



Tennessee Ready Mixed Concrete Association

Suggested Specification for
Roller Compacted Concrete Paving
For Municipal and Industrial Applications

Tennessee Department of Transportation
Commodity Code #: 745-56-044126

GENERAL

1.0 Description

- 1.1 This work consists of the construction of a Roller Compacted Portland Cement Concrete Pavement and shall include furnishing of all material, labor, and equipment necessary to prepare, place, and finish the work in accordance with this Specification.
- 1.2 This suggested specification is intended for use by consultants or owners in preparing detailed construction specifications for roller compacted concrete (RCC) pavements. These pavements may or may not be surfaced with asphalt, depending on the performance requirements of the pavement.
- 1.3 Work not covered in this suggested specification may be covered in the general or special provisions of the standard specification for the owner.
- 1.4 References to Sections in this specification are taken from the "ASTM."
- 1.5 The construction of the RCC pavement and the RCC mix design is the sole responsibility of the Contractor.

2.0 References

- 2.1 The following standards refer to the most recent version:
 - 2.1.1. ASTM C-150 Portland Cement
 - 2.1.2. ASTM C-595 or C-1157 Blended Hydraulic Cement
 - 2.1.3. ASTM C-42 Methods of Test for Concrete
 - 2.1.4. ASTM C-618 and C-989 Supplementary Cementing Materials
 - 2.1.5. ASTM C-171 Specification for Sheet Materials for Curing Concrete
 - 2.1.6. ASTM C-309 Specification for Liquid Membrane-forming Compounds for Curing Concrete
 - 2.1.7. ASTM C-1040 Density of Unhardened and Hardened Concrete In-Place by Nuclear Methods
 - 2.1.8. ASTM D-1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
 - 2.1.9. ASTM 1116 Fiber Reinforced Concrete

3.0 Measurement for Payment

- 3.1 RCC paving will be measured in cubic yards of completed pavement.
- 3.2 Item coverage for payment of roller compacted concrete will include the following:
 - 3.2.1. Furnishing all materials, labor, and equipment for the complete construction of RCC.
 - 3.2.2. Any final leveling, compacting, or dampening of the base course required.
 - 3.2.3. Delivery, placing, spreading, compacting, and curing the RCC.
 - 3.2.4. Carrying out of thickness measurements.

PRODUCTS

4.0 Materials

- 4.0.1 Portland cement: ASTM C-150, C-595, C-1157
- 4.0.2 Fly ash: ASTM C-618
- 4.0.3 Ground granulated blast-furnace slag: ASTM C-989
- 4.0.4 Water: Potable
- 4.0.5 Aggregates:
 - 4.0.5.1. Concrete aggregates: Normal density fine and coarse aggregates conforming to ASTM C-33
- 4.0.6 Synthetic Fibers
- 4.0.7 Curing compound:
 - 4.0.7.1. Water: Potable
 - 4.0.7.2. Liquid membrane forming curing compound to ASTM C-309, type 1.
 - 4.0.7.3. Emulsified asphalt primer.

4.1 RCC Mixes

Type I cement, or Type I cement with fly ash as partial cement replacement shall be used unless otherwise specified or permitted.

- 4.1.1. Proportioning for roller compacted concrete: The proposed roller compacted concrete design shall be one of the following unless otherwise specified or permitted.
 - 4.1.1.1. 275 lbs. Type I Portland cement
125 lbs. Class "C" fly ash
Course and fine aggregate in accordance to ACI 211
Water/cement ratio .28 to .33. Slump not to exceed 0 (zero)
1.5 lbs. synthetic fibers at the discretion of the Owner
 - 4.1.1.2. 300 lbs. Type I Portland cement
100 lbs. Class "F" fly ash
Course and fine aggregate in accordance with ACI 211
Water/cement ratio .28 to .33. Slump not to exceed 0 (zero)
1.5 lbs. synthetic fibers at the discretion of the Owner
 - 4.1.1.3. 400 lbs. Type I Portland cement
Course and fine aggregate in accordance to ACI 211
Water/cement ratio .28 to .33. Slump not to exceed 0 (zero)
1.5 lbs. synthetic fibers at the discretion of the Owner
- 4.1.2. Compressive strength: Specified 28-day compressive strength to be minimum 3,000 p.s.i.

EXECUTION

5.0 Equipment

- 5.1 Mixer: The method of mixing the RCC will be approved by the Owner, but can include:
 - 5.1.1. Continuous flow pugmill mixes
 - 5.1.2. Central mix concrete plant
 - 5.1.3. Concrete batch plant into a transit mixer
Any mixing method used must result in a uniformly mixed unsegregated material.
- 5.2 Compaction rollers: The RCC mix will be compacted with self-propelled smooth steel drum and/or rubber-tired rollers with a mass of 8 to 18 tons, capable of vibratory primary compaction and static finish rolling.
- 5.3 Haul trucks: The trucks for hauling the RCC mix from the plant to the job site shall be of adequate size, speed, and condition to ensure orderly and continuous operation and as follows:
 - 5.3.1 Boxes with tight metal bottoms.

5.3.2 Covers of sufficient size and weight to completely cover and protect RCC mix when truck fully loaded.

5.4 Other compaction equipment: Light walk-behind, or similar sized vibratory rollers and mechanical tampers shall be furnished for use in compaction areas inaccessible to the large rollers.

6.0 Grade Preparation

6.1 Excavate or fill as specified by the Owner.

6.2 Compact to minimum 95% Modified Proctor density in compliance with ASTM D-1557.

6.3 Repair disturbed subgrade and remove debris and loose matter from surface.

6.4 Moisten surface of subgrade without creating mud or ponding water, to minimize absorption of water from RCC mix to be deposited.

6.5 Proof roll subgrade upon completion of fine grading and compaction. Soft areas shall be sub-excavated and replaced with base course materials and compacted to 95% Modified Proctor density.

7.0 Transportation

7.1 Transport RCC mixture to site in dump trucks with boxes cleaned out before loading. Trucks will be provided with protective covers properly secured in place until discharge.

8.0 RCC Placing

8.1 Place RCC to thickness, grades, and lines as indicated or as directed by the Owner. No layer shall be in excess of 8 inches or less than 4 inches in compacted thickness.

8.2 Except for certain extremely small odd-shaped areas, all RCC shall be placed and spread with placement equipment.

8.3 Weather Conditions:

8.3.1 The RCC placement shall be discontinued when the air temperature reaches 40° F. and is falling, and shall not be resumed until the temperature reaches 40° F. and is rising.

8.3.2 Do not place RCC during rain or when rain is imminent. Take precautions that a light mist will not result in RCC tracking by the rollers.

- 8.4 Spreading: With the paving equipment, spread the RCC mix to a sufficient depth that will produce the specified thickness when compacted and conform to the required cross-section and grade. Operate the paving equipment in a manner that will prevent segregation and produce a smooth continuous surface without tearing, pulling or shoving. Limit the length of RCC spread to that which can be compacted and finished within the appropriate time limit under the prevailing air temperature, wind, and other climatic conditions.
- 8.5 Placing Adjacent Lanes: Not more than 45 minutes shall elapse between placement of RCC in adjacent lanes, unless a cold joint is provided. The time limit may be increased or decreased, depending on ambient conditions of temperature and humidity.
- 8.6 Placing Odd-shaped Areas: In isolated instances involving very small, odd-shaped areas where use of machine spreading is impractical, RCC shall be spread by hand. Spreading shall be in a manner to prevent segregation. Mixture shall be spread uniformly with shovels in a loose layer of thickness that, when compacted, will conform to density, grade, thickness, and surface texture requirements.
- 8.7 Multi-lift Construction: Not more than 60 minutes shall elapse between placement of lifts on multi-lift construction.
- 8.8 Placing shall be done in a pattern so that curing water from previous placements will not pose a runoff problem on the fresh RCC surface or on the base course.

9.0 Compaction

- 9.1 Compaction shall be accomplished by self-propelled vibratory steel wheel rollers or rubber-tired rollers. Rolling shall begin within 10 minutes of spreading and except for fresh joints shall be completed within 30 minutes of start of placement. The time may be increased or decreased depending on ambient conditions of temperature and humidity.
- 9.2 Establish a rolling pattern that will achieve the required density with a minimum number of roller passes. During vibratory compaction, do not let the roller start or stop in vibratory mode. Stagger the stopping point of successive rolling passes to avoid forming a depression on the surface. Where possible, roller shall be removed from pavement surface when stopped.

10.0 Joints

- 10.1 Fresh joint: A fresh joint is made when an adjacent RCC lane is placed within 60 minutes of placing the previous lane, with the time adjusted depending on ambient conditions. It is a vertical joint, and will not require treatment specified for cold joints.

- 10.2 Cold joints: Any planned or unplanned construction joints in the RCC that do not qualify as fresh joints shall be considered cold joints. Vertical longitudinal or transverse cold joints 15° or steeper shall be treated as follows:
- 10.2.1 Immediately prior to placing fresh RCC mixture against the vertical cold joint, the joint shall be prepared by first removing any loose or foreign material and then brushing on a thick layer of cement and water slurry. The slurry shall have the consistency necessary to fill and remain in the voids along the joint.
 - 10.2.2 For uneven surfaces or slopes over 15° from the vertical, the joint shall be cut vertically for the full depth. The edge of cold joints cut within 60 minutes of placement of the RCC material may be cut by an approved mechanical method. Edges of cold joints cut after 60 minutes of the placement of the RCC material should preferably be sawcut for the full depth of the RCC pavement.
- 10.3 Transverse joints: the rollers shall pass over the end of the freshly placed RCC mixture only when a vertical cold joint is to be made. The edge of the previously placed RCC pavement shall be cut back to expose an even, vertical surface for the full thickness of the course without disturbance of the RCC pavement that is to remain in place. Uneven areas and raveling shall be corrected by hand operations.
- 10.4 Multi-lift Construction: The top layer shall be placed so that longitudinal joints in that layer will coincide with joints in the lower layers of the pavement. Transverse joints in the top layer shall coincide with transverse joints in the lower layers of the pavement.

11.0 Curing

- 11.1 RCC without asphalt surfacing:
- 11.1.1 Water cure: Keep the RCC surface continuously moist by the application of water distributed by truck, sprinkler system or other means for a minimum of seven days or until the RCC reaches 2,500 p.s.i., whichever comes first.
 - 11.1.2. Curing compound: Apply a specified membrane-forming curing compound at the rate recommended by the manufacturer. A continuous void-free membrane shall be formed and maintained for a minimum of 7 days or until the RCC reaches a strength of 2,500 p.s.i., whichever comes first.
- 11.2. RCC with Asphalt Surfacing: Immediately after final rolling, apply the specified liquid asphalt prime coat. Asphalt may be applied immediately after sealing.

- 11.3. RCC with Concrete Overlay: Concrete overlay may be placed immediately after rolling or if delayed water cure only.

12.0 Quality Control

- 12.1. Inspection and testing of RCC will be carried out by an independent testing laboratory designated by the Owner. The Contractor shall provide reasonably safe and convenient access, acceptable to the Owner, for inspection and sampling of the RCC, and shall cooperate in the inspection and sampling process when requested to do so. Owner will pay costs for inspection and testing. Inspection or testing by the Owner will not augment or replace Contractor quality control nor relieve him of his contractual responsibility. The contractor will be required to ensure quality control at the plant to control aggregate quality, cement and water contents, obtain test samples, and to ensure segregation is not occurring while loading haul trucks.

The Inspector will ensure that compaction and grade specifications are met and make test specimens in the field and take cores.

- 12.2. Thickness: the Contractor shall check and ensure that the compacted thickness complies with the design thickness of the pavement. The Owner may, at his option and expense, take cores to verify the thickness of the pavement. The average thickness of all cores shall be greater than the design thickness with no individual core thickness less than the design thickness by 10%. A deficiency shall exist if the thickness of the constructed pavement is more than 10% less than the specified thickness.

- 12.3. Compressive Strength:

12.3.1. Field verification for compressive strength may be by 3 cores taken according to ASTM C-42 and evaluated according to ACI-318 when the RCC is 28-days old.

12.3.2. Additional cores may be taken if necessary for 7-day strength test.

12.3.3. The Contractor shall fill the core holes with Portland cement concrete as directed.

12.3.4. When cores are used, the average compressive strength of three 28-day cores taken for a unit area of RCC shall be equal to 85% of the specified 28-day strength, with no single core strength below 75% of the specified strength.

13.0 Repair of RCC

13.1 Repair of deficiencies:

13.1.1 Repair defective areas while RCC is still plastic, otherwise do repairs after 7-days curing. All repairs are subject to Owner's approval.

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

13.0 Protection

13.1 Plastic sheeting meeting the requirements of ASTM C-171 shall be provided and kept readily available to cover pavement less than 12 hours old if rainfall occurs.

13.2 Place and maintain suitable barriers to protect finished RCC from equipment, vehicles, or pedestrian traffic.

13.3 Do not open finished pavement to traffic until directed by Owner.

End of Section