SECTION 02795
POROUS CONCRETE

PART 1 GENERAL

1.1 RELATED WORK

Current Caltrans Standard Specification Sections

A. SECTION 02100 – Site Preparation
B. SECTION 02300 – Earthwork
C. SECTION 02321 – Trenching, Backfilling and Compacting
D. SECTION 02740 – Asphalt Concrete Paving
E. SECTION 02750 – Concrete Paving, Curbs, Headers and ramps

1.2 REFERENCES

   1. ASTM C29 “Test for Unit Weight and Voids in Aggregate”
   2. ASTM C33 “Specification for Concrete Aggregate”
   3. ASYM C42 “Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete”
   5. ASTM C138 “Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete”
   6. ASTM C140 “Methods of Sampling and Testing Concrete Masonry Units”
   7. ASTM C150 “Specifications for Portland Cement” (Types I and II only)
   8. ASTM C172 “Practice for Sampling Fresh Concrete”
   9. ASTM C260 “Specification for Air-Entraining Admixtures for Concrete”
   10. ASTM C494 “Specification for Chemical Admixtures for Concrete”
   11. ASTM C595 “Specification for Blended Hydraulic Cements” (Types IP or IS only)
12. ASTM C618 “Specification for Coal Fly ASH and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete”

13. ASTM 989 “Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars”

14. ASTM C1077 “Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and criteria for Laboratory Evaluation”


17. ASTM E329 “Standard Recommended Practice for Inspection and testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction”

B. American Association of State Highway and Transportation Officials (AASHTO) T-180 “Moisture-Density Relations of Soils Using a 101 pound (45.4 kg) Rammer and an 18 inch (457 mm) Drop”

1.3 SUBMITTALS

A. Concrete Mix Design

Contractor shall furnish a proposed mix design with proportions of materials prior to commencement of work. The data shall include unit weights determined in accordance with ASTM C29 paragraph 11, jigging procedure. Compacted void content shall be a minimum of 15%. Cement content shall be a minimum of 580 pounds per cubic yard, with total cementitious content to be a minimum of 630 pounds per cubic yard. Water cement ratio shall be a maximum of 0.30.

B. Test Panels:

1. Contractor shall place, joint and cure two test panels, each to be a minimum of 225 sq. ft. at the required project thickness to demonstrate to the Project Manager’s satisfaction that pavement compaction and finish can be installed at the site location.

   a. Test panels may be placed at any of the specified Portland cement porous locations. Test panels shall be evaluated for thickness, compaction, and porosity.

   b. If the test panels are found to be insufficiently porous or insufficiently compacted, the test panel shall be removed at the Contractor’s expense and disposed of in an approved landfill.

   c. If test panels are found to be satisfactory, they can be left in place and included in the completed work.
d. Determination of thickness, porosity, and compaction shall be determined by the Project Manager. Should the Contractor dispute findings of the Project Manager, acceptability shall be determined at the Contractor’s expense by achieving compacted thickness according to ASTM C42 of no less than ¼ inch of specified thickness; Void structure of 15% minimum and 21% maximum tested in accordance with ASTM C140; and unit weight within plus or minus 5 pcf of the design unit weight when tested in accordance with ASTM C140 paragraph 6.3.

1.4 QUALITY ASSURANCE

Contractor’s Qualifications:

A. ACI Concrete Flatwork Certified Finisher

B. Technical assistance and training in porous concrete placement is available at no cost to the bidding contractors by the California Cement Promotion Council (CCPC; contact Andy Youngs at 916-332-4841) and the Southern California Ready Mix Concrete Association (SCRMCA; contact Larry Maes at 662-441-3107).

PART 2 PRODUCTS

2.1 MATERIALS

A. To the extent that it is reasonably possible, provide materials manufactured off site with post consumer and/or post industrial recycled content.

B. Cement: Portland cement Type I or II conforming to ASTM C150 or Portland cement Type IP or IS conforming to ASTM C595.

C. Fly ash and Ground Iron Blast-furnace Slag: Fly ash conforming to ASTM C618 may be used in amounts not to exceed 20% of total cementitious material. Ground Iron Blast-Furnace Slag conforming to ASTM C989 may be used in amounts not to exceed 50% by weight of total cementitious material.

D. Aggregate: Use 3/8 coarse aggregate, which meets 3/8 to No. 16 per ASTM C33, or meeting 3/8 to No. 50 per ASTM D448. If other gradation of aggregate is to be used, submit data on proposed material to Project Manager for approval. Larger aggregate sizes increase pore size but decrease workability. Aggregates that are well graded reduce porosity.

E. Admixtures:

1. Type A Water reducing Admixtures – ASTM C494

2. Type B Retarding – ASTM C494

3. Type D Water Reducing / Retarding – ASTM C494
4. Also, a hydration stabilizer can be utilized and is recommended in the design and production of pervious concrete. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set. The admixture’s primary function should be as a hydration stabilizer, however it must also meet the requirements of ASTM C494 Type B Retarding or type D Water Reducing / Retarding admixtures. Air entraining agents shall comply with ASTM C260.

F. Water: Free of oil, acid, alkali, organic matter or other deleterious substances.

G. Reinforcement: Fiberglass reinforced plastic (FRP) reinforcing bar shall be used to tie adjacent concrete slabs together. Steel or epoxy-coated steel shall not be used due to the exposure to moisture experienced in porous concrete.

2.2 PROPORTIONS

A. Cement Content: For pavement subject to vehicular traffic loading, the total cement content shall not be less than 630 pounds per cubic yard. Portland cement content shall be at least 580 pounds per cubic yard.

B. Aggregate Content: The volume of aggregate per cubic yard shall be equal to 27 cubic feet when calculated as a function of the unit weight determined in accordance with ASTM C29 jigging procedure. Fine aggregate, if used, should not exceed 3 cu. ft. and shall be included in the total aggregate volume.

C. Admixture: Shall be used in accordance with the manufacturer’s instructions and recommendations.

D. Mix Water: Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration).

E. Insufficient water results in inconsistency in the mix and poor bond strength. High water content results in the paste sealing the void system primarily at the bottom and provides a poor surface bond.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION AND FORM-WORK

A. Subgrade Material: The top 6 inches shall be composed of granular or gravelly soil that is predominately sandy with no more than a moderate amount of silt or clay. Granular subbase may be placed over the subgrade.

B. Subgrade Permeability: Subgrade should have a reasonable level of permeability. One suggested test for subgrade permeability is double ring infiltrometer.
C. Subgrade Support: The subgrade shall be compacted by a mechanical vibratory compactor to a minimum of 92% of a maximum dry density as established by ASTM D1557 or AASHTO T180. Subgrade stabilization shall not be permitted. If fill material (embankment) is required to bring the subgrade to final elevation, it shall be clean and free of deleterious materials. It shall be placed in 8 inch maximum layers, and compacted by a mechanical vibratory compactor to a minimum density of 92% of a dry density as established by ASTM D1557 or AASHTO T180.

D. Subgrade Moisture: The subgrade shall be in a moist condition (within +/- 3% of the optimum moisture content as determined by the modified compaction test ASTM D1557 or AASHTO T180).

E. Forms: Forms may be of wood or steel and shall be the depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan profiles following spreading, strike-off and compaction operations. Forms shall have a removable spacer of ½ inch to 5/8 inch thickness placed above the depth of pavement. The spacers are removed following placement and vibratory strike-off to allow roller compaction. Forms shall allow for tie-in to adjacent concrete via the use of fiberglass reinforced plastic (FRP) reinforcing bar.

3.2 MIXING, HAULING AND PLACING

A. Mix Time: Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

B. Transportation: The Portland cement aggregate mixture may be transported or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by an engineer. This time can be increased to 90 minutes when utilizing the hydration stabilizer specified above under subsection 2.1 - E.4.

C. Discharge: Each mixer will be inspected for appearance of concrete uniformity. Water may be added to obtain the required mix consistency. A minimum of 20 revolutions at the manufacturer’s designated mixing speed shall be required following the addition of any water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and such that fresh concrete enters the mass of previously placed concrete.

D. Placing and Finishing: Unless otherwise approved by the Project Manager in writing, the Contractor shall provide mechanical equipment of either slipform or form riding with a following compaction unit that will provide a minimum of 10 psi vertical force. The pervious concrete pavement will be placed to the required cross-section and shall not deviate more than +/- 3/8 inch in 10 feet from profile grade.

Normal placement procedures involve utilizing a mechanical vibratory screed to strike
off the concrete ½ inch to 5/8 inch above the final height, utilizing the form spacers
described above in subsection 3.1 – E. Following strike-off, the spacers are removed,
and the concrete compacted to form level utilizing a steel roller made from nominal 8
inch diameter steel pipe. Care should be taken during compaction that full compactive
force is achieved without working the concrete surface enough to seal off the surface
porosity. Any apparent defects in the surface can be remedied by placing some fresh
mix into any depressions and compacting using a hand tamper.

After roller compacting and defect inspection/fixing, no further finishing is performed
on the concrete. Surface shall be immediately and continuously misted or fogged (see
subsection 3.2 – E. below) until curing material is applied.

E. Curing: Curing procedures shall begin within 20 minutes after final placement
operations. The pavement surface shall be covered with a minimum of a six (6) mil
thick polyethylene sheet or other approved covering material. Prior to covering, a fog
or light mist shall be sprayed above the surface when required due to ambient
conditions (temperature, wind and humidity). The low water/cement ratio and high
amount of exposed surface of porous concrete makes it especially susceptible to drying
out, so keeping the surface moist is critical. The cover shall overlap all exposed edges
and shall be secured (without using dirt or stone) to prevent dislocation due to winds
or adjacent traffic conditions.

F. Cure Time: Cure times listed are ideal. Cover shall remain on during cure. If
approved by the Project Manager, portions of the cure time after 48 hours can be met
by continuously misting the surface while uncovered and under light vehicle use only.

1. Portland Cement Type I, II or IS – 7 days minimum

2. Portland Cement Type I or II with Class F Fly ash (as part of the 600 lbs/cy
minimum cementitious) or Type IP – 10 days minimum

3. No truck traffic shall be allowed for 10 days (no passenger car / light trucks for 7
days).

G. Jointing: Control (contraction) joints shall be installed at regular intervals not to
exceed 40 feet, or two times the width of the placement. They shall be installed at ¼
the depth of the thickness of the pavement. These joints can be installed in the plastic
concrete or saw cut. Joints installed in the plastic concrete are generally rolled in
utilizing a small roller with a flange welded to the center. This type of jointing is done
immediately after roller compaction and immediately prior to curing.

If joints are saw cut, the procedure should begin as soon as the pavement has hardened
sufficiently to prevent raveling and uncontrolled cracking (normally after 24 hours, so
curing cover must be removed and surface remisted and recovered after joint sawing).
Transverse construction joints shall be installed whenever placing is suspended or a
sufficient length of time that concrete may begin to harden. In order to assure
aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled or sprayed on existing pavement surface edge. Isolation (expansion) joints will not be used except when pavement is butting slabs or other adjoining structures.

H. Grinding: Upon completion of curing, concrete is to be surface ground. Grinding is performed to improve surface quality and increase durability by preventing future raveling. Surface is ground to a depth such that the surface aggregate is ground to about its midpoint.

END OF SECTION