Date: September 1, 2005

# Georgia Department of Transportation

# State of Georgia

# Section 442—Roller Compacted Concrete Pavement

## 442.1 General Description

This work includes constructing pavement composed of Roller Compacted Concrete (RCC) on a prepared subgrade or subbase course. Follow the requirements of these Specifications and conform to the lines, grades, thickness, and cross sections shown on the Plans or as directed by the Engineer.

### 442.1.01 Definitions

General Provisions 101 through 150.

### 442.1.02 Related References

**A. Standard Specifications**

Section 106—Control of Materials

Section 430—Portland Cement Concrete Pavement

Section 500—Concrete Structures

**B. Referenced Documents**

ASTM C 1435

AASHTO T 22

AASHTO T 180, Method D

QPL 10

GDT 59

### 442.1.03 Submittals

Submit the following to the Engineer at least 35 days before start of any production of RCC:

**A. Concrete Mix Design**

Submit a mix design prepared by a qualified testing laboratory. The Engineer will transmit the design to the Office of Materials and Research for approval.

Include details on aggregate gradation, cementitious materials, admixtures (if used), compressive strengths, required moisture and density to be achieved and quantities of individual materials per cubic yard for the mix design.

**B. Paving Plan**

Submit paving procedures describing direction of paving operations, paving widths, planned longitudinal and transverse cold joints, curing methods and patterns and description of all equipment.

## 442.2 Materials

Ensure that materials meet the requirements of the following Specifications:

| Material | Section |
|---|---|
| Coarse Aggregate, Class A or B Crushed Stone or Gravel | 800 |
| Fine Aggregate, Size No. 10 | 801.2.02 |

| | |
|---|---|
| Portland Cement, Type 1 | 830.2.01 |
| Portland Pozzolan cement | 830.2.03 |
| Chemical Admixtures | 831.2.02 |
| Fly Ash and Slag | 831.2.03 |
| Curing Agents | 832 |
| Joint Fillers and Sealers | 833 |
| Low Modulus Silicone Sealant for Roadway Construction Joints | 833.2.06 |
| Water | 880.2.01 |

A. **Fly Ash**

Ensure the use of fly ash conforms to Subsection 430.2.A.1, 2 and 4, "Fly Ash" and that the fly ash mix conforms to Subsection 442.3.06, "Quality Acceptance".

**B. Granulated Iron Blast-Furnace Slag**

Ensure the use of slag conforms to Subsection 430.2.B.1, 2 and 4, "Granulated Blast-Furnace Slag" and that the slag mix conforms to Subsection 442.3.06, "Quality Acceptance".

**C. Composition of RCC**

1. Aggregates

Use aggregates manufactured to meet the gradation at the quarry or blended at the plant site to produce the desired results. Use aggregates that are well graded without gradation gaps and conform to the following gradation:

| Sieve Size | Percent Passing By Weight |
|---|---|
| 1 in (25 mm) | 100 |
| 3/4 in (19 mm) | 90 – 100 |
| 1/2 in (12.5 mm) | 70 – 100 |
| 3/8 in (9.5 mm) | 60 – 85 |
| No. 4 (4.75 mm) | 40 – 60 |
| No. 16 (1.18 mm) | 20 – 40 |
| No. 100 (150 µm) | 6 – 18 |
| No. 200 (75 µm) | 2 – 8 |

Produce evidence that the proportions have the potential for strength development at 28 days as required in Subsection 442.3.06.B, "Approval of Mix Design Proportions".

## 442.3 Construction Requirements

### 442.3.01 Personnel

General Provisions 101 through 150.

### 442.3.02 Equipment

Provide equipment and tools to construct RCC that will produce a completed pavement meeting the requirements for mixing, transporting, placing, compacting, finishing, and curing as provided in this specification. All equipment will be on hand and approved by the Engineer before work can proceed.

**A. Mixing Plant**

Produce an RCC pavement mixture in the proportions defined by the approved mix design and within the specified tolerances.

Capacity of the plant will be sufficient to produce a uniform mixture at a rate compatible with the placement equipment.

1. Pugmill Plant

   a. Pugmill plant shall be a central plant with a twin shaft pugmill mixer, capable of batch or continuous mixing.

   b. Equip plant with synchronized metering devices and feeders to maintain the correct proportions of aggregates, cement, fly ash and water.

   c. The pugmill plant will also meet the following:

      1) Aggregate Storage

         a. If previously blended aggregate is furnished, storage may be in a stockpile from which it is fed directly to a conveyor feeding mixer.

         b. If aggregate is furnished in two size groups, aggregate separation must be provided at the stockpile.

      2) Aggregate Bins

         a. Control feed rate by a variable speed belt or operate gate calibrated to accurately deliver any specified quantity of material.

         b. If two aggregate size stockpile sources are used, the feed rate from each bin shall be readily adjustable to change aggregate proportions, when required.

         c. Feed rate controls must maintain the established proportions of aggregate from each stockpile bin when the combined aggregate delivery is increased or decreased.

      3) Plant Scales

         a. If utilized, for any weigh box or hopper will be either of beam or springless dial type, and be sensitive to 0.5 percent of the maximum load required.

         b. Provide beam-type scales that have a separate beam for each aggregate size, with a single telltale actuated for each beam, and a tare beam for balancing hopper.

         c. Belt scales will be of an approved design.

         d. Provide standard weights accurate to plus or minus 0.1 percent for checking plant scales.

      4) Cement, Fly Ash or Slag Material Storage

         a. Provide separate and independent storage silos for Portland cement, fly ash or slag.

         b. Identify clearly each silo to avoid confusion during silo loading.

      5) Cement, Fly Ash or Slag Feed Unit

         To assure a uniform and accurate quantity of cementitious materials enters the mixer, provide satisfactory means of dispensing Portland cement, fly ash or slag, volumetrically or by weight.

      6) Water Control Unit

         a. Measure by weight or volume the required amount of water for the approved mix.

         b. Equip the unit with an accurate metering device.

         c. Keep RCC mixture at optimum moisture by having the rate of water added adjustable.

      7) Gob Hopper

         For continuous operating pugmills, attach a gob hopper to the end of the final discharge belt to temporarily hold the RCC discharge to allow the plant to operate continuously.

2. Central Mix Batch Plant

   Central mix batch plant may be used in RCC work meeting the requirements of Subsection 500.3.04.E of the Specifications.

3. Dry Batch Plant

   a. A dry batch plant meeting the requirements of Subsection 500.3.04.E of the Specifications may be used on projects with less than 5000 cubic yards of RCC.

   b. RCC may be mixed at a central point or wholly or in part in truck mixers as provided in Subsection 500.3.04.E of the Specifications.

**B. Paver**

Place RCC with an asphalt paver meeting the following requirements:

1. Equip the paver with compacting devices capable of producing a RCC pavement with a minimum of 90% of the maximum density in accordance with AASHTO T 180, Method D.

2. Spread and finish the RCC material without segregation, to the required thickness, smoothness, surface texture, cross-section and grade using a paver of suitable weight and stability.

**C. Compactors**

1. For primary compaction, use self-propelled smooth steel drum vibratory rollers having minimum weight of 10 tons (9.07 Mg).

2. For finish rolling as required for final compaction or for removing roller marks, use a steel drum roller, operating in static mode, a rubber tired roller or combination roller.

3. For compacting areas inaccessible to large rollers, use walk-behind vibratory rollers or plate tampers.

**D. Haul Trucks**

1. Provide sufficient number of trucks to ensure adequate and continuous supply of RCC material to paver.

2. Equip trucks hauling RCC material from the plant to the paver with covers to protect the material from inclement weather and to reduce evaporation losses.

**E. Water Trucks**

1. Throughout the paving and curing process, have at least one water truck or other similar equipment on-site and available.

2. Equip the water truck with a spreader pipe containing fog nozzles capable of evenly applying a fine mist of water to the surface of the RCC without damaging the final surface.

### 442.3.03 Preparation

Prepare the subgrade/subbase as required by the Plans and Specifications before placing the RCC.

Ensure that the foundation immediately under the RCC pavement and the areas supporting the paving equipment will not contribute to deficient pavement thickness or excessive yield losses.

### 442.3.04 Fabrication

General Provisions 101 through 150.

### 442.3.05 Construction

**A. Mixing RCC**

Use the same mix design and materials for the entire project. If the source of cement, fly ash, slag, or aggregates is changed, suspend construction and submit a new mix design to the Engineer for approval.

1. Mixing Time

    a. Assure complete and uniform mixing of all ingredients.

    b. The volume of RCC material in the mixing chamber should not exceed the manufacturer's rated capacity for dry concrete mixtures.

    c. Keep sides of the mixer and mixer blade surfaces free of hardened RCC and other materials.

    d. Check mixer blades routinely for wear and replace if wear is sufficient to cause inadequate mixing.

2. Mixing Ingredient Tolerances

    Ensure that mixing plant receive the quantities of individual ingredients to within the following tolerances:

| Material | Variation by Weight |
|---|---|
| Cementitious Materials | ± 2.0% |
| Water | ± 3.0% |
| Aggregates | ± 4.0% |

3. Plant Calibration

    a. Prior to RCC production, provide a complete and comprehensive calibration of the plant in accordance to the manufacturer's recommendation.

    b. Concrete batch plants currently listed on QPL 10, the calibration requirement is waived.

Supply daily plant records of production and quantities of materials used that day to the Engineer. These records may be used as a check on plant calibration.

**B. Transporting RCC**

Transport RCC pavement material from the plant to the paver as follows:

1. Use dump trucks fitted with retractable protective covers for protection from inclement weather or excessive evaporation.
2. Dump the trucks clean with no buildup or hanging of RCC material in the corners.
3. Deposit the RCC material directly into the hopper of the paver or secondary distribution system which deposits the material into the paver hopper.

**C. Placing RCC**

1. Subgrade/Subbase Condition

    a. Keep subgrade/subbase surface clean and free of foreign material, ponded water and frost prior to RCC placement.

    b. Uniformly moisten subgrade/subbase at the time of RCC placement.

    c. If the subbase becomes dry, uniformly water, but the method of watering used will not form mud or pools of freestanding water.

2. Paver Requirements

    a. Adjust the paver and regulate the speed to prevent segregation and provide a surface course that is smooth and continuous without tears and pulling. Limit the spread of the RCC to a length that can be compacted and finished within the appropriate time limit under the prevailing air temperature, wind, and climatic conditions.

    b. Proceed in a steady, continuous operation with minimal starts and stops.

    c. Regulate speed to assure a constant supply of RCC material in the hopper.

    d. Maintain RCC material above the auger shaft at all times during paving.

3. Lift Thickness

   Construct pavements greater than 10 in (250 mm) in two lifts of equal thickness.

4. Adjacent Lane Placement

   a. Place adjacent paving lanes within 60 minutes.

   b. If more than 60 minutes has elapsed between placements of adjacent lanes, the vertical joint will be considered a cold joint. Prepare the cold joint in accordance with Subsection 442.3.05.E.2, “Cold Vertical Joints”.

   c. At the discretion of the Engineer, this time may be increased or decreased depending on the use of set retarding admixtures or the ambient weather conditions of temperature, wind, and humidity.

5. Multiple Lift Placement

   a. The thickness of each lift will meet the requirements of Subsection 442.3.05.C.3, “Lift Thickness”.

   b. Place second lift within 60 minutes of the completion of the first lift.

   c. If more than 60 minutes has elapsed, the interface between the first and second lift will be considered a cold joint. Prepare cold joint in accordance with Subsection 442.3.05.E.4, “Horizontal Cold Lift Joints”.

   d. At the discretion of the Engineer, this time may be increased or decreased depending on the use of set retarding admixtures or the ambient weather conditions of temperature, wind, and humidity.

   e. To reduce the opportunity for cold joints to develop, the use of multiple pavers in tandem formation is advantageous.

6. Hand Spreading

   a. Limit hand spreading, broadcasting, or fanning to immediately behind the paver and before compaction.

   b. Remove any segregated coarse aggregate from the surface before compaction.

7. Segregation

   a. If segregation occurs in the RCC during paving operations, cease the spreading until the cause is determined and corrected to the satisfaction of the Engineer.

   b. If the Engineer determines the segregation to be severe, remove and replace the segregated area at no additional cost.

Place RCC in a pattern so that the curing water from the previous placements will not pose a runoff problem on the fresh RCC surface or on the subbase layer.

**D. Compacting**

1. Immediately begin compaction behind the placement of RCC material and complete within 60 minutes of the start of mixing at the plant.

2. This time may be increased or decreased depending on the use of set retarding admixtures or ambient weather conditions of temperature, wind and humidity.

3. Plan operations and supply sufficient rollers to ensure these criteria are met.

4. Determine the sequence and number of passes by vibratory and non-vibratory rolling to obtain the specified density and surface finish.

5. Operation of rollers in the vibratory mode while stopped or reversing direction is not allowed.

6. Using rubber tire rollers for final compaction to knead and seal the surface is permissible.

7. Rolling Longitudinal and Transverse Joints:

   a. Do not operate roller within 12 in. (300 mm) of the edge of a freshly placed lane until the adjacent lane is placed.

   b. Within the allowable time roll together both edges of the two lanes.

c. When a cold joint is planned, roll the complete lane and follow cold joint procedures as specified in Subsection 442.3.05.E.2, "Cold Vertical Joints".

d. Provide additional rolling for longitudinal joints with a vibratory roller as necessary to produce the specified density for the full depth of the lift and provide a tight smooth transition across the joint.

e. Smooth out any uneven marks left during the vibratory rolling utilizing a non-vibratory or rubber tire roller.

f. Roll until a smooth, flat surface, free of tearing and cracking is obtained.

g. Avoid displacement of RCC pavement by operating the speed of the rollers slow enough at all times.

h. Correct any displacement of RCC pavement resulting from reverse direction of the roller or from any other causes.

8. Density Requirements:

a. Perform in-place field density tests in accordance with GDT-59, direct transmission, as soon as possible, but no later than 30 minutes after completion of rolling. Only wet density will be used for evaluation.

b. In-place field density will be not less than 98% of the average maximum laboratory density obtained according to AASHTO T 180, Method D, based on a moving average of five consecutive tests, with no test below 95%.

c. RCC properly placed and compacted, but not meeting these requirements will be cored and tested at no additional cost.

d. If tested area achieves the 28 day design strength as outlined in Subsection 442.3.06.D, "Concrete Strength Acceptance", it will be paid for at full price.

e. Areas that fail the strength test will be removed and replaced at no additional cost.

**E. Joints**

1. Fresh Vertical Joints:

a. A vertical joint is considered a fresh joint when an adjacent RCC lane is placed within 60 minutes of placing the previous lane, with time adjusted depending on use of retarders or ambient conditions. Fresh joints will not require the treatment specified for cold joints.

b. Construct joints to assure continuous bond between new and previously placed lanes.

2. Cold Vertical Joints:

**Note: Vertical joints that are constructed utilizing a drop extension or edging shoe are exempt from the following requirement when placed up to 15 degrees from vertical.**

a. Cold joints are any planned or unplanned construction joint in the RCC pavement that does not qualify as fresh joints.

Treat longitudinal and transverse cold joints as followed:

1) Cut the joint vertically full depth. Cut vertically at least 6 in. (150 mm) from the exposed edge.

2) The edge of cold joints cut within 2 hours of placing the RCC pavement may be cut with an approved wheel cutter, or motor grader or other approved method provided that no edge raveling occurs.

3) Edges of cold joints cut after 2 hours of placing the RCC pavement, cut to 1/4 to 1/3 of the depth of the RCC pavement and excess material removed.

4) If the excess material cannot be removed without causing tearing and raveling, cut full depth.

b. Clean the joint of any loose or foreign material prior to placing fresh RCC material against a compacted cold vertical joint.

c. Before placement of fresh RCC, wet the compacted cold joint to prevent excess loss of moisture.

3. Fresh Horizontal Joints

    a. For multi-layer construction, a horizontal joint is considered a fresh joint when an subsequent RCC lift is placed within 60 minutes of placing the previous lift, with time adjusted depending on use of retarders or ambient weather conditions.

    b. Clean the surface of all loose material and moisten the surface prior to placement of the subsequent lift.

4. Horizontal Cold Lift Joints

    a. For horizontal cold joints, clean all loose material and moisten the surface prior to placement of the subsequent lift.

    b. The Engineer or Plans may require use of a cement slurry or grout between lifts. If required, apply supplementary bonding materials immediately prior to placement of the subsequent lift.

5. Control Joints:

    Joint locations shall be shown on the Plans or as directed by the Engineer.

    a. Early entry saws should be utilized as soon as possible behind the rolling operation and set to the manufacturer's recommendation.

    b. Saw cut control joints to 1/4 depth of the compacted RCC pavement.

    c. Saw as soon as possible without causing raveling or other damage to the pavement, but no later than 18 hours after placement.

6. Joints at Structures

    Treat joints between RCC pavement and concrete structures as cold vertical joints.

**F. Finishing**

1. The finished surface of the RCC pavement, when tested with a 10 foot (3 m) straight edge or crown surface template, will not vary by more than 1/4 inch (6 mm) at any one point.

2. When the surface smoothness is outside of the specified tolerance, grind the surface to within the tolerance by use of self-propelled diamond grinders at no additional cost.

3. Milling to obtain a final riding surface is not acceptable.

**G. Curing**

Immediately after final rolling and compaction testing, keep the surface of the RCC pavement continuously moist for 7 days or until an approved curing method is applied.

1. Water Cure:

    a. Apply water cure using water truck equipped with misting spray nozzles, soaking hoses, sprinkler system or other means that will assure a uniform moist condition to the RCC.

    b. Apply moisture in a manner that will not wash out or damage the surface of the finished RCC pavement.

2. Curing Compound:

    a. Apply curing compound as specified in Subsection 430.3.05.L.1 of the Specifications.

    b. Ensure the application provides a uniform void-free membrane across the entire RCC pavement surface.

3. White Polyethylene Sheeting

    Use sheet material as specified in Subsection 430.05.L.2 of the Specifications

**H. Sealing Joints**

If required by the Plans or directed by the Engineer, seal joints in accordance to Subsection 430.3.05.M, "Seal the Joints" of the Specifications.

**I. Permitting Traffic on Pavement**

Before using the pavement as a haul road for loaded or unloaded vehicles:

1. Protect the RCC from vehicular traffic during the curing period.
2. Ensure that compressive strength tests show the RCC has developed at least 2000 psi (14 MPa) and is at least 4 days old.
3. If required by the Plans or directed by the Engineer, seal the joints before permitting vehicles or equipment on the pavement.

### 442.3.06 Quality Acceptance

**A. Concrete Mixing**

Ensure mixing of RCC conforms to the requirements of Subsection 442.3.05.A, "Mixing RCC".

**B. Approval of Mix Design Proportions**

The Office of Materials and Research will review concrete mix designs and will verify compressive strength development.

The Department will approve material combinations and mix designs using approved materials and complying with Subsection 442.2, "Materials" and the following:

1. Compressive Strength

   Prepare and test 6 cylinders according to ASTM C 1435 and AASHTO T 22 to determine the 28 day compressive strength for RCC.

   The mix design will demonstrate a compressive strength of 4000 psi (28 MPa) at 28 days.

**C. Thickness**

The Engineer will designate pavement areas to be examined for depth measurement compliance with the Plan and Specifications.

The Engineer will evaluate areas deficient by more than 1/2 in (13 mm) thick. If the Engineer requires removal, remove and replace the pavement in full cross sections according to Plan requirements. The Engineer may require a reduction in payment if removal and replacement is not required.

**D. Concrete Strength Acceptance**

RCC pavement not meeting density requirements outlined in Subsection 442.3.05.D.8, "Density Requirements" will be accepted based on compressive strength development at 28 days. The compressive strength value shall be at least 3,500 psi (25 MPa).

### 442.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

## 442.4 Measurement

The work to be paid for under this Item is the number of square yards (meters) of RCC pavement completed and accepted as measured in place as determined by the specified lines, grades and cross sections shown on the Plans.

### 442.4.01

General Provisions 101 through 150.

## 442.5 Payment

The work will be paid for at the Contract Unit Price per square yard (meter). Payment is full compensation for providing materials, equipment, and labor, mixing, transporting, handling, placing, compaction and providing incidentals to complete the work.

Payment will be made under:

| | | |
|---|---|---|
| Item No. 442 | Roller compacted concrete pavement | Per square yard (meter) |

### 442.5.01 Adjustments

The Contract Unit Price per square yard (meter) of RCC pavement will be adjusted for RCC pavement accepted with a 28 day compressive strength or thickness deficiency.