of the concrete
- Concrete pavement equipment requirements
- Placing, finishing, and curing of the concrete pavement
- Construction of joints
- Protection of the pavement
- Performing concrete pavement crack treatment

Plant inspection specialists and testing personnel usually perform inspection and testing duties at the concrete batch plant. However, in addition to onsite inspection, mix design and plant inspection are part of the resident engineer's responsibility. Good communication between plant and inspection specialists and assistant resident engineers is essential. Inspectors and assistants must inform the resident engineer of test results in a timely manner.

This section covers mostly onsite inspection duties. For information on producing and transporting concrete, see Section 4-90, "Concrete," of this manual.

4-4002 Before Work Begins

4-4002A General

- Review the plans and specifications to determine the requirements for concrete pavement, including submittals, quality control and assurance, materials, construction, and payment provisions.
- Coordinate and hold a prepaving conference with the specified contractor's personnel prior to paving activities, including any test strips. Discuss the contractor's methods for performing each element of the work.
- Decide if crossings will be necessary for the convenience of public traffic and whether rapid strength concrete (RSC) should be used for such crossings. Advise the contractor accordingly.
- When long hauls are involved, review the contractor's proposed placement method to ensure that adequate time will be available.
- Discuss pavement areas to receive safety edge with the contractor and construction methods to be utilized.
- For concrete pavement widenings placed adjacent to existing pavements, ensure the existing pavement lane or shoulder is ground before new concrete is placed.

New concrete pavement must match the ground existing surfaces and meet specified smoothness requirements.

- Arrange for plant inspection and testing personnel to be present at the plant before startup.

4-4002B Submittals

- Verify that Form CEM-3101, "Notice of Materials to be Used," includes concrete pavement materials. Refer to Section 6-202, “Responsibilities for Acceptance of Manufactured or Fabricated Materials and Products,” of this manual for additional information.
- Review the contractor's proposed concrete mix design for conformance with specification requirements. The contractor's mix design submittal is to include a copy of their American Association of State Highway and Transportation Officials (AASHTO) accreditation for their laboratory determining the mix proportions and laboratory test reports including modulus of rupture information. Refer to Section 4-90 of this manual for information on concrete mix designs. Assistance with the concrete mix design review may be obtained from the district materials engineer.
- Ensure the aggregate material source complies with Section 7-103L (2), “Surface Mining and Reclamation Act,” of this manual.
- Obtain the contractor's quality control plan that details the methods the contractor will use to ensure the quality of the work. Review the quality control plan for conformance with specification requirements. Ensure that the quality control plan has met or exceeded the quality control testing requirements specified in the contract. If requested by the contractor or desired by the resident engineer, hold a meeting to discuss the quality control plan which addresses each element affecting pavement quality including those specified in Section 40-1.01D(4), “Quality Control Plan,” of the *Standard Specifications*. Pay extra attention to the contractor's plan for ensuring proper placement of contraction joints, dowel bars, and tie bars. The district materials engineer may be available to provide subject matter expertise at these meetings.
- Obtain certificates of compliance when tie bars, threaded tie bar splice couplers, dowel bars, tie bar baskets, dowel bar baskets, chemical adhesive for drilling and bonding tie bars and dowel bars, silicone joint sealant, asphalt rubber joint sealant, preformed compression seal, backer rods (including the manufacturer's statement of compatibility with the sealant to be used), joint filler material, and epoxy powder coating items are to be used in concrete pavement.
- For jointed plain concrete pavements, ensure the early age crack mitigation system information is provided a minimum of 24 hours in advance of each paving shift.
- Obtain calibration documentation and operational guidelines for frequency measuring devices for concrete consolidation vibrators.
- For cold weather conditions, obtain contractor's plan for protecting concrete pavement.
- Obtain the name of the contractor's independent third-party air content testing laboratory when the project is located in a freeze-thaw area.
- Obtain manufacturer's recommendations and instructions for storage and installation when threaded tie bar splice couplers, chemical adhesive for drilling

and bonding tie bars and dowel bars, silicone liquid sealant, asphalt rubber liquid sealant, preformed compression seals, and joint filler material items are to be used in concrete pavement.

- For concrete pavement crack treatment, ensure the following:
  1. High molecular weight methacrylate samples are submitted well in advance of the work.
  2. Where sealant is to be removed, the contractor has submitted the proposed removal plan in conformance with the specifications.
  3. Submittal of a public safety plan, a placement plan, and material safety data sheets in conformance with the specifications.
  4. Depending on the location of the work, additional requirements may apply to the public safety plan including an airborne emissions monitoring plan prepared by a certified industrial hygienist.
  5. A representative test area is constructed and acceptable results are obtained prior to starting crack treatment.
  6. Project specific requirements are discussed with the contractor in advance to avoid surprises and disagreements.
- For compression seals, obtain the manufacturer's data sheet used to develop the recommended preformed compression seal based on the joint seal dimensions.

4-4002C Training

- Ensure that just-in-time-training is conducted in conformance with contract provisions.
- Ensure that joint sealant and compression seal installation training is delivered to contractor and Caltrans personnel prior to installation of joint sealant or compression seals.

4-4002D Concrete Field Qualification and Pavement Test Strip

- Ensure that field qualification of proposed mix proportions is performed by an ACI-certified "Concrete Laboratory Technician, Grade 1." Obtain copies of certifications for project records. Review concrete field qualification information for conformance with contract requirements.
- For continuously reinforced concrete pavement, verify that the contractor performs coefficient of thermal expansion sampling, specimen fabrication, and testing as specified.
- For projects with concrete pavement volumes exceeding 2000 cubic yards, ensure a test strip is constructed for evaluating compliance with specification acceptance criteria including smoothness, dowel bar and tie bar alignment, thickness, and final finishing. Test strips not meeting requirements are rejected. Additional test strips are required if the contractor changes the intended method of placement or concrete mix proportions or where a test strip has been rejected. Ensure arrangements are made to evaluate the test strip within 3 business days of placement.

4-4003 During the Course of Work

4-4003A Prepaving

- Before the start of paving, check the accuracy of the final grade stakes.
- Inspect the subgrade to ensure compliance with the specified tolerances for compaction and elevation. Ensure that any low areas are identified in a way that will result in placing additional concrete as specified. Such additional thickness is considered paid for as part of the lower layer and must not be included when calculating pavement thickness and payment (refer to the specifications for cement-treated base, lean concrete base, and treated permeable bases). Note these areas in daily reports with stationing and offset information.
- To maintain the concrete pavement at the thickness specified, the contractor may adjust the planned finished grade provided two conditions are met:
    1. All lower layers have been constructed to at least the minimum required elevations.
    2. Such adjustments do not result in abrupt changes in grade or adversely affect smoothness. General practice is to limit any such adjustment so that the planned finished grade does not change more than 0.04 foot in 60 feet longitudinally.
- When slip-form pavers are used, inspect the grade on which the paver will ride to determine if the grade is smooth enough to prevent abrupt vertical changes in the finished surface. When a wire controls the grade and alignment of the paver, check the wire for any obvious variations. Ensure that the wire is tensioned sufficiently to prevent measurable sag between supporting stakes. If you anticipate any problems, advise the contractor. Keep in mind that the contractor is responsible for the thickness and smoothness of the pavement.
- Identify where the contractor will post quality control charts.
- Ensure any specified bond breaker material, curing seal, or other required treatment has been applied and maintained on the underlying material in conformance with contract requirements. These materials may also be helpful for determining pavement thicknesses when examining pavement cores.
- Examine the equipment or tools to be used. When obvious inadequacies exist, advise the contractor and record the details in the daily report. Do the following in examining equipment or tools:
    1. For side-form construction:
        a. Examine the forms to ensure specified attributes, including those for composition, weight, dimensions, and rigidity. Ensure that the forms are cleaned and oiled before each use.
        b. Ensure that installation of the forms complies with specifications. Order any necessary corrective work before the placement of concrete.
        c. Inspect the paving equipment for specification compliance.
    2. For slip-form construction, examine the paver for the specified attributes.
    3. Regardless of which method of construction is used, ensure that the contractor uses proper consolidation techniques that produce uniform concrete without

segregation. Where vibrators are used, ensure they are operated in conformance with contract requirements.

4. To ensure compliance with the requirements for protecting pavement, examine all equipment that will bear on previously completed pavement.

- Ensure a sufficient water supply has been developed for the work.
- Before concrete placement, ensure that the subgrade is uniformly moist, but free from standing or flowing water.
- When required, ensure that tie bars and dowels are on hand and conform to specifications.
- Ensure that equipment for constructing joints is onsite and that it conforms to specifications.
- Ascertain the curing method the contractor proposes to use. When curing compound will be used, discuss the labeling and packaging requirements for acceptance of the compound with the contractor. Obtain a certificate of compliance, including required test results, for each batch of curing compound.
- Ensure that equipment and materials meeting the requirements of Section 90-1.03B(3), "Curing Compound Method," or Section 90-1.03B(4), "Waterproof Membrane Method," of the *Standard Specifications* are onsite.
- If paving or finishing operations will extend beyond daylight hours, ensure that adequate lighting facilities are on the project before paving begins.

4-4003B Paving

- Maintain good communication between field personnel inspecting the placing portion of the paving operation and plant inspection personnel, so that problems related to mixing or hauling may be addressed and corrected effectively.
- Refer to Section 4-90, "Concrete," of this manual for a discussion of transporting concrete and receiving load tickets at the delivery point.
- Observe the concrete as it is placed for improper proportions or inadequate mixing. In the daily report, record the reasons for any concrete rejection and the approximate amount involved.
- At the start of each day's work, ensure that the specified date stamp is used to mark the new pavement.
- Ensure acceptance testing is performed on concrete pavement in accordance with Section 40-1.01D(13)(a), "General" of the *Standard Specifications* and Section 6-1, "Sample Types and Frequencies," of this manual for the identified quality characteristics.
- For California Test 523, "Method of Test for Flexural Strength of Concrete," select a location to store concrete beams. A good location is one convenient to a water source and removed from any traffic. Require the contractor to supply sufficient sand or earth for burying the beams. Arrange for the contractor also to supply labor for assistance with transporting and burying the beams. Note the safety precautions in the test method.
- Ensure sufficient beam samples are molded for modulus of rupture acceptance testing based on lot size and age strength requirements. Make additional sets of

beams to determine acceptable flexural strength when pavement crossings will be open to public traffic or to job traffic earlier than normally permitted. Ensure fabricated beams are properly handled, cured, and transported prior to testing.

- Where air entraining admixtures are required, perform verification testing and use quality control testing for acceptance for air content of concrete pavement. Follow the contractual procedure specified in Section 40-1.01D(13)(f), "Required Use of Air-Entraining Admixtures," of the *Standard Specifications*.
- Review control chart information and ensure the contractor is following their quality control plan including action and suspension limits.
- Obtain updated quality control charts on each day of paving.
- For continuously reinforced concrete pavements, verify that the contractor performs coefficient of thermal expansion sampling and specimen fabrication, and submits specimens as specified.
- Ensure that the contractor furnishes the required tachometer. Also, be sure the contractor does the vibrating at the locations and in the frequencies and amplitudes specified. Be alert for inoperative units, and ensure they are replaced immediately.
- Observe the operation of equipment that bears on existing pavements to ensure that no cracking or other damage occurs. If damage occurs, order immediate corrective action.
- Ensure that dowels and tie bars are not displaced during the pour.
- When joints are to be formed rather than sawed, be sure joint material is placed as specified.
- Ensure that the contractor constructs a transverse construction joint if the time interval between two successive concrete loads is greater than the specification allowance. Ensure such joints are constructed at permissible contraction joint locations.
- Encourage the contractor to construct the pavement so it meets requirements for profile index, straightedge, and edge slump before final finishing.
- Measure the pavement's width at the beginning of and periodically after paving. While the required width applies to both upper and lower surfaces, the bottom width can be greater than specified to reduce edge slump.
- Ensure that end anchors are constructed at all required locations and to the dimensions shown on the plans. Be sure transverse contact joints are constructed and tie bars and dowels are placed as shown on the plans. When required, ensure that pressure relief joints are constructed as specified and shown on the plans.

4-4003C Finishing Pavement

- Ensure that the contractor performs preliminary finishing according to specifications and in a way that imparts the desired surface characteristics.
- During concrete finishing observations, consider the following information:
  1. Pavement can be durable with inadequate texture or be well textured and not have enough durability to retain the texture.
  2. Mixing water with surface mortar during finishing reduces surface durability. This mixture may "bleed" water that has not evaporated that was added to the

surface to make finishing easier, or water that was added to prevent hairline cracking and checking.

3. If any of the concrete visible during finishing is more dilute than the mortar of the freshly placed concrete, too much water is being mixed into the surface. Telltale signs of the unacceptable practice include the following:

    a. Soupy mortar during finishing.

    b. Excess laitance.

    c. Small scallops in the slab's edge.

    d. Areas still soft and wet in the finished surface while the surrounding area has turned firm and lost its watery sheen.

4. Standing bleed water may appear on the surface under certain conditions shortly after pavement is placed. To avoid mixing bleed water with surface grout, complete preliminary finishing before bleeding progresses to this degree.

5. Water applied for the convenience of finishing, not otherwise needed to produce the specified product, is contrary to specifications regarding water use for retempering.

- Ensure that the contractor performs the final finishing as specified and in a way that results in a finished surface with the desired characteristics.
- When sufficient rain may fall to damage fresh pavement, stop pavement placement or ensure that other steps are taken (such as placing a covering) to prevent damage.
- Before texturing, ensure that the contractor rounds the pavement edges to specified radii. Observe texturing for compliance with requirements. Ensure the contractor performs initial texturing with a broom or burlap drag so as to produce striations parallel to the centerline.
- Ensure that burlap drags are used as specified and kept sufficiently clean to avoid unsightly irregularities in the texture. Brooms used must also be kept sufficiently clean to avoid significant irregularities. Final texturing must be done with spring-steel tines that produce grooves parallel to the centerline. Grooves not straight and parallel to the centerline are unacceptable. Ensure that the cross section of the steel tines complies with specifications. Inspect the pavement surface to ensure that grooves meet the specified depth.
- Before and after the application of curing seal, ensure that the contractor keeps the pavement surface moist as specified.
- Ensure the contractor uses either the waterproof membrane method or curing compound method specified in Section 90-1.03B, "Curing Concrete," of the *Standard Specifications*. During observations, also note the following:

    1. Waterproof membrane:

        a. Ensure the contractor sprays the concrete with a mist of water until the concrete has set before placing the membrane.

        b. Examine the waterproof membrane to see that it meets specifications. For assistance, consult the district materials engineer.

c. Ensure that membrane material is placed and secured and that any damaged sheeting is repaired as the specifications require. Make sure that the contractor adheres to the specified curing period.

2. Curing compound:

a. Ensure that the contractor applies the curing compound uniformly at the specified time. See that sawed cuts or other disturbed areas receive additional curing compound. Your inspection should ensure the following attributes for the compound:

(1) It is not contaminated, diluted, or altered before application.

(2) It is mixed thoroughly before application.

(3) It is applied when concrete surfaces are still visibly moist.

(4) The curing film remains unbroken for the specified duration of curing.

b. Perform measurements and calculations for the curing seal's application rate. To determine the rate, you may use California Test 535, "Determining the Application Rates of Concrete Curing Compounds in the Field." Record the measurements in the daily report.

- Ensure concrete pavement joints are constructed in conformance with Section 40-1.03E, "Joints" of the *Standard Specifications*; the contractor's quality control plan; and, when applicable, the contractor's early crack mitigation system. Longitudinal and transverse contraction joints must be sawed before cracking occurs and after the concrete is hard enough to saw without spalling, raveling, or tearing. The contractor is responsible for determining the exact time of sawing. Ensure that concrete debris, water residue, and paste are immediately removed during saw cutting operations and that slurry from the sawing operation is immediately washed from the joint and removed. Where spalling, raveling, and tearing are observed, ensure the contractor performs repairs in conformance with Section 40-1.03Q(2), "Repair of Spalls, Raveling, and Tearing," of the *Standard Specifications*.
- Ensure concrete pavement temperature is maintained above 40ºF during the initial 72 hours after placement.

4-4003D Post-Paving

- Identify where core locations are to be taken by the contractor to verify proper placement of dowel bars and tie bars and proper concrete consolidation around these bars. Verify specified tolerances have not been exceeded.
- Visually examine concrete pavement surface once the cure period is complete. Identify any partial depth cracks or working cracks (full-depth) within the pavement slabs. If necessary, order the contractor to obtain concrete cores to further evaluate. Ensure partial depth cracks are treated with a high molecular weight methacrylate resin in accordance with Section 40-6, "Concrete Pavement Crack Treatment," of the *Standard Specifications*. Ensure working cracks within 0.5 foot of either side of a planned contraction joint are treated in accordance with Section 40-1.03Q(3), "Repair of Cracks," of the *Standard Specifications*. Pavement slabs with working cracks more than 0.5 foot from a planned contraction joint require the removal and replacement of slab or slab portions.

- Measure the finished surface with a straightedge, especially at contact joints, to determine compliance with specifications. The pavement's final surface must comply with both straightedge and profilograph requirements.
- Observe the contractor's pavement profiling operation. Ensure that the profilograph is calibrated and that the contractor operates it in accordance with California Test 526, "Operation of California Profilograph and Evaluation of Profiles." The profilograph operator must be qualified in accordance with Caltrans' *Independent Assurance Manual*. The contractor is responsible for controlling and performing necessary intermediate steps to produce final profilograms indicating the pavement surface is within the profile index specified. When corrective grinding is performed, it must conform to Section 42-3, "Grinding," of the *Standard Specifications*. Read the final profilograms in a timely manner. Inform the contractor if the profile index is acceptable or if further grinding is required. Record details of the contractor's profilograph operation, corrective measures, and final results in the daily report. Ensure the contractor submits the final profilograms to the specified email address.
- With the district materials engineer, arrange to measure the coefficient of friction (California Test 342, "Surface Skid Resistance with the California Portable Skid Tester"). Do not open pavement to traffic unless the coefficient of friction has been obtained.
- Note the following for coefficient of friction:

    1. Areas with uniform surface texture require testing only at representative locations to ensure that the required coefficient of friction has been provided. Test areas with visibly smoother texture as completely as necessary to ensure compliance or delineate areas that must be corrected.
    2. Tests made at temperatures below 40°F will yield low results; therefore, do not rely on such tests as indications of failure. However, you may use values higher than the required minimum to indicate compliance even if you made measurements below 40°F.
    3. To determine if the contractor's method of texturing is capable of producing the specified results, perform some tests as soon as possible after paving begins. Note that tests performed before the concrete is 7 days old are not valid for acceptance. Whenever early tests are performed, advise the contractor that such areas are subject to retesting. If the contractor has used the pavement for hauling or conducted an operation that could reduce the friction factor from the one originally determined, retest such areas before opening them to public traffic.
    4. Areas not meeting coefficient of friction requirements must be corrected by grooving or grinding in conformance with Section 42, "Groove and Grind Concrete," of the *Standard Specifications*. Retest the corrected sections as necessary to verify the coefficient of friction value has been met.

- After any required corrective grinding, determine locations where coring for thickness will be performed by the contractor. Observe coring operations and obtain drilled corings in properly identified plastic bags from the contractor. Use cores to determine acceptance of concrete pavement thickness. For more details about pavement thickness measurements, refer to Section 4-4004, "Measurement

and Payment." Do not allow coring machines on fresh concrete while any danger exists of damaging the concrete. Wait at least 72 hours as a minimum.

- Ensure any required rumble strips are ground into the concrete pavement after the minimum specified time and strength have been obtained. Ensure the completed rumble strip conforms to the tolerances for alignment, spacing, depth, length, and width. Ensure noise restrictions are met.
- For concrete pavement crack treatment, ensure application takes place after any corrective grinding. Ensure surface to be treated is properly cleaned and adjacent areas such as pavement joints, drains, and openings are protected. Refer to Section 40-6.03, "Construction," of the *Standard Specifications* for other placement provisions.

4-4004 Measurement and Payment

4-4004 Measurement and Payment

Using the dimensions shown on the plans, calculate the quantity of concrete pavement to be paid for. Use curve corrections to make sure that calculations account for curves in alignment. Make deductions from contract payments for deficient pavement thickness.

4-4004A Measurement of Pavement Thickness

Cores taken in each primary unit of pavement at the minimum specified rate and cores in primary unit areas taken at the contractor's request are referred to as "primary cores."

Primary cores do not include cores taken for secondary thickness measurements. These cores and those taken to determine the limits of secondary units are referred to as secondary cores.

Before coring begins in primary units, designate areas where coring is excluded. Limit excluded areas to the following:

- Dig-out spots in the subgrade.
- Thickened slabs at bridge approaches.
- End anchors.
- Local areas where authorized modifications to the planned pavement thickness have been permitted.

Do not exclude portions of the primary unit where equipment had difficulty or where unauthorized deviations from planned pavement thickness occurred.

4-4004A (1) Location of Primary Cores

Do the following to locate primary cores:

- For each pavement thickness on each day's paving, determine the net area, in square yards, of pavement placed, excluding the area of structures and other areas on which pavement is not placed during that day. The resulting measurement is the area of the primary unit. Divide the area of the primary unit by 1200 square yards and take the next highest whole number. The resulting number is the number of primary cores to be taken, unless the contractor requests additional ones.
- Divide the net length of the primary unit by the number of primary cores to be taken in that unit. The resulting distance is the primary coring interval.

Locate the first core in any primary unit by starting at either end of the unit (preferably proceeding in the direction of increasing stations), and select a lane at random. Select any factor from the longitudinal factors shown in Table 4-40.1, "Calculation Factors to Locate Cores," and multiply the factor by the primary coring interval. The result is the distance from the beginning of the primary unit to the first core. (Any random method of selecting the longitudinal location of the first core is within the intent of the specification.) Determine the lateral location of the first core by selecting a value from the lateral column shown in Table 4-40.1 and measuring that distance from the right-hand edge (when looking ahead) of the lane selected.

Table 4-40.1. Calculation Factors to Locate Cores

Longitudinal (Factor)	Lateral (Feet)
0.6	6
0.1	10
0.2	2
0.9	9
0.5	5
0.7	7
0.4	4
0.8	8
0.3	3

- In turn, locate the remaining primary cores in the lanes. Space them uniformly, from the first core in the unit, at longitudinal intervals equal in length to the primary coring interval for the unit. Then locate them laterally within each lane as used for the first core by applying successive values from the lateral factors in Table 4-40.1. All values in the table are to be used successively for each primary unit throughout the project after the value for the first core in the unit is selected at random. The location of each core should be spotted on the pavement within "pacing accuracy" longitudinally and within about 1 foot laterally.

4-4004A (2) Location of Secondary Cores

To determine the limits of secondary units, locate cores in approximately the center of each adjacent panel.

4-4004A (3) Thickness Variation

For all cores, determine the pavement thickness variation by subtracting the specified thickness of pavement from the thickness determined by core measurements. Record excess thickness by using a plus sign and deficient thickness by using a minus sign.

4-4004B Calculation of Deductions in Payment to the Contractor for Deficient Thickness

Take these steps when calculating deductions based on deficient thickness:

4-4004B (1) When None of the Primary Cores are Deficient in Thickness by More Than 0.05 Foot

When no primary cores are deficient in thickness by more than 0.05 foot, make an adjustment as follows:

- To determine the average thickness deficiency, if any, for the primary unit, average the thickness variations of all primary cores. Record this value to the nearest 0.01 foot. If the average thickness deficiency is less than 0.01 foot, make no deficiency adjustment. If the average thickness deficiency is more than 0.01 foot, continue with the steps below.
- To obtain the deficiency adjustment in dollars per square yard, use the table in Section 40-1.04, "Payment," of the *Standard Specifications*. The average thickness value is to be rounded to the nearest hundredth of a foot for averages from 0.01 foot to 0.05 foot when using the pay adjustment table.
- To obtain the total amount of payment to deduct for the primary unit, multiply the deficiency adjustment by the total area of the primary unit in square yards.

4-4004B (2) When One or More of the Primary Cores are Deficient in Thickness by More Than 0.05 Foot

When one or more cores are deficient in thickness by more than 0.05 foot, determine the limits of the deficiency by taking a secondary core in adjacent panels. Continue taking a secondary core in adjacent panels, expanding as necessary, until the deficient area is bounded by panels with deficient thickness of 0.05 foot or less. The bounded area is referred to as a secondary unit. Reject the secondary unit area for noncompliance pursuant to Section 5-1.30, "Noncompliant and Unauthorized Work," of the *Standard Specifications*. Exclude the secondary unit areas from payment and deduction calculations. In the calculation to determine average thickness of the primary unit, use the average thickness of all secondary cores outside the secondary unit to replace the thickness of the initial primary core within that secondary unit.

To determine the primary unit deduction, multiply the primary unit area, excluding any secondary unit areas, by the appropriate factor (if any) in the table titled "Pay Adjustments for Deficient Thickness" within Section 40-1.04, "Payment," of the *Standard Specifications*.

To determine the total deduction, add the deductions for primary units and the cost of all secondary cores, including those taken outside secondary unit areas.

Below is an example illustrating the procedure for measuring the pavement for thickness and calculating deductions for thickness deficiencies. The procedures and the dollar figures used for deductions from payments to the contractor used in the example are based on Section 40-1.01D(13)(e), "Concrete Pavement Thickness," and Section 40-1.04, "Payment," of the *Standard Specifications.*

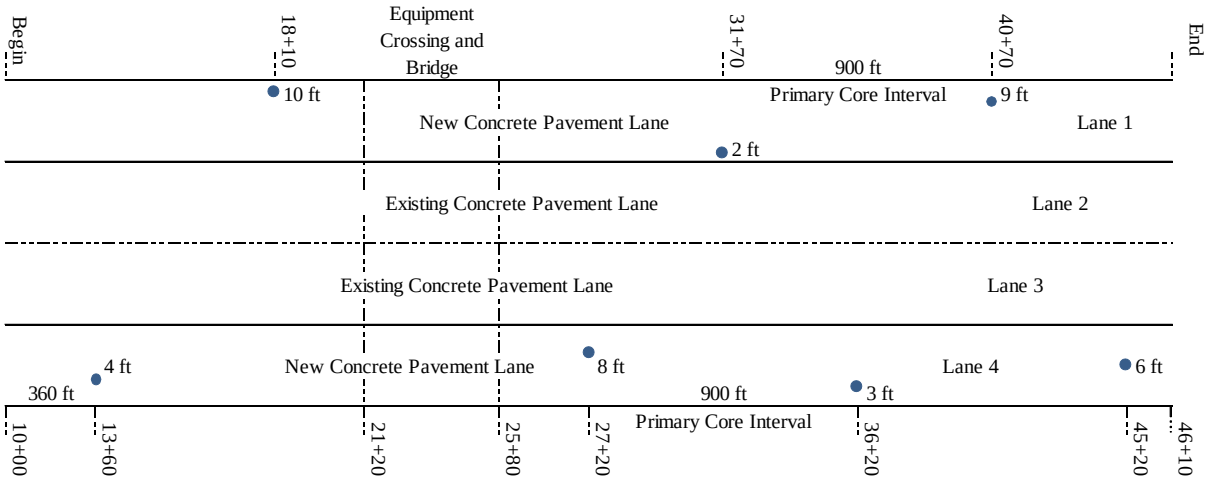
Assume the following:

The contractor paved two lanes (1 and 4) from Station 10+00 to Station 46+10. An equipment crossing and a bridge within the limits of the day's run caused "skips" in the length paved totaling 460 feet (from Station 21+20 to

Station 25+80). The actual length paved was 6300 feet (3150 feet x 2 lanes). The total area paved on this date was 8400 square yards.

The engineer calculated the number of cores required for thickness measurements in the primary unit (8400/1200 = 7) and the core interval (6300/7 = 900). To determine the location of the first core, the engineer chose the outside lane (4), at random and used the seventh set of numbers at random, from Table 4-40.1, "Calculation Factors to Locate Cores." The first core was taken at a longitudinal distance of 360 feet from the beginning and at a lateral distance of 4 feet from the right edge of the lane. Subsequent cores were taken at a core interval of 900 feet, excluding skip areas, proceeding from lane 4 to lane 1. Figure 4-40.1, "Primary Cores," illustrates the primary unit and the locations of all the primary cores.

Figure 4-40.1. Primary Cores



a. Length of primary unit = 6300 ft {[(4610-1000) - (2580-2120)]*2}
b. Number of cores = Area/Core Frequency = (6300 ft x 12 ft x 1 sqyd/ 9 sf) / (1200 sqyd/core) = 7 cores
c. Primary core interval = 6300 ft / 7 cores = 900 ft/core
d. Location of the first primary core:
In this example the outside lane (4) is chosen (at random), and the seventh set of numbers (at random) from Table 4-40.1 is used. The first core is taken at a longitudinal distance from the beginning of 360 ft (0.4 x 900 ft). The first core is taken 4 ft from the right edge of the lane.

The core thickness variations for the respective numbered cores were determined as follows:

Core Number	Stationing and Lane	Core Offset	Thickness Variation
1.	Sta. 13+60 Lane 4	4 ft off right edge	-0.03 ft
2.	Sta. 27+20 Lane 4	8 ft off right edge	+0.02 ft
3.	Sta. 36+20 Lane 4	3 ft off right edge	+0.03 ft (use +0.02 ft)
4.	Sta. 45+20 Lane 4	6 ft off right edge	-0.03 ft
5.	Sta. 18+10 Lane 1	10 ft off right edge	-0.04 ft
6.	Sta 31+70 Lane 1	2 ft off right edge	-0.00 ft
7.	Sta 40+70 Lane 1	9 ft off right edge	-0.07 ft

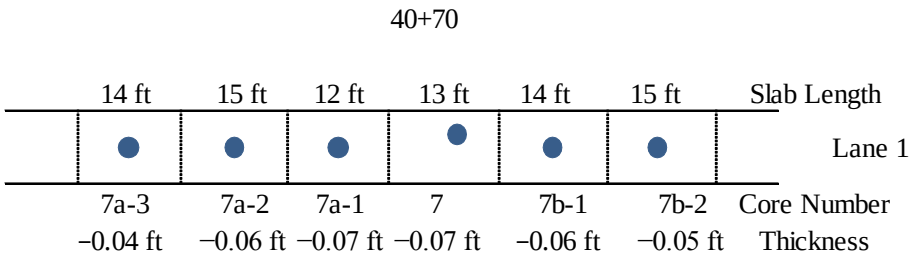
Core 3 is more than 0.02 foot greater than the specified thickness, so + 0.02 foot was used in the calculation to determine thickness deficiency in the primary unit in accordance with Section 40-1.01D(13)(e), "Concrete Pavement Thickness," of the *Standard Specifications*.

Core 7 was deficient by more than 0.05 foot. Because of this deficiency, the next step was to determine the dimensions of the secondary unit from secondary thickness measurements.

To determine the limits of the secondary unit, the resident engineer ordered secondary thickness measurements in the panels adjacent to the panel where Core 7 was taken. Subsequent thickness measurements were in panels adjacent to panels with thickness deficiencies of more than 0.05 foot. This process continued until the secondary unit was bounded by panels in which the secondary measurements were deficient in thickness by 0.05 foot, or less. Cores in each of these panels were taken in the center of the panel.

Figure 4-40.2, "Secondary Cores," illustrates the thicknesses of the secondary cores taken.

Figure 4-40.2. Secondary Cores



Core Number	Thickness Variation
7a-1	-0.07 ft
7a-2	-0.06 ft
7a-3	-0.04 ft
7b-1	-0.06 ft
7b-2	-0.05 ft

The panels in the secondary unit area represented by cores 7, 7a-1, 7a-2 and 7b-1 were measured and found to be 54 feet in length and represent 72 square yards.

The engineer averaged thickness variations of the secondary thickness measurements outside the secondary unit area. The resulting value was used in the calculation in lieu of the thickness variation for Core 7 to determine the average thickness deficiency of the primary unit area. The core thickness variations in the panels surrounding the secondary unit are tabulated below.

Core Number	Thickness Variation
7a-3	-0.4 ft
7b-2	-0.5 ft

The average of the thickness variations in the above table is -0.045 feet. This average was rounded to -0.05 foot, and used for the thickness variation for Core 7 in the primary unit.

Using -0.05 foot for the Core 7 thickness deficiency, the engineer calculated the average thickness deficiency (cores 1 through 7) for the primary area to be -0.016 foot. This average was rounded to -0.02 foot and used for the thickness deficiency for the primary unit.

The remaining area of the primary unit, after the area of the secondary unit was subtracted, was as follows:

8400 - 72 = 8328 square yards.

The deduction from payment to the contractor for thickness deficiency in the primary area in accordance with Section 40-1.04, "Payment," of the *Standard Specifications* was calculated as follows:

8328 square yards x $2.30/square yard = $19,154.00

The secondary unit area was later removed, reworked, and replaced. A single core was then taken to determine thickness variation and found to be -0.01 foot. A deduction was then taken on the remedied secondary unit as follows:

72 square yards x $0.90/square yard = $64.80

In addition to the deductions for pavement thickness deficiencies in the primary and secondary units, a deduction from payment to the contractor was made for the cost of all secondary thickness measurements. The cost of secondary thickness measurements was the cost of cores 7a-1 through 7a-3, 7b-1 through 7b-2, and 7c-1 (core taken after replacement of secondary unit).

4-4004B (3) Contractor's Requests for Additional Thickness Measurements

If, after the primary coring is performed, the contractor requests additional thickness measurements in any primary unit, treat the request as a request for doubling the frequency of coring in the primary unit area. Locate the additional cores in a manner similar to that used for locating the primary cores. This approach will halve the interval distance between primary cores. To calculate the deficiency adjustment, do not separately consider additional cores that are deficient in thickness by no more than 0.05 foot. Instead, include these cores with the original primary cores. If additional cores are deficient in thickness by more than 0.05 foot, determine the limits of the secondary areas.

Do not grant permission to a request from the contractor for selective coring. However, if the contractor requests additional thickness measurements before the performance of any of the primary coring, you may shorten the length of the coring interval for the primary unit accordingly. For example, the contractor may request a rate of one core for each 600 feet of traffic lane rather than one core for each 900 feet. The request will have the effect of increasing, not necessarily doubling, the number of cores.

Deduct from the payment to the contractor the cost of additional thickness measurements that resulted from the contractor's request.

If a contractor requests more than one round of additional cores, consult with the construction field coordinator before granting permission.

4-4004C Handling of Skips in the Original Day's Pour and Secondary Areas to Be Removed and Replaced

Skips (such as gaps left for traffic or equipment crossing, short distances between adjacent bridges, and secondary areas to be removed and replaced) are ultimately poured at a later date. The net area of such pavement placed in any one day technically becomes a primary unit area and, as such, is subject to the specifications regarding thickness measurements. Use judgment regarding which of these areas warrant thickness coring. In general, any area excluded from final coring should be small, and you must have other measurements to confirm that the thickness of the pavement is not deficient.

4-4004D Handling Deficient Areas Not Cored

When you have specific knowledge of areas deficient in thickness and you have records of the extent of such deficiency, exclude these areas from the random coring. Make the deficiency adjustment on the average thickness deficiency in the same manner as for areas that have been cored.

4-4004E Administration

Notify the contractor in writing of the date and place where coring will be performed. Follow up orally, if necessary, to be certain the contractor knows when and where coring will take place.

After measuring and recording pavement thickness, retain the cores until final agreement is reached on payment for the concrete pavement, usually after the contractor returns the proposed final estimate.

The personnel who measure core thickness prepare the coring records, which include information about core location and measured thickness. The original records and one copy are given to the resident engineer, who retains the original and forwards the copy to the contractor. Personnel from the district materials laboratory will keep one copy; another copy goes to METS in Sacramento.

Use Form TL-3096, "Pavement Core Record," which must include sketches showing the location of the cores. Separate reports should be prepared and identified for secondary area measurements. These reports will help determine the cost to the contractor for secondary coring and provide a clear record of secondary areas. Follow the same distribution of copies described in the previous paragraph for primary unit reports.

4-4004F Other Payment Items

Coring for determining acceptance of dowel bars and tie bar placement is to be conducted in a similar manner as that of thickness, except use revised lot sizes based on the specified frequencies. If dowel or tie bars are placed outside the specified tolerances or cores show air voids around the bars, obtain additional cores to determine the limits of unacceptable work. Determine the areas that will require removal. If authorized as specified in Section 40-1.01D(13)(g), "Dowel Bar and Tie Bar Placement," of the *Standard Specifications*, apply deduction in payment on represented areas that are allowed to remain in place using amounts specified in Section 40-1.04, "Payment," of the *Standard Specifications*. Note that the adjusted areas to be used include the slab dimensions adjacent to the joint identified.

Certain areas may also receive multiple payment deductions (i.e. thickness, dowel bars, or tie bars/reinforcement deductions). These are to be applied to the representative area and will be added to the other deductions.