

**CITY OF COLUMBUS
PUBLIC SERVICE DEPARTMENT
TRANSPORTATION DIVISION**

**SUPPLEMENTAL SPECIFICATION 1523
ROLLER COMPACTED CONCRETE PAVEMENTS (RCC)**

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ROLLER COMPACTED CONCRETE PAVEMENTS (RCC)

1523.01 Description

This Supplement outlines the requirements for production and construction of Roller Compacted Concrete (R.C.C.) pavement for City streets. In addition to this supplement, items 305, 306, 401, 407, 451, and 700 of the City of Columbus Construction and Material Specifications (CMSC) apply where applicable.

1523.02 Materials Requirements

All materials to be used shall be from approved sources as documented on the "Approved Materials List" on file in the City's testing laboratory.

Cement: Portland Cement shall conform to the standard specification for Portland Cement Type I, ASTM C 150 (latest edition).

Fly Ash: Fly Ash shall conform to ASTM C 618 Class F and section 705.13 of the CMSC.

Aggregates: Fine and course aggregates shall meet the requirements of section 703.02 of the CMSC for Portland Cement Concrete, item 305 and 306. The aggregates shall be well graded to conform to the following composite gradation.

<u>Sieve Size</u>	<u>Percent Passing</u>
1"	100
3/4"	85 – 100
1/2"	70 – 90
3/8"	60 - 85
#4	40 – 70
#16	10 – 40
#100	5 – 20
#200	2 - 8

Water: Clean, potable and free from oil, acid, and strong alkalies or organic materials.

Admixtures (other than fly ash): Meet applicable ASTM standards.

1523.03 Mix Design

The Contractor/Supplier shall develop an R.C.C. mixture proportioned in accordance with this specification and procedures discussed in ACI 325.10R-95 "State-of-the-Art Report on Roller-Compacted Concrete Pavements" sections 4.2 and 4.3. Once the mix has been designed, certified test data shall be submitted in accordance with Section

101.10 of the CMSC from a recognized testing laboratory that shows the proposed mix design will meet the following requirements.

Compressive Strength, Cylinders: 3500 psi @ 28 days
Flexural Strength, Beams: 500 psi @ 14 days
Splitting Tensile Strength, Cores: 400 psi @ 14 days

The minimum Cementitious Material shall be 350 pounds per C.Y.

Fly Ash may only be used between April 1 and November 1 unless otherwise authorized by the Project Engineer.

1523.04 Equipment

Mixing Plants: Mixing plants shall be of a design that can produce an R.C.C. pavement mixture of the proportions defined in the approved mix design and within the specified tolerances in ASTM C 94 and ASTM C 685. The mixing plant may be a Central-Mix Drum or a Stationary Continuous-Mixing Twin-Shaft Pugmill mixer. The plant shall have a minimum manufacturer's rated capacity of 200 tons per hour.

Paver: RCC shall be placed with a high-density or conventional asphalt type paver subject to approval by the Engineer. The paver shall be capable of placing RCC to a minimum of 85% of the maximum wet density in accordance with ASTM D 1557 or equivalent test method. The paver shall be of suitable weight and stability to spread and finish the RCC material, without segregation, to the required thickness, smoothness, surface texture, cross-section and grade.

Alternative Paving Equipment. In areas not accessible to paving machines, alternative paving equipment including graders and dozers may be used, if approved by the Engineer. The equipment shall be capable of producing a finished product that results in a smooth, continuous surface without segregation, excessive tearing, or rock pockets. Work in areas inaccessible to paving machines will be performed according to 1523.07 of these specifications.

Pneumatic Rollers: Pneumatic rollers shall be self-propelled, with overlapping tire positions capable of providing full compaction in a single pass. Static weight shall be no less than 10 tons, or more than 20 tons. Tire configuration shall be 5 front and 6 rear.

Vibratory Rollers: Vibratory rollers shall be self-propelled, double drum, steel wheel vibratory rollers having a static weight of at least 10 tons. Each roller drum shall be equipped with a properly operating scraper and brush. The rollers shall transmit a dynamic impact to the surface through smooth steel drums by means of revolving weights, eccentric shafts or other equivalent methods. The roller drum shall be between 4 and 5-1/2 foot in diameter and 5-1/2 to 8 feet in width.

Finish Rollers: Finish rollers shall be self-propelled, double drum, steel wheel rollers having a static weight of between 3 and 10 tons. Each drum shall be equipped with a properly operating scraper and brush. A single drum vibrator roller with a vulcanized rubber coating may be utilized for finish rolling, at the approval of the engineer.

Equipment for Vertical Cuts in R.C.C. Pavement: To cut vertical joints in fresh R.C.C. pavement, equipment such as a wheel cutter or other approved equipment capable of cutting vertically, the full depth of the layer, shall be used. If the Contractor waits until the R.C.C. hardens to make vertical cuts, concrete sawing equipment shall be used to make the vertical cuts.

1523.05 Placing RCC

Cold Weather Limitations: R.C.C. shall not be placed on any surface containing frost or frozen material. R.C.C. shall only be placed when the ambient temperature is a minimum of 35°F and rising. When the ambient temperature is expected to fall below 35° F, the Contractor must follow the procedures set forth in section 451.061 of the CMS.

Hot Weather Precautions: During periods of hot weather or windy conditions, special precautions shall be taken to minimize moisture loss due to evaporation. Precautions may include cooling of aggregate stockpiles by the use of a water spray, protective covers on dump trucks, temporary windbreaks to reduce wind velocity, cooling of concrete mix water, decreasing the allowable time between mixing and final compaction, and keeping the surface of the newly placed R.C.C. pavement damp with a light spray during compaction and finishing operations.

Rain Limitations: No placement of R.C.C. pavement shall be done while it is raining hard enough to be detrimental to the finished product. Placement may continue during light rain or mist provided the surface of the R.C.C. pavement is not eroded or washed. Dump truck covers must be used during these periods. The Engineer will be the sole judge as to when placement must be stopped due to rain.

Subgrade Preparation: Prepare the subgrade according to Section 204 of the CMSC. If required, construct a granular base according to Section 304.

Moisten the surface of the subgrade or base without creating mud or ponding water, to minimize absorption of water from R.C.C. mix to be deposited.

Transporting: Transport the R.C.C. mixture to the site in dump trucks with boxes cleaned out before loading and provided with protective covers properly secured in place until discharge. The trucks shall dump directly into the hopper of the paver unless placement is by hand as directed by the Engineer. Hauling over the freshly placed R.C.C. will not be permitted.

Continuity: Co-ordinate R.C.C. delivery so the mix can be spread and rolled within the specified time limit and to ensure uniform progress of the paver until the paving operation is complete. The time between mixing, and compacting shall not exceed ninety (90)minutes, for all RCC placed, provided that the temperature of the RCC does not exceed 90 degrees (F). This time limit may be increased or decreased by the Engineer dependent upon ambient conditions of temperature and humidity.

Spreading: Spread the material to a sufficient depth that will produce the specified thickness when compacted and conform to the required cross-sections and grade. Operate the paver in a manner that will prevent segregation and will produce a smooth continuous surface without tearing, pulling or shoving. Placing of the R.C.C. mix shall be done in a pattern so that the water from previously placed R.C.C. will not affect the fresh surface or subgrade. Where required, broadcasting or fanning of R.C.C. must be performed immediately behind the paver. Any R.C.C. surface that has been compacted "rolled" but is not cured, must be scarified at least one inch deep prior to broadcasting fresh R.C.C. over the top. Broadcasting must be completed in the allotted time within these specifications.

Segregation: If segregation occurs, suspend the paving operation until the cause is determined and corrected. Rake off segregated coarse aggregate before rolling. Broadcasting or fanning of R.C.C. mixture onto areas being compacted is not permitted.

Placing Adjacent Lanes: All R.C.C. on both sides of the longitudinal joint formed by placing an adjacent lane, must be compacted within 90 minutes of plant mixing, unless a cold joint is provided.

1523.06 Compaction and Finishing

Required Density: The Contractor is responsible for achieving 98% of the maximum wet density, as determined in the laboratory according to ASTM D 1557.

Start of Rolling: Begin compaction operations within fifteen (15) minutes after spreading of the R.C.C. mix. Any additional delay will result in the coring of the affected area at the Contractors expense to ensure that it meets the requirements of this specification.

Rolling Pattern: Establish a rolling pattern that will achieve the required density with a minimum number of roller passes.

Vibratory Rolling: During vibratory compaction, the roller shall not be started, stopped, or left standing in vibratory mode. Stagger the stopping point of successive rolling passes to avoid forming depressions on the surface.

Surface Check: Continually check the R.C.C. surface while still plastic to ensure surface and grade tolerances are met. Immediately correct excessive variations in accordance with the spreading requirements.

Finish Rolling: Remove any roller marks on the surface using a steel drum roller in static mode.

Lane Edge: Each edge of each lane shall be constructed with a vertical or a 15-degree from vertical configuration.

1523.07 Small Areas

Spread RCC mix by hand in areas not accessible by the paver, as directed by the Engineer.

Compact the mix to the required density using suitable walk-behind vibratory compaction equipment. The vibratory equipment must have a minimum centrifugal force of 2,200 pounds and/or 70 pounds per square inch. Compaction of these areas must be performed immediately after placement of the R.C.C. in order to avoid moisture loss.

1523.08 Joints

Fresh Joint: A fresh joint is made when R.C.C. on both sides of the joint are compacted within 90 minutes of plant mixing. Ensure that the contact face is moist and not segregated. Before rolling, hand-finish the joint as necessary to produce a tight surface. Roll extra passes as necessary to achieve the required density and smoothness in the joint area.

Cold Joint: A cold joint is made when either side of the joint is not compacted within 90 minutes of plant mixing. Sawcut the edge of previous lane back to sound R.C.C. to form a vertical face. Trimming by grader blade may be permitted if done at the end of the workday or the first thing the following day. Place fresh grout on the vertical face just before placing fresh R.C.C. against it. Before rolling, hand-finish the joint as necessary to produce a tight surface. Roll extra passes as necessary to achieve the required density and smoothness in the joint area. Every effort shall be made to maintain longitudinal joints as a fresh joint as described in "Fresh Joint" above.

Transverse Joint: May be a Fresh Joint or Cold Joint as described above. They shall be spaced at a maximum of 30 foot intervals, or at intervals directed by the Engineer and cut to a depth 1/3 of the specified pavement thickness.

Longitudinal Joint: Leave the outer 12 to 18 in. of the paving lane uncompacted during the initial rolling operation. This uncompacted edge is then used to set the height of the paver screed for paving the adjacent lane. After the adjacent lane is placed, the

joint is compacted by centering the roller drum over the joint and compacting the adjacent lane edges simultaneously.

1523.09 Curing

R.C.C. without Asphalt Surfacing applied within 72 hours: Keep the R.C.C. surface continuously moist by water, fog spray, wet burlap, or an approved membrane-forming curing compound, or polyethylene sheeting for a period of 7 days. Apply curing compound at 1-1/2 times the rate specified by the manufacturer.

R.C.C. with Asphalt Surfacing applied within 72 hours: Immediately after final rolling, apply an asphalt emulsion per item 407 of the CMS. Apply at 1-1/2 times the rate specified by the manufacturer.

1523.10 Tolerances

R.C.C. pavement construction shall be subject to Section 451 of the CMSC.

1523.11 Quality Assurance and Control

Responsibility: Testing at the plant and the paving site is the responsibility of the Contractor or Developer and shall be performed by a private Independent Testing Laboratory approved by the City. The Contractor and Supplier shall provide safe and convenient access, acceptable to the Engineer, for the inspection and sampling of the R.C.C. and constituent materials, at both the production plant and the paving site, and shall cooperate in the inspection and sampling process at all times.

Test Strip: The contractor shall construct a test section of a thickness equal to the design thickness with at least 100 tons of R.C.C. The test strip will be used to resolve anticipated problems with equipment, mix behavior, compaction, and/or strength characteristics. The test strip shall be constructed at a location chosen by the contractor at least 30 days before the start of paving operations. The contractor shall cooperate fully with the Engineer during construction and testing of the test strip. During construction of the test section, the Contractor will establish an optimum rolling pattern and procedure for obtaining a density of not less than 98% of the maximum wet density in accordance with ASTM D 1557. In addition, the Contractor must also demonstrate the ability to achieve a smooth, hard, uniform surface free of excessive tears, ridges, spalls and loose material. After completion of the test section, beams and cores will be extracted to verify mix compliance. This will be performed by the Independent Testing Laboratory, at the expense of the Contractor. During the trial placement, the City's Testing Personnel shall calibrate their nuclear density gauges in accordance with ASTM C 1040, with a sample of the test section mix. Moisture readings of the gauge shall be calibrated using oven dry samples of the plant-mixed R.C.C. If all aspects of the test strip have been previously satisfied, the engineer may waive this requirement on a project-by- project basis.

Pre-placement: The Contractor shall ensure quality control at the plant, by controlling materials, obtaining test samples and ensuring segregation is not occurring while loading haul trucks.

The private Testing Laboratory will develop a moisture/density relationship of the actual job materials in accordance with ASTM D 1557. Optimum moisture content, maximum dry and wet densities will be established.

Compressive Strength Testing: During the mix design development, the Independent Testing Laboratory shall produce six (6" x 12") diameter cylinders, in accordance with ASTM C 1435, to perform a 28 day compressive strength test of the material to verify mix conformance. Handling and curing shall be in accordance with ASTM C 31. The Engineer may require additional tests at different ages. Compressive strength testing shall be in accordance with ASTM C 39.

During Placement: The Contractor, in cooperation with the Independent Testing Laboratory, shall ensure that compaction and grade specifications are met and time limits are adhered to.

Field Density: The City's Testing Laboratory shall perform density testing of the R.C.C. in accordance with ASTM C 1040, direct transmission mode, as soon as possible, but no more than 30 minutes, after completion of rolling. Only wet density shall be used for evaluation. The required density shall be a minimum of 98% of the maximum wet density. At least 5 tests shall be performed for each 250 cubic yards placed. The Contractor shall be responsible for verifying required densities are achieved by the paver.

If density tests indicate that the material does not meet the required density, the Engineer, in collaboration with the Contractor and the City's Testing Laboratory, shall determine the source of the problem, whether mix properties, segregation, or gauge calibration. If mix properties have changed, or the concerns cannot be resolved, placement shall be suspended until the problem is corrected.

After Placement: The City's Testing Laboratory shall core at least nine (9) 3 1/2 inch diameter cylindrical specimens from the interior of the slab for compliance verification. Length measurements of the cores and compressive strength testing shall be in accordance with ASTM C 42. The actual number of cores will be determined as defined in section 451.16 of the CMSC.

Testing will be conducted as follows:

Compressive Strength Testing: Three (3) of the cores obtained for thickness verification will be tested for compressive strength at 28 days.

Splitting Tensile Strength: Three (3) of the cores obtained for thickness verification will be tested for splitting tensile strength at 14 days.

Density Test: The three (3) core samples obtained for splitting tensile strength will also be tested for density PCF.

The remaining three cores will be held for backup testing and/or further review as necessary.

Flexural Strength Testing: At the option of the project Engineer, the Contractor/Independent Testing Laboratory shall cut at least three (3) rectangular beams from the interior of the slab, in accordance with ASTM C 42, to perform a 14 day flexural strength test of the material. Additional tests at different ages may be required by the Engineer.

1523.12 Defective RCC

Repairs: All repairs are subject to the Engineers approval. Correct deficiencies while R.C.C. is still plastic; otherwise do repairs after seven (7) days. After seven (7) days, the R.C.C. shall be removed by saw cutting full depth before removal. Replace the R.C.C. utilizing a Cast-in-Place concrete meeting the requirements of section 499; Class B or E Concrete as directed by project Engineer. The new concrete shall be doveled into the existing R.C.C. utilizing epoxy coated reinforcing bars unless the RCC option is utilized.

Remove and replace R.C.C. if determined deficient in thickness by following the procedure set forth in section 451.16 of CMSC.

Any R.C.C. pavement found to be of unacceptable thickness, or deficient in any testing done according to 1523.11, may be subject to removal and replacement by the contractor, at no cost to the City, including removal and replacement of any intermediate and surface asphalt courses.

Grind off high surface variations to a finish acceptable to the Engineer.

Filling of low areas with fresh R.C.C. is not permitted.

If asphalt surfacing is specified, low areas shall be made up with additional surfacing material without extra payment.

1523.13 Asphalt Surfacing / Opening to Traffic

The R.C.C. pavement may be asphalt surfaced as specified on the plans once the requirements of Section 1523.06 have been met and all transverse contraction joints have been constructed.

If the R.C.C. pavement is not to be asphalt surfaced immediately, all traffic shall be restricted from using the R.C.C. until seven (7) days has elapsed or all strength requirements of Section 1523.03 have been met. At any time prior to the expiration of

the above mentioned seven (7) day period, the R.C.C. may be asphalt surfaced as specified on the plans and then opened to traffic.

1523.14 Warranty

This new process is being evaluated on a preliminary approval basis for use as base pavement on City of Columbus projects. The preliminary approval period shall begin after the first installation of the new product and extend for a period of five (5) years thereafter. During this period, a five (5) year unlimited warranty shall be provided by the Contractor for each and every installation of this product.

In order for this warranty to take effect, the installation must have been performed in accordance with this supplemental specification and the applicable sections of the City of Columbus, Construction and Material Specifications.

At any time during the five (5) year evaluation period, and in the judgment of the City, the product has failed to meet the specification requirements, the Contractor shall, at his expense, remove and replace the R.C.C. base with the applicable 305 or 306 base pavement and any intermediate/surface course(s).

1523.15 Basis of Payment

The accepted quantities of R.C.C. pavement will be paid for at the contract unit price per square yard (*square meter*), which price and payment shall be full compensation for furnishing and placing all materials including reinforcing steel, dowels, and joint materials.

No additional payment over the unit contract bid price will be made for any pavement which has an average thickness in excess of that shown on the plans.

Payment for accepted quantities, complete in place, will be paid for at the contract price for item Supplemental Specification 1523.

Item	Unit	Description
1523	Square Yard (<i>Square Meter</i>)	Roller Compacted Concrete