Specification for Roller-Compacted Concrete Pavements as Exposed Wearing Surface

Version 1.0 – Oct 2021

This document provides the offically adopted specification which the members of the RCC Pavement Council follow and recommend to be utilized to build high quality RCC Pavements. This specification is for roller compacted concrete (RCC) as an exposed RCC pavement surface, that may or may not be diamond ground for smoothness and/or texture. RCC as a base/subbase layers is not covered in this specification.

This document references appropriate material standards, test methods and specifications of American Association of State Highway and Transportation Officials (AASHTO), ASTM International (ASTM), and Canadian Standards Association (CSA). These references assume that the contractor and the engineer will use the most up-to-date and applicable standards or methods that are in effect when bids are solicited for the project. It also assumes that the specification writer will choose the standard or test most suitable for their agency/project.

APPLICABLE MATERIAL AND TESTING STANDARDS

AASHTO:

M6	Standard Specification for Fine Aggregate for Portland Cement Concrete
M80	Standard Specification for Coarse Aggregate for Hydraulic Cement Concrete
M85	Standard Specification for Portland Cement
M148	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
M194	Standard Specification for Chemical Admixtures for Concrete
M240	Standard Specification for Blended Hydraulic Cement
M295	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
M302	Standard Specification for Slag Cement for Use in Concrete and Mortars
T26	Standard Method of Test for Quality of Water to Be Used in Concrete
T99	Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
T180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ACI:

214	Evaluation of Strength Test Results of Concrete

ASTM:

C31	Practice for Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
C42	Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C78	Test Method for Flexural Strength of Concrete (Using Simple Beam with 3rd Point Loading)
C94	Standard Specification for Ready-Mixed Concrete
C150	Standard Specification for Portland Cement
C171	Standard Specification for Sheet Materials for Curing Concrete
C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C494	Standard Specification for Chemical Admixtures for Concrete
C496	Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
C566	Test Method for Total Evaporable Moisture content of Aggregate by Drying
C595	Standard Specification for Blended Hydraulic Cements
C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
C1040	Test Method for Density of Unhardened and Hardened Concrete in Place by Nuclear Methods
C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
C1170	Standard Test Method for Determining Consistency and Density of Roller-Compacted Concrete Using a Vibrating Table
C1157	Standard Performance Specification for Hydraulic Cement
C1176	Standard Practice for Making Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Table
C1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
C1435	Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer
C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
D698	Standard Method of Test for Moisture-Density elations of Soils Using a 2.5-kg (5.5-lb) Rammer and 305-mm (12-in.) Drop.
D977	Standard Specification for Emulsified Asphalt
D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
E329	Standards of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

CSA:

CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test Methods

and Standard Practices for Concrete

CSA A3001 Cementitious Materials for Use in Concrete

TERMINOLOGY

Approval: Written authorization or acceptance from the Engineer prior to starting an activity.

Construction Stakes, Lines, and Grades: The Engineer positions construction stakes to establish lines and grades for street work and for structures; the Engineer stakes the centerline and furnishes bench marks necessary to correctly lay out the pavement. The contractor maintains these lines, grades, and bench marks and uses them to lay out the work under the contract. The contractor must carefully preserve stakes and bench marks.

Contractor: The contracted construction firm or its subcontractor hired to perform all or part of the work under the contract specifications and drawings.

Design Strength: The strength used by the designer in the thickness design method or software to determine the RCC Plan thickness.

Engineer: The owner or an agent of the owner that issues drawings and specifications, or administers the work under contract specifications and drawings, or both.

Intent of the Contract: For the contractor to build the pavement in accordance with the specification and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown in the project plans or as established by the engineer/owner. Construction methods are generally left to the discretion of the contractor, as long as progress and workmanship are satisfactory.

Lot: Term used for acceptance testing, representing the pavement/material placed in a maximum area or volume specified for quality assurance testing; placed in one day; placed with one construction method; or with one unique mixture.

Maximum Dry Density (MDD): The maximum unit weight (density) of a dry RCC mixture corresponding to the optimum moisture content typically determined per ASTM D1557.

Optimal Moisture Content (OMC): The water content at which the maximum dry unit weight (density) is achieved for a specific compaction effort, typically determined per ASTM D1557.

Plan Thickness: The nominal pavement layer thickness shown in the Plans.

Reference Wet Density (RWD): The unit weight density calculated by multiplying the Maximum Dry Density (MDD) by 1 + Optimum Moisture Content (OMC), where the MDD and OMC are determined in the laboratory in accordance with ASTM D1557. [Example: assume an RCC mix has a Modified Proctor MDD of 142 lb/ft^3 (2,275 kg/m^3) and the OMC = 6%. The calculated RWD = 142 · (1+(0.06)) = 150.5 lb/ft^3 or in SI Units: RWD = 2,275 · (1+(0.06)) = 2,412 kg/m^3].

Required Average Strength: the average strength of concrete used in mixture proportioning to ensure a high likelihood that the concrete will meet specified strength acceptance criteria

Specified Compressive Strength: Compressive strength of concrete used in design. It shall be 4,000 psi minimum at 28 days in areas not subjected to freeze-thaw conditions and 4,500 psi minimum in areas subjected to freeze-thaw cycles.

Sublot: The volume, area or lineal quantity requiring a sample test(s) for acceptance.

Supplementary Cementitious Materials: Mineral admixtures consisting of powdered or pulverized materials which are added to concrete before or during mixing to improve or change some of the plastic or hardened properties of concrete. Materials are generally natural or by-products of other manufacturing processes, such as fly ash, silica fume, metakaolin, or ground-granulated blast-furnace slag that reacts pozzolanically or hydraulically.

Testing Laboratory: An organization that measures, examines, performs tests, or otherwise determines the characteristics or performance of materials or products. This may include organizations that offer commercial testing services, an in-house quality control function, or other organization providing the required testing services. These firms must meet requirements of ASTM C1077, "Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation."

Testing Technician: Person or persons that are either engineers, engineering technicians, or experienced craftsman with qualifications to perform tests.

The Plans: The drawings, diagrams, details or standards describing the dimension, elevation, form, location or size of the pavement or any of its components, including the foundation and any existing infrastructure.

SPECIFICATION

1.0 General

RCC-1.01 **Description of Work.** This work consists of constructing roller compacted concrete pavement as an exposed pavement surface on a prepared base or subgrade layer. The final surface may or may not be natural, trowelled, trowelled and broomed, diamond ground, milled or grooved depending on the application, and smoothness and texture requirements.

RCC-1.02 **Prequalification.** Submit the information required in RCC-1.02.1 and RCC 1.02.2 for prequalification to perform the work on this project.

1.02.1 Completed Project Listing. Provide evidence of successful installation of RCC pavement on 5 prior projects of comparable size and application. Include a brief project description for each project as well as the final contract amount and the owners name and contact information.

1.02.2 Proposed Installation Equipment. For prequalification, supply a list of the proposed installation equipment, including mixing plant and paving machine(s). Include the make, model, and equipment specification sheet for each piece of equipment with the prequalification submittal. Make the equipment available for inspection by the Engineer upon request. The paving machine(s) and mixing equipment must match that listed on the submittal, unless a substitution is made, which meets these specifications and is approved by the Engineer.

2.0 Materials

RCC-2.01 Material Requirements. Furnish materials conforming to the latest version of the standard material specifications in Table RCC-1, as appropriate. Only furnish materials from sources approved by the Engineer.

Table RCC-1

Material	Specification(s)		
	AASHTO	ASTM	CSA
Aggregate– Coarse (quality not gradation requirements)	M80	C33	A23.1
Aggregate – Fine (quality not gradation requirements)	M6	C33	A23.1
Chemical Admixtures	M194	C494	A266.2
Concrete - Made by Volumetric Batching and Continuous Mixing	—	C685	—
Concrete – Ready Mixed	—	C94	A23.1
Curing - Liquid Membrane-Forming Compounds	M148	C309	A23.1
Curing – Sheet Materials	—	C171	—
Curing –Emulsified Asphalt	—	D977	—
Fly Ash or Calcined Natural Pozzolan	M295	C618	A3001
Ground Granulated Blast Furnace Slag	M302	C989	A3001
Hydraulic Cement (Performance Specification)	—	C1157	—
Portland Cement	M85	C150	A3001
Portland Cement – Blended	M240	C595	A3001
Silica Fume	—	C1240	A3001
Water	T26	C1602	A23.1

RCC-2.02 Material Approval. Prior to use, obtain the Engineer's approval on all materials for RCC construction based on certifications and, where required, laboratory tests of representative samples of the materials that will be used in the actual construction.

RCC-2.03 Aggregate Gradation. Use a blend of fine and coarse fractions that in combination conform to the sieve size ranges listed in Table RCC-2, or size ranges approved by the Engineer. The aggregate and sand must be furnished in 2 or more stockpiles. Obtain all aggregates from qualified sources for concrete pavement appearing on the local state DOT qualified products listing, as well as conforming to requirements in Table RCC-1. Aggregates not listed on the local state DOT qualified products listing may be approved by the Engineer based on performance data from previous projects, laboratory testing, and field testing of a test section. Do not use an aggregate with a plasticity index exceeding five.

Table RCC-2: Combined Aggregate Gradation Ranges for RCC

Sieve Size	Lower & Upper Specification Limits 1/2 in (12.5 mm)		Lower & Upper Specification Limits 3/4 in (19.0 mm)		Lower & Upper Specification Limits 1 in (25.0 mm)	
1.5 in. (37.5 mm)					100.0	100.0
1 in. (25 mm)			100.0	100.0	82.0	100.0
3/4 in. (19 mm)	100.0	100.0	95.0	100.0	72.0	95.0
1/2 in. (12.5 mm)	81.0	100.0	70.0	95.0	61.0	81.0
3/8 in. (9.5 mm)	71.0	91.0	60.0	85.0	50.0	71.0
No. 4 (4.75 mm)	49.0	70.0	40.0	60.0	36.0	55.0
No. 8 (2.36 mm)	33.0	54.0	30.0	50.0	25.0	43.0
No. 16 (1.18 mm)	24.0	40.0	20.0	40.0	15.0	32.0
No 30 (600 µm)	15.0	30.0	15.0	30.0	10.0	26.0
No 50 (300 µm)	10.0	25.0	10.0	25.0	5.0	19.0
No. 100 (150 µm)	2.0	16.0	2.0	16.0	2.0	16.0
No 200 (75 µm)	0.0	8.0	0.0	8.0	0.0	8.0

3.0 Quality Management Plan

RCC-3.01 Quality Management Plan. The RCC Contractor shall submit a quality management plan to the Engineer at least 30 days prior to start of paving operations. As a minimum include the following information in the quality management plan:

1) Organizational chart that identifies the key individuals assigned to production and placement operations. As applicable, include a project manager, RCC consultant, project superintendent, RCC production supervisor and quality control manager, or other positions as appropriate given the application. Include all appropriate contact data and the chain of command for decision-making.
2) List of subcontractors, including proposed job site personnel, for any construction operations.
3) If the project documents require the RCC Contractor to engage an an independent testing firm to perform quality control testing during construction, identify the testing firm and submit the quailifications of testing personnel.
4) Construction schedule for all RCC work.
5) List of all mixing, hauling, placing, compaction, curing and sawing equipment with manufacturer's data and specifications.
6) Outline of procedures for calibrating the mixing plant and monitoring materials during construction.

7) Plan for locating the mixing plant, required haul times to the furthest location of the placement, and use of set-retarding, or hydration stabilizer admixtures, if required to faciliate the delivery logistics.
8) Proposal for:
    a. Lift thicknesses (if multiple lifts are necessary).
    b. Paving width and staging plan.
    c. Direction of paving operation.
    d. Daily production, including trucking, placement and production rates.
    e. Planned longitudinal and transverse cold joint locations.
    f. Horizontal cold joint cleaning and preparation procedures.
    g. Location and operation of mixing plant, including proposed mixing cycle time, drum capacity targeted per batch if using a drum-type mixing plant, cement and aggregate storage, and water supply on or off site.
9) Certification for aggregate source, quality and sizing as required by the appropriate material specification.
10) Certification of all cementitious materials and chemical admixtures as required by the appropriate material specification.
11) Outline of procedures and methods for curing and weather protection for cold [less than 40°F (4.5°C)], hot [more than 90°F (32°C)] and rainy conditions.
12) Mixture design as outlined in Section 4.0.

RCC-3.02 **Pre-Construction Meeting.** Schedule a pre-construction meeting with the Engineer after submitting the quality management plan and prior to installation of a test section or the start of construction. Include project personnel identified in the quality management plan in the meeting, including but not limited to: general contractor representative/consultant, sitework contractor, RCC paving contractor, RCC plant manager, and construction testing laboratory representative.

RCC-3.03 **Records.** Maintain records of all certifications, tests, construction reports, material tickets, and remedial actions taken on the work. Supply the Engineer with all records upon request.

RCC-3.04 **Independent Testing Firm.** Only use an independent testing laboratory meeting the requirements of ASTM C1077 for preparing, handling, coring, storing and testing concrete specimens, who have the testing equipment necessary to carry out all proposed testing methods, and who can demonstrate adequate knowledge of the testing methods prescribed. Obtain the written qualifications of the testing firm, indicating their compliance with ASTM E329. Obtain the most recent certificates of calibration for testing equipment, showing that the equipment has been calibrated at a minimum 12-month interval by devices of accuracy traceable to either National Bureau of Standards or an established value. Submit all certification records from the testing firm and equipment to the Engineer. Provide testing personnel access to the paving and plant sites for inspection and sampling of the RCC layer and constituent materials.

RCC-3.05 **Quality Control at Mixing Plant.** Conduct quality control testing at the mixing plant in accordance with the requirements in Table RCC-3. Obtain specimens, as required, for post-construction testing.

Table RCC-3: Quality Control Requirements at Mixing Plant

Item	Method	Frequency or Lot Size	Acceptance
Plant Calibration	ASTM C685 for volumetric batch or continuous mixer;	Prior to start-up, after equipment changes, and after shutdowns longer than 14 days	Material tolerances given in ASTM C685
Plant Calibration	ASTM C94 for weigh batch plant	Prior to start-up, after equipment changes, and after shutdowns longer than 14 days	Material tolerances given in ASTM C94

RCC-3.06 Quality Control at Placement Site. Conduct quality control testing during placing operations to ensure the RCC material is placed, compacted, finished and cured in accordance with the requirements in Table RCC-4. Obtain specimens, as required, for post-construction testing.

Table RCC-4: Quality Control Requirements at Placement Site

Item	Method[1]	Frequency or Lot Size	Limits
RCC Moisture Content	ASTM C566	Sample at point of placement from initial truck load, and as required	±1.0% of optimum moisture content per ASTM D1557
In-place Wet Mat Density	ASTM C1040 direct transmission mode	At beginning of placement immediately behind the paver, and within 30 minutes of final compaction; One Test per lot	At least 98% of the laboratory reference wet density by ASTM D1557 based on an average of four consecutive tests with no test below 96%
In-place Wet Joint Density	ASTM C1040 direct transmission mode	One test per lot, and within 30 minutes after final compaction	At least 96% of the laboratory reference wet density by ASTM D1557 based on an average of four consecutive tests with no test below 94%
Longitudinal Joint tightness when sealed joints are specified	Observation after joint saw-cutting ½" wide minimum	All longitudinal joints	Joints shall have square edges. Isolated raveling of aggregates shall not be more than 3/8" wide from the saw-cut edges.
Surface elevations on both sides of longitudinal joint	Surveying, measuring tape, or other appropriate methods to determine difference in elevation	All longitudinal joints	Surface elevations on both sides of joints shall not vary by more than ¼" (6 mm)
Cylinders for Compressive Strength	ASTM C1435 for molding cylinders; ASTM C31 for curing and handling cylinders; and ASTM C39 for testing cylinders	One set of three cylinders for every lot, or one day of production, whichever is less.	Average strength equal to 100% of the specified strength in Section RCC-4.03, with no single result below 90%.
Surface Smoothness	See Section 7.04	One Test per lot	See Section 7.04
Thickness	ASTM C42	One core for every two lots, or one day of production, whichever is less.	See Section 7.01

Core Visual Inspection	Visual	One core for every two lots, or one day of production, whichever is less.	Visually inspect cores to ensure that compaction at the bottom of the lift is obtained. If significant honeycombing or other signs of lower density are evident, check the cores for strength (See Section 7.03)
Multiple Lift Bond Determination	Core with Normal handling	One core for every two lots, or one day of production, whichever is less.	See Section 7.05

4.0 RCC Mixture Design

RCC-4.01 Mixture Design and Submittal. Proportion one or more mixtures complying with requirements in Sections RCC-2.02 and RCC-2.03. Submit certified test data for each proposed mixture in accordance with the quality management plan from the declared independent testing laboratory. Do not submit mix designs unless they meet the requirements outlined in Sections RCC-4.02 to RCC-4.03.

Include the following information for each mix design: 1) manufacturer certifications of material compliance with requirements listed in Table RCC-1; 2) quantity and gradation of each aggregate, as well as combined gradation; 3) quantity and types of each cementitious material; 4) type(s) of chemical admixtures and range of dosages; 5) optimum moisture content and reference wet density; and 6) strength results.

RCC-4.02 Cementitious Materials Content. Report the portland cement content in pounds per cubic yard (kilograms per cubic meter) as part of the mixture design. Replacing portland cement with supplementary cementitious materials (SCMs) is allowable to a maximum of 50% of the portland cement with ground granulated blast furnace slag or 25% of the portland cement with fly ash, or a combination of both, with fly ash not exceeding 25%. Content of total cementing material (portland cement plus supplementary cementing materials) shall be established by preconstruction mix design studies, as further provided, but shall not be less 450 pounds per cubic yard.

RCC-4.03 Minimum Laboratory Compressive Strength. The proposed laboratory mix design(s) shall meet the specified compressive strength used in the design plus 500 psi minimum safety factor (or as approved by Engineer) at 28 days when cylinders are prepared in accordance with ASTM C1435 and tested per ASTM C39.

5.0 Equipment

RCC-5.01 General. Furnish equipment matching those listed in the quality control plan and approved by the Engineer before starting work.

RCC-5.02 Mixing Plant. Obtain the Engineer's approval of the mixing plant before starting RCC production. Use a mixing plant capable of producing a homogeneous RCC mixture in the proportions defined in the approved mixture design and conforming to the tolerances specified in ASTM C94 for batch mixing plants or ASTM C685 for continuous mixing plants.

Use a plant with production capacity sufficient to produce a uniform RCC mixture at a rate compatible with the placement operation. The Engineer can halt operations if

the plant is unable to produce the RCC mixture sufficiently in quality or quantity, until operations are adjusted or a plant meeting all requirements is obtained.

5.02.1 Pugmill Plant. Pugmill plants shall be central plant type with a twin-shaft pugmill mixer, capable of continuous mixing.

5.02.1.a: Synchronized metering devices and feeders. Provide synchronized metering devices and feeders to dispense the correct proportions of aggregate, cement, supplementary cementing materials, water, and admixtures for continuous mixing within the tolerance requirements of ASTM C685 depending on plant type. The feed rate from each aggregate bin shall be readily adjustable to change aggregate proportions, when required. Feed rate controls must maintain the established proportions of aggregate from each stockpile bin when the combined aggregate delivery is increased or decreased.

5.02.1.b Surge Hopper. Provide a surge or gob hopper attached to the final discharge belt to temporarily hold the mixed RCC, in order to minimize segregation when loading into haul trucks, and to allow the plant to operate continuously.

5.02.2 Central Mix Batch Plant. Central Mix Batch plants shall be Tilt Drum Rotary or Horizontal Shaft Mixers. Use a mixer capable of producing a homogeneous mixture, uniform in texture and meeting the requirements of ASTM C94. Equip the mixer with batching equipment to meet the following requirements:

5.02.2.a Weigh Hoppers. Provide sufficient capacity to hold at least 10 percent more cementitious material than required for one batch, and equipped with vibrators to operate automatically and continuously while being dumped.
5.02.2.b Timing Device. Provide an accurate measure and visible indication of mixing time after all the materials, including the water, enter the mixer.

RCC-5.02.3 Alternate Mixing Equipment. Obtain the Engineer's approval before using alternative mixing equipment, including portable pugmill mixers for dry batch plants conforming to ASTM C685. Truck mixers conforming to ASTM C94 are not allowed for mixing RCC. Volumetric trucks are not allowed for mixing RCC. Demonstrate that the proposed alternate mixing equipment has the ability to produce a consistent, well-blended, non-segregated, homogeneous RCC mixture in the proportions defined in the approved mixture design, and within the capacity and tolerance limits specified in Section 5.02.1 or Section 5.02.2, as appropriate. Demonstrate that the equipment meets hourly production rates proposed in the Quality Management Plan.

5.02.4 Cementitious Material Storage Silos. Provide separate and independent storage silos to store and supply portland cement, blended cement and individual supplementary cementitious materials. Label each silo clearly near the fill inlet to prevent loading errors.

RCC-5.04 Paving Machine. Obtain the Engineer's approval of the paving equipment before starting RCC placement. Furnish a paving machine equipped with a high-density screed capable of placing the RCC material to a minimum of 90% of the reference wet density in accordance with ASTM D1557 or equivalent test method, prior to any

additional compaction. High-density screeds are equipped with 2 or more compaction devices in the screed such as: dual tamper bars, a tamper bar and pressure bar, or a tamper bar and dual pressure bars. Ensure that the paver is of suitable weight and stability, equipped to spread, compact, and place the RCC mixture to the required thickness, cross slope, edge and surface texture. Do not use graders, bulldozers, or any equipment that does not provide compaction during paving. Areas inaccessible to a paving machine or requiring odd shapes shall be placed with conventional concrete or hand placement. Hand placement of RCC is allowed in areas smaller than 50 square feet. Larger areas must be approved by the Engineer. In these areas, small ancillary compaction equipment will be required. The final RCC density in these areas must meet all time, compaction, and surface finish requirements as defined in this specification. All hand placement of RCC must be approved by the engineer.

RCC-5.05 **Compaction Equipment.** Furnish self-propelled vibratory dual steel drum and/or pneumatic rollers capable of providing primary and final compaction efforts necessary to meet the in-place, wet-density requirements of Table RCC-4, as appropriate, and in a manner comparable to the test strip demonstration. Furnish each drum on steel drum vibratory rollers with a properly operating scraper and brush. Only operate steel drum vibratory rollers in static mode for final compaction. Never operate a roller or paver in vibratory mode when the equipment is not in motion.

RCC-5.06 **Haul Trucks.** Furnish trucks for transporting the RCC material from the plant to the paver. On long hauls, equip open-bed haul trucks with retractable protective covers to protect the RCC material from rain, evaporation, heat and other detrimental weather conditions. Provide a sufficient number of trucks to ensure adequate and continuous supply of RCC material to the paver.

RCC-5.07 **Water Truck.** Furnish a water truck, or other similar equipment, on-site and available for use throughout the paving and curing process. Equip the truck or device with a spray bar capable of evenly applying a fine spray of water to the RCC, subgrade or subbase surface without damage.

RCC-5.08 **Concrete Saws.** Furnish early entry concrete saws that are capable of sawing new RCC for crack control with minimal raveling and to 1/4 depth of the thickness of RCC lift, or maximum 3.5 inches. Equip all saws with blade guards and guides or devices to control alignment and depth.

6.0 Construction

RCC-6.01 **Proof Rolling.** Prior to placing RCC pavement, check for any soft or yielding subgrade or subbase areas by proof rolling with a loaded tandem axle dump truck having a gross weight of not less than 50,000 lbs. over the entire area to be paved. Correct and make stable any soft or yielding subgrade areas that are deflecting more than ½" (12.5mm) prior to RCC layer construction. Remove any unsuitable soil or material and replace with acceptable material.

RCC-6.02 Test Section. Construct a *100-ft* long test section no less than 7-days prior to starting construction. Construct the test section using the proposed mixture design, and with the materials and equipment listed in the quality management plan and approved by the Engineer. If the placement requires more than one pass of the paver, construct the test section a minimum of two paver widths wide. If the pavement placement requires more than one lift, construct the test section to the required number of lifts. Place the test section in a location approved by the Engineer. It is acceptable to place and leave the test section as part of the completed pavement if it complies with all acceptance testing criteria.

The Engineer shall evaluate the following criteria from the test section:

- Adequacy of mixing plant to meet productivity requirements and produce consistent material.
- Maximum density directly behind the paver prior to roller compaction.
- Suitability of the proposed lift thickness.
- Sequence of primary/ secondary roller passes (with and without vibration).
- Maximum density following roller compaction.
- Texture and surface finish acceptability.
- Joint details
- Integrity of both fresh and cold joints (vertical and horizontal).
- Comparison of RCC compressive strength from cylinders and extracted cores tested at 7 days with the understanding that ACI 318 allows cores to be 85% of the specified strength.
- If used on project, trowelling process and finish acceptability

If the test section does not meet acceptance requirements, remove and reconstruct a new test section with corrected procedures at no additional cost to the Owner.

RCC-6.03 Producing RCC. Conform to applicable sections of ASTM C94 and ASTM C685, and the following requirements.

6.03.1 Storing and Handling Material General. Store and handle all material in a manner that prevents cross contamination. Do not use any material that has been stored for a period exceeding the manufacturer's recommended shelf life. Do not use cement or supplementary cementitious materials containing evidence of moisture contamination. Where recommended by the manufacturer, agitate chemical admixtures to ensure consistency during use.

6.03.2 Storing and Handling Aggregate. Place aggregate stockpiles on paved pads, stabilized subgrades, or 12 inch (300 mm) sacrificial layers of the aggregate to prevent accidental contamination by stockpile loader operators. Store and handle aggregate in a manner that ensures reasonably uniform moisture content at the time of batching.

6.03.3 Mixing RCC. Mix the RCC material following the approved mixture proportions and within the tolerances in ASTM C94 for central mixed concrete and ASTM C685 for volumetric batching and continuous mixed concrete. For a new or additional mixture, submit a revised mixture design for approval by the Engineer

before making any changes in supply sources or character of the materials. Follow the guidelines of 4.0 RCC Mixture design. Do not use unapproved RCC mixtures.

6.03.4 Plant Calibration. Prior to RCC material production, conduct a complete and comprehensive calibration of the plant in accordance with the manufacturer's recommended practice. Provide all scales, containers, and other items necessary to complete the calibration. Calibrate the plant at the times specified in Table RCC-3.

To maintain accuracy, keep the sides of the mixer and mixer blades free of hardened RCC material or other buildups. Routinely check mixer blades for wear and replace if wear is sufficient to cause inadequate mixing per manufacturer's recommendations.

6.03.5 Charging the Mixer. For plants conforming to ASTM C94 ensure that the volume of mixed material per batch does not exceed 75% the manufacturer's rated capacity of the mixer and may need to be lower if required by the Engineer. For batch mixers, discharge all material in the mixing chamber before recharging.

6.03.6 Mixing Time. Mix the materials a sufficient length of time in the mixer to ensure thorough and complete blending of all ingredients. For plants conforming to ASTM C94, mix each batch for the minimum time recommended by the plant's manufacturer.

6.03.7 Daily Reports. Produce and maintain records of production and quantities of materials used in the plant. Supply these reports to the Engineer daily.

RCC-6.04 Transporting RCC. Transport the RCC material from the plant to the areas to be paved in dump trucks equipped with retractable protective covers for protection from rain or excessive evaporation, as necessary for the weather conditions. Do not exceed a 30 minute haul time. The Engineer may increase or decrease the time requirement depending upon the ambient conditions and approved use of set retarding admixtures in the mixture. To minimize segregation during loading, load trucks uniformly across the entire bed of the truck. Ensure that the trucks are dumped clean with no buildup of RCC material in the corners.

RCC-6.05 Placing RCC. Deposit the RCC material directly into the hopper of the paver or into a secondary material distribution system that deposits the material into the paver hopper. Time the delivery and placement so that RCC material is spread with minimum stops and compacted within the time limits specified in Section 6.09.1. Place the RCC mixture without segregation.

For projects with a speed limit greater than 40 mph unless for pavements that will be diamond ground, or when using dual lift construction, feed the RCC material to the paver by an approved material transfer device that possesses the following characteristics:

- The ability to feed the paver at a rate which allows for continuous forward motion of the paving machine.
- The ability to feed the paving machine from an offset position which is outside of the initial lift of RCC pavement.

If RCC material is left in the paving machine past the delivery and placement time limits specified in Section 6.09.1, pull the paving machine off the placement and

construct a cold joint in accordance with Section 6.10.2. The Engineer may increase or decrease the placement time requirement depending upon the ambient conditions and approved use of set retarding admixtures in the mixture.

RCC-6.06 Subbase Condition for Placement. Do not place RCC material on frozen ground or in standing water. Prior to proof rolling the grade and placing RCC material, ensure that the surface of the subgrade/subbase is clean and free of foreign material, ponded water, and frost. Ensure that the subgrade/subbase is uniformly moist at the time of RCC material placement. If moistening certain areas is necessary, ensure that the method of sprinkling will not form mud or pools of free standing water.

6.06.1 Subbase Fine Grading Tolerance. Prior to placement of the RCC, the subbase shall be fine graded to design elevations with a tolerance of +0, -1/2".

The subgrade or subbase tolerance for grade elevation and tolerance must be compatible with the RCC thickness requirement. The thickness, grade elevation, and smoothness of both the RCC and Subbase / Subgrade requirements must be compatible.

RCC-6.07 Weather Conditions.

6.07.1 Cold Weather Precautions. Stop placement operations when the air temperature falls below 40°F (5°C) and is declining. Start operations only if the air temperature is at least 35°F (2°C) and is rising.

If the air temperature is expected to fall below 40°F (5°C) at some time during placement operations, apply the cold weather procedures outlined in the quality management plan and approved by the Engineer. Provide a sufficient supply of protective material on site. RCC paved during cold weather is subject to the quality requirements outlined in Sections RCC-4.01 to RCC-4.03 and Table RCC-4.

6.07.2 Hot Weather Precautions. Take special precautions to minimize moisture loss due to evaporation during periods of hot weather [more than 90°F] or windy conditions, including but not limited to the following options: cooling of aggregate stockpiles by shading or the use of a fine misting, covering haul truck beds, cooling RCC mix water, decreasing the allowable time between mixing and final compaction, paving at night, and using hydration stabilizing or retarder admixtures. Keep the surface of the newly placed RCC layer continuously moist with mist sprayers until applying curing compound. Evaporation retarders must only be used after final compaction and not worked into the surface of the RCC.

6.07.3 Rain Limitations. Stop placement operations when it is raining hard enough to be detrimental to the finished product. Placement is acceptable during light rain or mist provided the surface of the RCC layer does not erode, scab or damage. Cover dump truck beds during these periods to protect material during transport.

RCC-6.08 Paving. Only place RCC material with equipment prequalified in Section RCC 1.02.2, listed in the quality management plan and meeting the requirements of Section RCC-5.04, including subsections.

6.08.1 Lift Thickness Range. Place RCC in lifts generally between 4 in. (100 mm) and 10 in. (250 mm) thick. The Engineer may approve placing lifts at thicknesses at 10 in. (250 mm) or greater with successful demonstration that the proposed method meets all requirements of Table RCC-4, Sections 5.04, 6.02 and 7.04, including ASTM C 1040 density testing using direct transmission test method (with a probe) at multiple locations throughout the entire lift thickness range.

6.08.2 Adjacent Lane Placement. When Fresh Longitudinal Joints are Approved by the Engineer. Place adjacent paving lanes within 30 minutes. Keep the fresh edge (fresh vertical joint) from drying out until the adjacent lane is placed either by increasing productivity with tandem paving, spraying the joint surface with a light water mist, applying wet burlap cover, or by using a set-retarding admixture in the RCC mixture with proper approval.

If more than 30 minutes elapses between placements of adjacent lanes, consider the fresh vertical joint a cold vertical joint and prepare it in accordance with Section 6.10.2. The Engineer may increase or decrease the 30-minute adjacent lane placement requirement depending upon the ambient conditions and approved use of set retarding admixtures in the mixture.

6.08.3 Multiple Lift Placement. For multiple lift placements, compact the bottom lift to the specified minimum wet density before placing the next lift. For Multiple lift placements, high density pavers must be used for placing both layers in equal thicknesses. Place and compact the top lift within 45 minutes of the placement by the paver of the bottom lift. Keep the surface of the bottom lift clean of debris and prevent it from drying prior to placing the subsequent lift. Acceptable methods include synchronizing placement of bottom and top placements to keep both pavers within a short distance from each other, spraying the bottom lift surface with a light water mist, or by using a set-retarding or hydration stabilizer admixtures in the RCC mixture with proper approval.

If fresh horizontal joint requirements are not met, consider the interface between the top and bottom lifts as a cold joint and prepare the bottom lift surface in accordance with Section 6.10.4. The Engineer may decrease the 45-minute lift placement requirement depending upon the ambient conditions and approved use of set retarding, or hydration stabilizer admixtures in the mixture. Bonding of both lifts must be verified as described in RCC 7.05.

6.08.4 Hand Spreading. Do not broadcast or spread RCC material across areas being compacted. Hand repair of small, isolated surface locations is permissible only immediately behind the paver and before any roller compaction operations begin in the area. The area must be dug out and material removed. Use only fresh RCC material from in front of the paver as repair material.

RCC-6.09 Compaction. Only compact RCC material with approved equipment listed in the quality management plan, and that meets the requirements of Section RCC-5.05, including subsections.

6.09.1 Compaction Timing. Begin compaction as soon as practical after paver placement and complete all compaction operations within 60 minutes of the RCC material being mixed. The Engineer may increase or decrease this time depending

on use of set retarding, or hydration stabilizer admixtures or the ambient conditions of temperature, wind, and humidity. Do not delay rolling operations from the timing approved in the quality management plan and validated in test strip construction unless approved by the Engineer.

6.09.2 Compaction Process. Apply the sequence and number of passes by vibratory and non-vibratory rolling to obtain the specified density proposed in the quality management plan and verified on the test section. Do not operate rollers in the vibratory mode while stopped. Use steel drum rollers in static mode and/or rubber-tire rollers for final compaction.

6.09.3 Compacting Longitudinal and Transverse Joints. Do not operate a roller within 2 ft (0.6 m) of the edge of a freshly placed lane until the adjacent lane is placed. Then, roll both edges of the two lanes simultaneously within the allowable time. If a cold joint is planned, roll the complete lane and follow the cold joint requirements specified in Section 6.10.2. For freshly placed RCC next to an existing cold joint, roll the complete lane, taking extreme care not to bridge the roller drum between the new unconsolidated fresh material and a previous cold joint edge. Such bridging of roller drum over cold joint edges, especially in vibratory mode, can significantly degrade the cold joint edge.

6.09.4 Density Requirements. Perform in-place density tests in accordance with the requirements of Table RCC-4.

RCC-6.10 Joints.

6.10.1 Fresh Vertical Joints. Are not allowed unless approved by the Engineer for specific locations. A vertical joint is considered fresh only when a subsequent RCC lane is placed within 30-minutes, or the time limit approved by the Engineer. See Section 6.08.2 for allowable procedures to keep a fresh edge from drying out. If more than 30 minutes or the time limit approved by the Engineer elapses between placements of adjacent lanes, consider the fresh vertical joint a cold vertical joint and prepare it in accordance with Section 6.10.2.

6.10.2 Cold Vertical Joints. Consider any planned or unplanned vertical construction joint that does not qualify as fresh vertical joint as a cold vertical joint. Prior to placing fresh RCC material against a compacted cold vertical joint, thoroughly clean the cold vertical joint of loose or foreign material. Wet the cold vertical joint face and maintain it in a moist condition immediately prior to placement of the new lane.

Remove a minimum of 4 in. full-depth from the exposed longitudinal edge of any cold vertical joint that does not meet the minimum joint density requirements in Table RCC-4. Do not perform this operation any sooner than 2 hours after final compaction. Demonstrate to the Engineer that saw cutting will not cause significant edge raveling and remove all slurry and excess material from the cutting operation.

The use of an edge shoe for vertical cold joint construction is allowed. The Engineer may disapprove the edging shoe if the cold joint produced from the edging does not meet the minimum joint density requirements in Table RCC-4. The edge shoe must produce a face with no more than an angle of 10 degrees from vertical.

Completed cold longitudinal joints must have a finish similar to the pavement surface however some ragged and or spalled edges are normal when looking from the top down onto the joint. Due to the nature of RCC, there will be some inconsistencies and minor spalling up to 3/4 inch from the edge of the joint. The edges may have areas with minor voids, however they must be of sound concrete. For spalls greater than 3/4 inch but less than 1 1/2 inches, the joint must be sealed for the length of the panel. For spalls greater than 1 1/2 inches, the joint must be repaired using partial depth patching practices, or the panel removed and replaced.

6.10.3 Horizontal Joints. A horizontal joint is considered fresh only when a subsequent RCC lift is placed within 45-minutes of lower lift placement by the paver, or the time limit approved by the Engineer. See Section 6.08.3 for allowable procedures to keep the surface of the bottom lift continuously moist and clean of all loose material prior to placing the subsequent lift.

If more than 45 minutes elapses between lift placements, consider the interface between the top and bottom lifts as a cold horizontal joint. The Engineer may decrease the 45-minute lift placement requirement depending upon the ambient conditions and approved use of set retarding admixtures in the mixture. The bottom lift of the cold horizontal joint should be prepared by cleaning with air or water jets to remove debris and dust before the top lift is placed. Then apply a thin layer of high-slump mortar or grout immediately prior to placement of the upper lift while mortar is still fresh. This method of Cold Horizontal joints preparation should be kept to small sizes less than 1,000 square feet and is not intended to be used over large portions of the project. The Engineer may also approve another method demonstrated by the contractor and approved on the test section to ensure that bond occurs between layers.

6.10.4 Crack Control Joints. According to the plans, construct transverse contraction or crack control joints in the RCC layer by sawing with approved equipment listed in the quality management plan, and that meets the requirements of Section RCC-5.08. Saw crack control joints to the interval specified on the plans with no joints spaced more than 15 ft apart. The width of the crack control joints shall be 1/12” to 1/8”, and the depth must be ¼ the depth of single lift pavement and 3.5” maximum for dual lift-pavements having total thickness up to 18”. Extend all crack control joints the entire width of paving. To prevent spalling at the ends of transverse cuts, terminate the early entry saw cuts 2 to 3 inches before the edge of the slab. The saw cut joints can be extended when the joints for the subsequent lane are cut or at a later time in preparation for sealant application. When sawing crack control joints, begin as soon as the RCC cuts without excessive raveling along the saw cut and finish before conditions induce uncontrolled cracking, regardless of the time or weather.

6.10.5 Isolation Joints. Line the perimeter of fixed structures such as building foundation slabs, manholes, valves, trench drains, and concrete curbs and gutters with strips of fiberboard or other approved isolation joint material, as noted in the plan details, prior to paving.

6.10.6 Expansion Joints. Install expansion joints to the details, dimensions and locations shown on the Plans. If the plans do not include details and conditions warrant expansion joints, propose a plan and install expansion joints in the

pavement, with approval of the Engineer. Include width, filler, sealing material, location and/or spacing recommendations in the expansion joint plan, considering thermal effects, regional climatic conditions, RCC coefficient of thermal expansion and expected daily temperature ranges at the time of placement.

6.10.7 Joint sealing. If required by the project documents, install joint sealants using approved materials and joint details specified in the project documents. Sealant installation procedures shall follow the joint sealant manufacturers recommendations.

The joint must be prepared by power washing and sand blasting to remove all dust, debris, and unsound concrete from the joint wall, edges or corners. The sidewalls of the joints must be dry prior to applying the joint sealer.

RCC-6.11 Curing. Immediately after final rolling and compaction tests, keep the surface of the RCC layer continuously moist for a minimum of five days or until an approved curing method outlined in the quality management plan is applied.

6.11.1 Water Cure. Apply water cure using water trucks equipped with misting spray nozzles, soaking hoses, sprinkler system or other means that will ensure a uniform moist condition to the RCC layer surface without damage. Apply misting spray in a manner that will not erode or damage the surface of the finished RCC layer.

6.11.2 Curing Compound. Use a white-pigmented concrete curing compound conforming to Table RCC-1 requirements. Apply the curing compound at the minimum application rate recommended by the manufacturer on the surface and edges of the RCC layer no later than one hour after completion of finishing operations. The spray rate may need to be increased or areas sprayed multiple times in order to obtain an appearance of uniform white color, without mottling or discoloration due to incomplete coverage.

6.11.3 Sheet Materials. Use sheet curing materials conforming to Table RCC-1 requirements. Ensure coverings are held securely in place and weighted to maintain a close contact with the RCC layer surface throughout the entire curing period. Overlap the edges of adjoining sheets and hold in place with sand bags, planking, or similar method, as approved by the Engineer.

6.11.5 Opening to Traffic. Protect the RCC layer from vehicular traffic during the early curing period until the surface can withstand turning movements without marring or displacing RCC surface aggregates. In addition, do not place vehicular traffic on the pavement until the RCC attains the minimum strength required for structural consideration per Table RCC 5. Non-truck mounted curing equipment or saw-cutting equipment, necessary for proper construction and to meet other provisions of this specification, are allowable using techniques to prevent marring or displacing RCC surface aggregates.

Table RCC-5 – Minimum Opening Strength For Structural Adequacy

Slab Thickness	Compressive Strength for Opening to Public Traffic

	Autos	Mixed Traffic
≤ 5 inches	2000 psi	4000 psi
5 – 6 inches		3500 psi
6 – 7 inches		2500 psi
7 – 8 inches		2200 psi
> 8 inches		2000 psi

RCC-6.12 Finishing and Surface Appearance. The final surface may or may not be natural, trowelled, trowelled and broomed, diamond ground, milled or grooved depending on the application, and smoothness and texture requirements.

7.0 Acceptance Criteria

RCC-7.01 Thickness Requirements.

7.01.1 Thickness Verification by Cores. Determine the pavement thickness from cores by average caliper measurements in accordance with ASTM C174. Extract one core for each lot of RCC pavement per Table RCC-4. For pavement placement units consisting of less than one lot of RCC pavement, include the pavement with the previous or next placement unit. In selecting thickness testing locations, avoid getting too close to locations where it is known that the placement was constrained to meet a specific site requirement.

7.01.2 Thickness Verification by Non-Destructive Device. The Engineer may approve a non-destructive method for thickness verification with successful demonstration that the proposed alternate is sufficiently accurate to satisfy the requirements of Table RCC-4.

7.01.3 Defective Area Correction for Pavement Thickness. The thickness after compaction shall be no less than 0.25 in. (6 mm) under the RCC thickness, as specified on the Plans or drawings. Full payment shall be made for pavement represented by verification tests meeting this requirement.

Pavement represented by any thickness verification test that is outside of the tolerance is subject to further evaluation. Take two additional tests, about 30 ft on either side of the deficient test in the direction paving (within the same placement unit). Define the limits of thickness deficiency through additional tests as needed. For areas defined by the limits of testing to be deficient, perform an analysis to evaluate the as – built structural capacity as determined by 3rd party or propose a solution (either removal and replacement or repair method) to the Engineer/Owner or follow the below adjusted contract unit price. The proposed solution shall provide an as-built condition structurally equivalent to or greater than the design, or compensate for reduced value through a unit price adjustment, to the approval of the Engineer and at no expense to the Owner.

Table RCC-6: Deficient Thickness Price Adjustment Factor

Deficiency in Pavement Thickness in.	Proportional Part of Contract Price Allowed (adjustment factor)
≤ 0.25	1.00

0.26 – 0.35	0.80
0.35-0.45	0.65
0.45-0.5	0.5
>0.51	Remove and replace

RCC-7.02 Density Requirements.

7.02.1 In-Place Wet Mat Density Determination. Determine the In-place Wet Mat Density on pavement at least 24 in. (610 mm) from any joint in accordance with ASTM C1040, direct transmission mode. Testing frequency and acceptance for each lot shall be per Table RCC-4. The test depth must be as close to bottom of lift as possible without going beneath it and within 2 inches of the bottom of the lift. For pavement placements of less than the size of one lot, include the pavement with the previous or next lot.

7.02.2 In-Place Wet Joint Density Determination. Determine the In-place Wet Joint Density on joints at distance 12 in. (305 mm) or greater from a free edge and 6 in. (150 mm) or greater from a confined edge accordance with ASTM C1040 direct transmission mode for each lot per Table RCC-4. The test depth must be as close to bottom of lift as possible without going beneath it and within 2 inches of the bottom of the lift. For pavement placements of less than the size of one lot, include the pavement with the previous or next lot.

7.02.3 Correction for Density. For in-place wet mat and joint density, full payment shall be made for pavement based on the acceptance criteria in Table RCC-4. Lots that have a density measurement that is less than the required density requirement are subject to further evaluation. Take an additional test within a 5 to 8 ft (1.5 to 2.5 m) radius of the original test (within the same placement unit). If the additional test result is below the acceptance criteria in Table RCC-4, apply additional roller passes across the full lane width between the last testing location that produced an acceptable reading and the paver. If the additional rolling does not correct the problem, or causes the density to decrease, discontinue paving until corrections are made to assure the Engineer that the minimum density is achieved. In addition, cores must be taken and tested in accordance with RCC-7.03 to validate strength of potentially deficient concrete.

RCC-7.03 Strength Requirements.

7.03.1 Strength Determination. Determine the compressive strength of cylinders based on the acceptance criteria in Table RCC-4. For pavement placements of less than the size of one lot, include the pavement with the previous or next lot.

7.03.2 Remedial Action for Deficient Strength. Full payment shall be made for tested lot -if the average cylinder strength is equal to 100% of the specified strength in Section RCC-4.03 with no single result below 90%. Pavement lots that have an average strength less than the specified strength in Section RCC-4.03 are subject to further evaluation.

Extract three cores at random locations in the suspect area once the pavement is 28 days old. Remove, handle, and test the compressive strength of the cores according to ASTM C42.

For single lift pavements, outside core barrel diameter shall be 4 inches resulting in an extracted core diameter of approximately 3.7 inches. Cores shall be trimmed to provide a flat surface on the top and bottom portions that is perpendicular to the longitudinal axis. To ensure that a representative portion of the RCC core is tested for compressive strength, approximately equal amounts of material should be removed from the top and bottom portions of the RCC core where possible. Unequal amounts may be needed depending on the core thickness and bottom deviation / aggregate size and requirement to maintain L/D > 1.0. The minimum amount of material to be removed from the top and bottom sides of the core shall be ¼ inch.

When testing dual lift RCC cores for pavement thicknesses, the top and bottom lifts shall be tested independently. The outside core barrel diameter shall be 4 inches resulting in an extracted core diameter of approximately 3.7 inches. The final overall RCC strength of the dual lift RCC core shall be the average compressive strength of the top and bottom cores. When sizing RCC dual lift RCC cores, the horizontal bonded joint shall be clearly identified prior to sizing. The minimum amount of trimming for dual lift RCC cores shall be increased to 3/8" above and below this joint. This section of the core shall be removed to ensure that the horizontal joint has not been included in either the top or bottom lift cores after sizing.

RCC Cores shall be moisture conditioned in accordance with ASTM C42

RCC cores shall be capped with bonded caps. Prior to capping, the core surfaces at both ends must be dried sufficiently to ensure the cap bonds to the core.

Determine the average and standard deviation of the compressive strength of the three cores. If the average of the three cores exceeds 85% of the minimum specified compressive strength in Section RCC-4.03, the RCC in the sublot is acceptable and is subject to full payment and acceptance per ACI 318. If the average strength of the three cores is less than 85% of the specified compressive strength in Section RCC-4.03, the RCC requires either performing an analysis to evaluate the as – built structural capacity as determined by a 3rd party, or removal per Section 7.03.3, or acceptance at a reduced value through a unit price adjustment as shown in Table RCC-7, to the approval of the Engineer.

Table RCC-7: Deficient Strength Price Adjustment Factor

Core Compressive Strength % of Design Strength	Proportional Part of Contract Price Allowed (adjustment factor)
> 85	1.00
80-84	0.80
75-89	0.65
<74	Remove and Replace

7.03.3 Removal and Replacement. Areas determined to have strength deficiencies that are not resolved through referee testing (Section 7.03.2) require removal and replacement without additional payment. After the referee period or at least seven days, remove the hardened RCC material by saw cutting the perimeter of the deficient area full depth. Repair the area using cast-in-place concrete meeting the strength requirements of Table RCC-3 or as directed by the Engineer. If doweling is required, drill and grout dowels in the sawed, butt-faced transverse perimeter joints per table RCC-8.

Table RCC-8: Dowel Configuration for RCC Replacement with Conventional Concrete Pavement

Pavement Thickness in. (mm)	Dowel Spacing in.	Dowel Length in.	Dowel Diameter in.	Drilled Hole Diameter for	
				Grout in.	Epoxy in.
≤ 7	None	–	–	–	–
7 to 8	12	12	1.0	1.2	1.08
8 to 9.5	12	12	1.25	1.45	1.33
10+	12	12	1.5	1.7	1.58

RCC-7.04 Surface Requirements.

7.04.1 Smoothness for RCC Pavements. Ensure that the finished surface, when tested with a 10-foot straightedge, does not vary from the straightedge or template by more than 0.375 in. at any one point. In addition, the finished surface shall be within 0.625 in. of the specified finished grade. Pavement surfaces that have been purposely warped to meet fixtures (manholes, drainage inlets, and catch basins), existing curb and gutter, or cross- and side-roads are exempt from straightedge measurement. Correct surface irregularities outside of these tolerances per the requirements of Section 7.04.2.

7.04.2 Correction for Smoothness: Correct smoothness deficiencies from 7.04.1 using an approved grinding device without additional payment. After correction, verify the corrective work by measuring the smoothness according to 7.04.1. Where the RCC surface elevations on both sides of longitudinal cold joints vary by more than ¼", grind the surface to bring the elevations to within ¼" or less.

7.04.3 Surface Texture: The final surface texture after rolling and curing shall be smooth and uniform over the entire area of pavement and shall reasonably match the surface condition of the test strip without significant rips, tears, cracking, segregation, rock pockets, or areas of loose aggregate. It is common for the surface to have a similar finish as "white asphalt", however paste should be consistently distributed around the larger aggregate materials. The surface area shall be free of tears greater than 1/4" depth and 1/4" width as measured in the longitudinal direction of paving.

7.04.3.1 Surface Trowelling

Troweling of the RCC may be utilized to improve the overall aesthetic appearance of the RCC surface. Trowelling will not eliminate or change any other requirement of this specification. All density, strength, depth, surface

requirements, etc. of this specification are still applicable on troweled RCC.

Use self-propelled machine trowels. Determine the number of machine trowels required to perform the work at a rate equal to the concrete delivery rate. Maintain the time from concrete placement to machine trowels finishing exceeds 45 minutes. Trowels must be equipped with devices that adjust the underside to a true flat surface. Perform texturing that produces striations parallel or perpendicular to the centerline according to the Engineer. Trowelling must be demonstrated in the test section if it will be used on the project.

Admixtures may be used to facilitate trowelling of the surface as approved by the Engineer. Refer to the manufacture's recommendations for dosage rates.

7.04.4 Correction for Surface Texture: Correct surface texture deficiencies from Section 7.04.3 using an approved grinding device without additional payment, or removal and replacement per Section 7.03.3. With the Engineer's approval, defective surface areas may remain in place.

RCC-7.05 Multi-lift Bond Strength Requirements.

7.05.1 Bond Determination for Multi-lift RCC Pavements. Bond is determined by coring the section at 7 days or later, no earlier than 7 days is allowed. A 4-inch (100 mm) diameter or larger core must be used to evaluate bond. The coring machine shall be mounted on a vehicle to allow coring without excessive vibration. Or the coring machine shall be anchored to the slab using a mechanical anchor or be equipped with a vacuum suction device to prevent excessive vibration during coring. Hand held coring machines shall not be allowed. If the core is intact with normal handling at extraction, the layers are determined to be bonded. It is important to ensure the coring process does not inadvertently cause the core to erroneously de-bond.

7.05.2 Correction for de-bonded Multi-lift pavements: Correct bonding deficiencies from 7.05.1 by removal and replacement of the lot using RCC or conventional concrete of similar compressive strength without additional payment. After correction, verify the corrective work by measuring the bond according to 7.05.1.

RCC-7.06 Responsibility Prior to Acceptance of Work.

7.06.1 Maintenance and Care. Maintain the RCC pavement in good condition until all work is completed and accepted.

7.06.2 Snow and Ice Removal. Do not apply any de-icing agents to the RCC surface for at least 60 days after placement.

8.0 Measurement and Payment

RCC-8.01 Measurement. The quantity measured for payment under this specification shall be the number of square yards (square meters) of RCC pavement completed and

accepted, as measured in place. RCC material placed outside of the area designated to be paved under the contract shall not be included in computing the number of square yards (square meters). Construction of joints and correction of defective placement is included in the total square yard (square meters) basis and no direct payment will be made for this work.

RCC-8.02 Basis of Payment. The area unit price shall provide compensation for furnishing all labor, equipment, and materials to place, finish, texture, cure and saw joints, in accordance with the Plans and these specifications, including compensation for furnishing all raw materials, and for proportioning, mixing and delivering concrete to the paving machine. All pavement accepted by the Engineer shall be paid at the contract price per unit for the pay items shown on the bid schedule or approved estimate, except for lots requiring price adjustments for deficiencies.