

1 Application conditions shall be 40°F Air/Steel temperature and rising, steel temperature shall  
 2 be 5°F above the dew point and relative humidity shall be 85% or less. Follow paint  
 3 manufacturers recommendation if more restrictive than above requirements.

4 Follow paint manufacturers written instructions on storage temperatures, mixing application,  
 5 continuous agitation and pot life. No thinners are to be used when applying organic zinc  
 6 repair paint by brush or roller.

7 Instead of repairing by painting with organic zinc repair paint, other methods of repairing  
 8 galvanized surfaces that are abraded or damaged are allowed provided the proposed method is  
 9 acceptable to the Engineer.

10 Excessive damage to galvanized surfaces as determined by the Engineer is cause for rejection.  
 11 Replace or re-galvanize rejected galvanized material.

## 12 SECTION 1077

### 13 PRECAST CONCRETE UNITS

#### 14 1077-1 GENERAL

15 Use precast concrete units from sources participating in the Department's Precast Concrete  
 16 QC/QA Program. A list of participating sources is available from the Materials and Tests  
 17 Unit. The Department will remove a manufacturer of precast concrete units from this  
 18 program if the monitoring efforts indicated that non-specification material is being provided  
 19 or test procedures are not being followed.

20 This section covers the materials for and the production of precast reinforced concrete units  
 21 produced in accordance with the contract. Where precast reinforced concrete circular  
 22 manhole sections are used, they shall meet AASHTO M 199.

#### 23 1077-2 PLAN REQUIREMENTS

24 The plans for precast units will be furnished by the Department in the *Roadway Standard*  
 25 *Drawings* or details shown in the project plans.

26 When the Department does not make precast plans available and the Contractor chooses to  
 27 precast, submit drawings to the Engineer for the items proposed to precast. Submit one  
 28 complete set of drawings for review, at least 40 calendar days before beginning production.  
 29 After acceptance, submit 7 complete sets of drawings. Acceptance by the Engineer of  
 30 contractor drawings will not be considered as relieving the Contractor of any responsibility  
 31 for precast units. When precast units are load bearing and require structure design, have the  
 32 plans prepared and certified by an engineer licensed by the State of North Carolina.  
 33 Contractor furnished drawings shall show complete design, installation and construction  
 34 information in such detail as to enable the Engineer to determine the adequacy of the  
 35 proposed units for the intended use. Contractor drawings shall include details of steel  
 36 reinforcement size and placement and a schedule that lists the size and type of precast units at  
 37 each location where the precast units are to be used. Produce precast units in accordance with  
 38 the approved drawings.

#### 39 1077-3 MATERIALS

40 Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Curing Agents	1026
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6

## Section 1077

Item	Section
Miscellaneous Metals	1074
Portland Cement	1024-1
Reinforcing Steel	1070
Silica Fume	1024-7
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Water	1024-4

### 1 1077-4 INSPECTION

2 The Department reserves the right to place a duly authorized inspector in the plant at any time  
3 work related to the production of units for the Department is being performed. Notify the  
4 Engineer at least 7 days in advance when such work is scheduled to begin.

5 Provide an office area for the inspector of at least 50 sf with desk, chair, telephone, facilities  
6 for proper heating and cooling, adequate lightning and electrical outlets.

7 Acceptance of precast units will be on the basis of tests of materials, compression tests on  
8 concrete cylinders and inspection of the finished units, including amount and placement of  
9 steel reinforcement, to determine their conformance with the approved dimensions and design  
10 and their freedom from defect. The inspector will have the authority to reject any or all units  
11 not manufactured in accordance with these specifications. Any unit found to be defective in  
12 any manner at any time will be rejected and replaced by an acceptable unit or repaired in a  
13 manner approved by the Engineer.

#### 14 (A) Storage

15 Store all Department units in a separate area on the yard. Store all units on a solid,  
16 unyielding foundation free of standing water or in a manner directed by the Engineer. Do  
17 not stack units before inspection.

#### 18 (B) Transporting

19 Do not transport units away from the casting yard until the concrete has reached the  
20 minimum required 28 day compressive strength and a period of at least 5 days elapses  
21 after casting, unless otherwise permitted by the Engineer.

22 Do not transport any unit from the plant to the job site before the approval of that unit by  
23 the plant inspector. Such approval is stamped on the unit by the plant inspector.

### 24 1077-5 PORTLAND CEMENT CONCRETE

#### 25 (A) Composition and Design

26 Portland cement concrete is composed of Portland cement, coarse aggregate (#67 or  
27 78M), fine aggregate, water and unless otherwise permitted by the Engineer, an air  
28 entraining agent. If other cementitious materials and/or chemical admixtures are used,  
29 use these materials in the proper proportions to obtain the optimum effect. Do not use  
30 calcium chloride or other admixtures containing calcium chloride.

31 Supply concrete that develops a minimum compressive strength as shown in  
32 Table 1077-1 unless other strengths are designated on the approved drawings. When  
33 required, air entrain concrete to provide an air content of  $4.5\% \pm 1.5\%$ . Supply concrete  
34 with a maximum slump of 3.5" unless a high range water reducer (super plasticizer) is  
35 approved by the Engineer. Do not use concrete with a slump exceeding 6". As  
36 an option, reduce the cement content of the mix design by up to 20% and replace with fly  
37 ash at a rate of 1.2 lb of fly ash for each pound of cement replaced or reduce the cement  
38 content up to 50% and replace with blast furnace slag on a pound for pound basis.

<b>TABLE 1077-1 PRECAST CONCRETE STRENGTH REQUIREMENTS AT AN AGE OF 28 DAYS</b>		
<b>Precast Units</b>	<b>Requirement</b>	<b>Specification Reference</b>
<b><u>BARRIER:</u></b>		
Portable	4,500 psi	Sect. 854, 1090 and 1170
Permanent	4,500 psi	Sect. 854, 857 and 1090
<b><u>CULVERTS:</u></b>		
Circular Pipe	4,000 psi	Sect. 310, 1032, 1034, 1520 and AASHTO M 170
Single Cell Box Sections	5,000 psi	Contract and AASHTO M 259
Pipe Tees	4,000 psi	Sect. 310, 1032 and AASHTO M 170
Pipe Elbows	4,000 psi	Sect. 310, 1032 and AASHTO M 170
Cross & Parallel Special End Sections	3,500 psi	Sect. 310 and 1032
<b><u>DRAINAGE STRUCTURES:</u></b>		
Boxes (Solid & Waffle)	4,000 psi	Sect. 840 and ASTM C913
<b><u>CIRCULAR MANHOLES:</u></b>		
Base	4,000 psi	Sect. 1525 and AASHTO M 199
Riser Section	4,000 psi	Sect. 1525 and AASHTO M 199
Top Section	4,000 psi	Sect. 1525 and AASHTO M 199
Grade Ring	4,000 psi	Sect. 858 and AASHTO M 199
<b><u>WALLS AND PANELS:</u></b>		
Wing, Head & End Walls	4,000 psi	AASHTO T 23
Precast Retaining Wall (PRW) Units	4,000 psi	Contract
Precast Retaining Wall Coping	3,000 psi	Contract
Retaining Wall Panels	4,000 psi	Contract
Sound Barrier Wall Panels	4,500 psi	Contract
<b><u>INCIDENTAL PRECAST ITEMS:</u></b>		
Concrete Pads For Outlet Pipe, Controller Base Cabinets	2,500 psi	Sect. 815, 816 and 825
Right-of-Way Markers	2,500 psi	Sect. 806 and 1054
Concrete Anchor For Cable Guardrail	3,000 psi	Sect. 1046
Picnic Tables	2,500 psi	Contract
Waste Containers	2,500 psi	Contract

## Section 1077

1 Submit a proposed concrete mix design for the precast units. Determine quantities of fine  
2 and coarse aggregates necessary to provide concrete in accordance with this section by  
3 the method described in ACI 211 using the absolute volume method.

4 The Engineer will review the mix design only to ascertain general compliance with the  
5 *Standard Specifications*. Do not use a mix until notified that the mix is acceptable.  
6 Acceptance of the mix design does not relieve the Contractor of his responsibility to  
7 furnish an end product meeting the *Standard Specifications*. Upon request from the  
8 Contractor, a precast concrete unit mix design accepted and used satisfactorily on any  
9 Department project may be accepted for use on other projects.

### 10 (B) Testing

11 Make all representative concrete test cylinders and all testing required herein in the  
12 presence of the plant inspector for items with strength requirements greater than 2,500 psi  
13 in Table 1077-1, unless otherwise approved by the Engineer. For items with strength  
14 requirements of 2,500 psi, furnish a Type 3 material certification in accordance with  
15 Article 106-3 certifying that the item meets this Specification.

16 Before the first load is placed, determine the air content by a calibrated Chace indicator in  
17 accordance with AASHTO T 199. If the air content as determined by the Chace indicator  
18 fails to meet the *Standard Specifications*, perform 2 more tests with the Chace indicator  
19 on the same load and average all 3 tests. Acceptance or rejection of the load is based on  
20 the average of the 3 Chace indicator tests. As an alternate method determine the air  
21 content by AASHTO T 152, T196 or T121.

22 Perform temperature, air and slump tests whenever cylinders are cast.

23 Determine slump in accordance with AASHTO T 119 with no more than 3 1/2" allowed.

24 For the purpose of testing for the required 28 day compressive strength, furnish, at no  
25 cost to the Department, at least 4 concrete cylinders for each class of concrete, each  
26 structure and each day that precast units are produced for the Department. If the  
27 contractor anticipates an early break request, furnish the Department with 2 concrete  
28 cylinders for each early break request. These cylinders are in addition to the 4 concrete  
29 cylinders required for each day of production. Make and cure cylinders in accordance  
30 with AASHTO T 23 unless, by permission of the Engineer, the units are cured by one of  
31 the methods in Article 1077-9 for the full time required to meet the specified compressive  
32 strength requirements. In such case, cure the cylinders with the members and in the same  
33 manner as the members. Test cylinders in accordance with AASHTO T 22. If the  
34 average of 2 cylinders tested to determine compressive strength at the age of 28 days fails  
35 to indicate a compressive strength as shown in Table 1077-1, or such compressive  
36 strength as is required by the approved drawings, such failure is cause for the rejection of  
37 the members represented.

### 38 (C) Temperature Requirements

39 Maintain the concrete temperature at the time of placing in the forms not less than 50°F  
40 nor more than 95°F unless otherwise directed by the Engineer.

41 Place concrete in cold weather in accordance with Article 420-7.

### 42 (D) Use of Water Reducing Admixtures

43 Use water reducing admixtures in accordance with Subarticle 1000-4(G). Use high range  
44 water reducers (super plasticizers), if approved by the Engineer.

1 **1077-6 FORMS**

2 Use forms of sturdy construction and which are capable of consistently providing straight  
 3 lines and uniform dimensions in the finished product. Use metal forms except where other  
 4 materials are approved by the Engineer. Provide an identifying number on each form, and  
 5 mark each precast unit with the same identifying number as the form used to cast unit. Forms  
 6 not meeting these requirements are subject to rejection by the Engineer. Provide joints in  
 7 forms that are smooth and tight enough to prevent leakage of mortar. Provide inside surfaces  
 8 of forms that are accessible for cleaning. After each use, clean the forms thoroughly. Before  
 9 casting, free the inside surfaces of the forms from rust, grease or other foreign matter. Do not  
 10 allow coatings used for release of members to build up and in no case allow liquid or powder  
 11 from coating materials to come in contact with the reinforcement steel.

12 **1077-7 REINFORCEMENT**13 **(A) Steel Reinforcement**

14 Furnish steel reinforcement and place as shown in the plans and in accordance with  
 15 Section 1070.

16 **(B) Macro Synthetic Fiber Reinforcement**

17 Substitute as an option, macro-synthetic fibers instead of 4" x 4" W1.4 x W1.4 welded  
 18 wire reinforcement for selected precast concrete products in accordance with the  
 19 following requirements.

## 20 (1) Materials

21 Refer to Division 10.

<b>Item</b>	<b>Section</b>
Portland Cement Concrete	1077-5

22 Substitute macro-synthetic fibers only for steel reinforcement with an area of steel of  
 23 0.12 sq.in./ft or less in the following items:

24 (a) Precast drainage structure units in accordance with *Roadway Standard*  
 25 *Drawings* No. 840.45.

26 (b) Precast manhole 4.0 ft riser sections in accordance with *Roadway Standard*  
 27 *Drawings* No. 840.52.

28 All other requirements, including reinforcement for these precast concrete items will  
 29 remain the same.

## 30 (2) Submittal

31 Submit to the Department for approval by the precast producer and fiber  
 32 manufacturer, independently performed test results certifying the macro-synthetic  
 33 fibers and the precast concrete products meet the requirements listed herein.

## 34 (3) Macro-Synthetic Fibers

35 Manufacture from virgin polyolefins (polypropylene and polyethylene) and comply  
 36 with ASTM D7508. Fibers manufactured from materials other than polyolefins.  
 37 Submit test results certifying resistance to long-term deterioration when in contact  
 38 with the moisture and alkalis present in cement paste and/or the substances present  
 39 in air-entraining and chemical admixtures.

40 Fiber length shall be no less than 1.5". Use macro-synthetic fibers with an aspect  
 41 ratio (length divided by the equivalent diameter of the fiber) between 45 and 150,  
 42 a minimum tensile strength of 40 ksi when tested in accordance with ASTM D3822  
 43 and a minimum modulus of elasticity of 400 ksi when tested in accordance with  
 44 ASTM D3822.

## Section 1077

### (4) Fiber Reinforced Concrete

Approved structural fibers may be used as a replacement of steel reinforcement in allowable structures of *Roadway Standard Drawings* Nos. 840.45 and 840.52. The dosage rate, in pounds of fibers per cubic yard, shall be as recommended by the fiber manufacturer to provide a minimum average residual strength of concrete, tested in accordance with ASTM C1399, of no less than that of the concrete with the steel reinforcement that is being replaced and no less than 5 lb/cy. Submit the recommendations of the manufacturer that correlate the toughness of steel-reinforced concrete with that of the recommended dosage rate for the fiber-reinforced concrete.

Use fiber reinforced concrete with a  $4.5\% \pm 1.5\%$  air content and a compressive strength of at least 4,000 psi in 28 days.

Determine workability of the concrete mix in accordance with ASTM C995. The flow time shall at least 7 seconds and no greater than 25 seconds.

Assure the fibers are well dispersed and prevent fiber balling during production. After introduction of all other ingredients, add the plastic concrete and mix the plastic concrete for at least 4 minutes or for 50 revolutions at standard mixing speed.

### 1077-8 PLACING CONCRETE

Use the procedures and equipment for handling, placing and consolidating the concrete such that a uniformly dense and high grade concrete is obtained in all parts of the unit under all working and weather conditions. Do not mix, handle, deliver, place or finish concrete using devices made of aluminum or containing aluminum.

Internal, external or a combination of internal and external vibration is required as necessary to produce uniformly dense concrete without honeycomb.

### 1077-9 CURING CONCRETE

#### (A) General

Precast units are subjected to one of the methods of curing described below or to other methods or combinations of methods approved by the Engineer. Cure the precast units for a sufficient length of time so the concrete develops the specified compressive strength at 28 days or less. Do not strip forms until at least 24 hours after the concrete attains initial set. For this purpose, initial set is defined as at least 500 psi resistance to a standard penetrometer. The option to strip forms earlier is available provided concrete cylinders indicate a strength of at least 75% of the 28 day compressive strength is attained before release for each day's production. Do not deface or injure the units.

#### (B) Curing at Elevated Temperatures

Cure at elevated temperatures in accordance with Subarticle 1078-10(B).

#### (C) Water Curing

Water curing of precast units is allowed as described in Subarticle 420-15(B), by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hoses or by any other method that keeps the units moist during the specified curing period. Do not use methods that deface or injure the precast units.

#### (D) Curing Compound

Application of a curing compound is allowed provided it is left intact until the specified compressive strength is met. Keep all surfaces moist before the application of the compound and damp when the compound is applied. Seal the surface with a single uniform coating at the rate of coverage recommended by the curing compound manufacturer, or as directed by the Engineer, but not less than 1 gallon per 150 sf of area.

**1 1077-10 LIFT HOLES, HANDLING**

2 Do not cast or drill more than 4 holes in each unit for the purpose of handling or placing  
3 unless otherwise approved by the Engineer. Locate all lift holes and handling devices in  
4 accordance with plan and design requirements. Units damaged while being handled or  
5 transported are rejected or require repair in a manner approved by the Engineer.

**6 1077-11 FINAL FINISH**

7 Unless otherwise required by the contract, finish all concrete in accordance with  
8 Subarticle 420-17(B).

9 Do not repair units with honeycomb, cracks, or spalls until inspected by the Engineer. Use  
10 repair methods that are approved by the Engineer before their use. Any appreciable  
11 impairment of structural adequacy is cause for rejection.

**12 1077-12 EXPOSED AGGREGATE FINISH FOR PRECAST CONCRETE PANELS**

13 When required, provide an exposed aggregate finish for front faces of panels with a depth of  
14 exposure ranging from 0 to 1/4". Before beginning production, furnish three 12" x 12"  
15 sample panels to establish acceptable variations in color, texture and uniformity of the finish.  
16 After the sample panels are accepted and within 30 days of beginning production, produce a  
17 reinforced test panel of the largest size that will be used for the project with the accepted  
18 exposed aggregate finish. Acceptance of the appearance of panels during production will be  
19 based on the test panel and accepted sample panels.

20 Use aggregate and cement from the same source as was used for the test panel and accepted  
21 sample panels to produce panels with an exposed aggregate finish. Provide access to visually  
22 inspect the entire finish of each completed panel and compare it to the test panel appearance  
23 before stacking panels. Replace the test panel with a new test panel every 3 months during  
24 production or when fly ash or cement source changes.

**25 1077-13 STEPS FOR PRECAST DRAINAGE STRUCTURES**

26 Supply steps meeting AASHTO M 199 for design, materials and dimensions. Incorporate  
27 steps in all drainage structures over 3.5 ft in height. Do not detail the lowest step more than  
28 16" from the bottom.

**29 1077-14 MARKING**

30 Clearly show the following information on each precast member:

31 (A) Date of manufacture,

32 (B) Name of the manufacturer,

33 (C) Piece mark designations where such designations are shown in the plans, and

34 (D) For precast culverts, match mark each precast member by a method approved by the  
35 Engineer, before shipment.

36 Indent marking into the concrete or paint on with waterproof paint.

**37 1077-15 DIMENSIONS**

38 Ensure that all dimensions allow assembly of the units in place without objectionable  
39 deviation from the lines shown in the plans. If requested by the Engineer, assemble the  
40 precast members to ensure a quality fit before shipment of the precast members.

**41 1077-16 INCIDENTAL PRECAST ITEMS**

42 Furnish a Type 3 materials certification in accordance with Article 106-3 for incidental  
43 precast items in Table 1077-1. Signal Cabinet Foundations shall meet the requirements herein  
44 and in Section 1098.