11. HPC SPECIFICATIONS

SPECIAL PROVISIONS

Revised 3/13/95

PROJECT NO. RS-BRS-STP-TMT-379C(1)
STATION 2098+98.00
ON GILES ROAD
ACROSS THE SOUTH BRANCH OF PAPILLION CREEK
IN SARPY COUNTY, NEBRASKA

GENERAL NOTE

The design and construction of Giles Road bridge across the South Branch of Papillion Creek is part of a federal research project on the use of high performance (HP) concrete for bridge structures. This study is a cooperative effort between Sarpy County, the University of Nebraska's Center for Infrastructure Research (CIR), the Federal Highway Administration (FHWA), and the Nebraska Department of Roads. The research team is from the Center for Infrastructure Research. The success of both the research and the construction project requires that the research team play an integral part in the construction process and that the contractor and subcontractors cooperate fully with the researchers. The following special provisions describe special consideration required of the contractor and outlines the role of the researchers in various aspects of the construction process.

COORDINATION OF WORK WITH CONTRACTOR

All aspects of the research team's work will be coordinated with the contractor. After contract letting, a preconstruction meeting will be scheduled between the researchers, sponsors, general contractor, and pertinent subcontractors. During construction, coordination between the research team and the contractor's representatives will be requires to ensure implementation of the necessary measures for design and control of high performance concrete.

During casting of the HP concrete girders and placing of the HP concrete deck, concrete specimens in addition to those required by the specifications will be made by the researchers. The contractor shall make the necessary provisions to allow adequate sampling of the concrete.

HIGH PERFORMANCE (HP) CONCRETE MIX DEVELOPMENT

The researchers will provide technical expertise to the contractor in developing and evaluating the high performance concrete mix designs used for the bridge structure. The design and control of the high performance concrete shall be in accordance with the standard specifications, special provisions and contract plans.

HIGH PERFORMANCE (HP) CONCRETE FOR USE IN PRECAST PRESTRESSED GIRDERS

The Nebraska Department of Roads prestressed plant inspector is responsible for overseeing fabrication of the prestressed girders. Concrete for use in precast prestressed girders shall be HP concrete and shall comply with the 1985 Standard Specifications except as amended by these Special Provisions. Concrete shall include aggregate, portland cement, and water. Concrete may also include other admixtures approved by the Nebraska Department of Roads, and shall meet the following performance criteria:

Water-Cementitious Ratio ..... $\leq$ 0.28
Compressive Strength (f'c) at 56 days..... 12,000 psi
Compressive Strength (f'ci) at Transfer ..... 5,500 psi

A trial placement of at least 4 cubic yards shall be required a minimum of two weeks before initial project placement. The contractor will be required to demonstrate proper batching, placement, finishing and curing of HP concrete. The trial placement shall simulate the actual job conditions in all respects including plant conditions, transit equipment, travel conditions, admixtures, forming, placement equipment and personnel. If there are problems, the state may require more trial batches. Trial batches shall be made by the contractor subsidiary to other items of work for which direct payment is made.

Subsection 707.01 is amended to include the following:

3. State inspectors shall be furnished with a four-week production schedule that is updated as necessary. Less than one working day's notice of a change may delay the fabricator. The state inspector may observe any or all of the procedures and shall have access to all reported data anytime during fabrication. The state inspector shall report any inconsistencies to the job superintendent and note them in the plant diary.

4. The concrete producer shall report the following information for each load of concrete used in the fabrication of girders:

a) brand, mill, type, certified test number, and weight of cement;

b) brand, mill, class, certified test number and weight of fly ash;

c type, source, location, weight, and free moisture content for each aggregate; Aggregate moisture shall be determined according to NDR T506 (Nebraska Department of Roads Standard Methods of Tests) for each half day.

d) source, type, name and amount of each admixture;

e) water added during batching and at placement site;

f) time water and cement are initially mixed into batch;

g) time placement is completed.

Subsection 707.02, paragraph 1 is void and superseded by the following:

1. All prestress concrete structural units shall be produced in a Precast/Prestressed Concrete Institute (PCI) certified plant for which the method of manufacture and quality of concrete are subject to the approval of the Nebraska Department of Roads.

Subsection 707.04, paragraph 6.d. is void and superceded by the following:

6.d The manufacturer is responsible to submit the mix design for the high performance concrete to the Nebraska Department of Roads Materials & Tests Division for review and acceptance in sufficient time so that a delay of work shall not occur. The mix design shall be submitted no less than 60 days prior to casting the girders and in sufficient detail to be reproducible in the laboratory. Both the proportion and source of the components shall be provided. No proprietary mixes will be accepted. The mix design shall be submitted with the following test results:

a) 56-day compressive strength (ASTM C39);

b) chloride permeability (ASTM T277);

c) flexural strength of concrete (ASTM C78);

d) alkali reactivity of aggregates (ASTM C1260) for 16 days and 30 days, (Note: Not required if aggregate is from a source approved by Nebraska Department of Roads.);

e) modulus of elasticity (ASTM C469)

f) Splitting tensile strength of cylindrical concrete specimens (ASTM C496);

g) shrinkage (ASTM C157); and

h) abrasion resistance (ASTM C944).

A preplacement conference at a time mutually agreed upon shall be held prior to the initial placement of HP concrete. Representatives of the admixture manufacturers, the concrete producer, the bridge contractor, the University of Nebraska, and the Nebraska Department of Roads Concrete Materials Section shall meet with the project manager to discuss the following:

Mix Proportions
Batching Sequence
Batch Size
Work Schedule

Applicable Specification and Special Notes
Delivery Details
Roll of all Personnel
Special Training for Finishers
Overlay Construction Details
Testing Requirements
Acceptance Criteria
Contingency Plans
Methods of Measurement
Basis of Payment
Instrumentation

No separate payment will be made for the services of the representatives.

Subsection 707.09 is amended to include the following:

4. Quality control of the fresh concrete shall be the responsibility of the fabricator. During casting of HP concrete girders, the contractor shall make concrete cylinders to establish the compressive strength at release and at 7, ~~14~~, 28, and 56 days. All of the test data shall be reported in writing to the state inspector on a weekly basis. Fresh concrete shall be sampled and tested as follows:

a. Yield shall be determined according to ASTM C 138, using the air meter bowl is acceptable. One yield per day per class of concrete. The state inspector shall perform a minimum of one correlation test for every 10 the fabricator performs.

b. Air content shall be determined according to ASTM C 231. One air content per load. The state inspector shall perform a minimum of one correlation test for every five days of production. The acceptable variation in test results is 0.8%.

c. Concrete temperature shall be determined according to ASTM C 1064. The temperature shall be determined for each load. The state inspector shall perform a minimum of one correlation test for every five days of production.

d. Concrete cylinders shall be made according to ASTM C 31. Curing shall be according to ASTM C 31 Section 9.3 "Curing for Determining Form Removal Time or When Structure May be Put Into Service." The same number of cylinders shall be made from each load, based upon the number necessary for testing. A minimum of four 6"x12" and four 4"x8" cylinders shall be made from each load of concrete placed. No fewer that eight 6"x12" and eight 4"x8" cylinders shall be made for any one day. One 4"x8" cylinder shall be tested at release and at 7, 14, 28 and 56 days.

(1) A cylinder from the last load of concrete placed shall be tested to determine release time, except when there is reason to suspect another load will be lower in strength.

(2) Acceptance at release and 56 days shall be based upon the average of one day's pour provided no single cylinder is greater than 5.00% below the required strength.

(3) If necessary, two cylinders from different loads of concrete, one representing the low strength cylinder, shall be broken to determine 56-day strength. If either cylinder is low in strength, then a cylinder from each of the other loads of concrete shall be broken. The Nebraska Department of Roads Materials and Testing Division shall evaluate the test results and determine the acceptability of the girders below design strength. For girders accepted for use that are more than 5.00% below design strength, a reduction in payment of 25% shall be made for each girder.

e. Compressive strength shall be determined according to ASTM C 39.

HIGH PERFORMANCE (HP) CONCRETE FOR BRIDGE DECK

The owner's inspector is responsible for overseeing all field construction operations. Concrete for use in bridge deck, curb, and median shall be HP concrete and shall comply with the 1985 Standard Specifications except as amended by these Special Provisions. Concrete shall include aggregate, portland cement, water, and an approved air-entraining admixture. Concrete may also include other admixtures approved by the Nebraska Department of Roads, and shall meet the following performance criteria:

Compressive Strength (f'c) at 56 days.....8,000 psi
Chloride Permeability at 56 days.....x < 1800 coulombs
(in accordance with AASHTO T277)
Air Content.....5.0% $\leq$ x $\leq$ 7.5%

The contractor is responsible to submit the mix design for the high performance concrete to the Nebraska Department of Roads Materials & Tests Division for review and acceptance in sufficient time so that a delay of work shall not occur. The mix design shall be submitted no less than 60 days prior to placing the bridge deck concrete and in sufficient detail to be reproducible in the laboratory. Both the proportion and source of the components shall be provided. No proprietary mixes will be accepted. The mix design shall be submitted with the following test results:

a) 56-day compressive strength (ASTM C39);

b) chloride permeability (ASTM T277);

c) flexural strength of concrete (ASTM C78);

d) alkali reactivity of aggregates (ASTM C1260) for 16 days and 30 days;

e) modulus of elasticity (ASTM C469)

f) Splitting tensile strength of cylindrical concrete specimens (ASTM C496);

g) shrinkage (ASTM C157); and

h) abrasion resistance (ASTM C944).

A preplacement conference at a time mutually agreed upon shall be held prior to the initial placement of HP concrete. Representatives of the admixture manufacturers, the concrete producer, the bridge contractor, the University of Nebraska, and the Nebraska Department of Roads Concrete Material Section shall meet with the project manager to discuss the following:

Mix Proportions
Batching Sequence
Batch Size
Work Schedule
Applicable Specifications and Special Notes
Delivery Details
Roll of all Personnel
Special Training for Finishers
Overlay Construction Details
Testing Requirements
Acceptance Criteria
Contingency Plans
Methods of Measurement
Basis of Payment
Instrumentation

No separate payment will be made for the services of the representatives.

Materials Requirements:

1. All materials shall conform to the State of Nebraska 1985 Standard Specifications for Highway Construction or the following requirements:

	Specification
Portland Cement Concrete	1002
Curing Materials	1071 & 1072
Fine Aggregate for 47B Concrete	1005 & 1015

Coarse Aggregate for High Density
Low Slump Concrete .....1006 & 1015
Water for Concrete 1004
Chemical Admixtures shall be preapproved and meet the requirements of ASTM C494 & C260

Silica Fume shall conform to the following:

Silicon Dioxide (SiO_2)	minimum 85.0%
Sulfur Trioxide (SO_3)	maximum 3.0%
Moisture Content	maximum 3.0%
Loss on Ignition	maximum 6.0%
Available Alkalis (Na_2O)	maximum 1.5%
Specific Surface, air, permeability	minimum 29213 sq.ft./lb.
Pozzolanic Activity Index with Portland cement at 28 days in accordance with ASTM C 618	minimum 100
Autoclave Expansion or Contraction	maximum 0.8%
Variation of Specific Gravity	maximum 5.0% from average

Only fine particle silica fume will be permitted. The silica fume admixture will be accompanied by a certificate from the manufacturer attesting to the conformance of the material to the above requirements. The certificate will also state the date of manufacture, batch or lot number, quantity represented, and name and location of the manufacturer.

Silica fume admixture will be stored in suitable enclosures that will protect it from exposure to freezing and temperatures in excess of 85^{o}F. Containers of admixture will be protected from exposure to direct sunlight and insulated with suitable material to meet these requirements. In order to meet these requirements, it may be necessary to refrigerate the containers or drape them with continuously moistened burlap.

Coarse aggregate to be used in HP concrete shall be at a moisture greater than or equal to saturated surface dry for the 24-hour period before it is used.

Equipment:

1. All equipment shall meet the requirements of Subsection 708 of the State of Nebraska 1985 Standard Specification for Highway Construction.
2. Proportioning and mixing equipment shall meet the requirements of Subsection 1002.04 of the State of Nebraska 1985 Standard Specification for Highway Construction.
3. Placing and finishing equipment shall meet the requirements of Subsection 708.03 paragraph 5, 6, 7 of the State of Nebraska 1985 Standard Specification for Highway Construction.

Proportioning and Mixing:

1. Measuring and handling materials shall meet the requirements of Subsection 1002.05 of the State of Nebraska 1985 Standard Specification for Highway Construction.

2. Mixing shall meet the requirements of Subsection 1002.06 and 1002.07 of the State of Nebraska 1985 Standard Specification for Highway Construction.

    a. Suggested batch sequence is as follows:

        (1) Put in 3/4 of the water with the air entrainment and water reducing admixtures.

        (2) Add all silica fume and mix for 50 revolutions.

        (3) Batch aggregates and cement.

        (4) Add remaining water and mix for 20 revolutions.

        (5) High range water reducer may be added during Step 2 if necessary and on the project site. Air entraining admixture may be added at the project site if supplier has approval from the Nebraska Department of Roads Materials & Tests Division.

    b. The contractor must demonstrate to the project manager the procedure for adding admixtures on the project site. The process involves backing the load of concrete up to the chute; stopping short of discharge. The admixture is spread over the entire surface and mixed.

    c. Testing for slump shall commence within four to eight minutes after the concrete is discharged. and shall be performed as frequently as necessary to maintain control. The maximum allowable slump shall be 8 inches. All loads shall be consistent to within $\pm$ 1 inch. Slump shall be controlled by the addition of Type F, high-range water reducer.

    d. Water shall not be added to the concrete after it is batched and placed on the truck for delivery to the project site. Only enough water to rinse the chute and fins, after the addition of admixtures, is allowed; this must be accounted for on the proportioning report.

Placing and Finishing:

1. A trial placement of a least 4 cubic yards shall be required a minimum of two weeks before initial project placement. The contractor will be required to demonstrate proper batching, placement, finishing and curing of HP concrete. The trial placement shall simulate the actual job conditions in all respects including plant conditions, transit equipment, travel conditions,

admixtures, forming, placement equipment and personnel. If there are problems, the state may require more trial batches. Trial batches shall be made by the contractor subsidiary to other items of work for which direct payment is made.

2. Transporting the concrete shall meet the requirements of Subsection 711.06 paragraph 2 of the State of Nebraska 1985 Standard Specifications for Highway Construction.

3. Placement of concrete shall be in accordance with the State of Nebraska 1985 Standard Specifications for Highway Construction. Placing concrete shall be a continuous operation throughout the pour. Fresh concrete 3 inches of more in thickness shall be internally vibrated in addition to surface screeding. The concrete shall be placed slightly above grade and then struck-off, screeded, and finished to final grade. The forward speed of the finishing machine or machines shall be adjusted to the average progress of the concrete production, in order that the strike-off operations shall be as continuous and uninterrupted as possible. Hand finishing with a float may be required to produce a tight uniform surface. The addition of water directly to the surface during the finishing operations will not be permitted. Moisture shall be maintained on the surface of the concrete by an approved fogging system. An approved fogging system shall be capable of maintaining a fog over the entire surface of the fresh concrete. Use of an evaporation retardant/finishing aid approved by the Nebraska Department of Roads is allowed but shall not be used in place of fogging.

4. a. A construction dam or bulkhead shall be installed in case of a delay in placement of concrete exceeding 30 minutes. Further placement shall be discontinued any may be resumed only after 48 hours of cure have elapsed. This restriction does not prohibit continuation of the placement provided a gap is left in the placement. This gap shall be sufficient in length to allow the finishing machine to clear the previously placed concrete.

   b. During delays of 30 minutes or less, the placement shall be protected from drying with fogging.

5. Texturing shall meet the requirements of Subsection 711.06, paragraph 4 of the State of Nebraska 1985 Standard Specification for Highway Construction, except the texture shall be achieved by use of a corrugated bull float.

Limitation of Operations:

1. The requirements of Subsection 711.07, Paragraphs 1, 2, 3, 4, and 6 of the State of Nebraska 1985 Standard Specification for Highway Construction shall be met.

2. The bridge deck may be opened to traffic after the specified curing time and the concrete has achieved a compressive strength of 8000 psi.

3. HP concrete for bridge deck shall be placed when the rate of evaporation will not exceed 0.15 pounds per square foot per hour. The rate of evaporation will be obtained by measuring the relative humidity, the wind velocity, and the air temperature near the deck and the concrete mix temperature. Enter the appropriate parameters in the Evaporation Nomograph in Appendix B to determine the rate of evaporation. This section must be adhered to because silica fume does not bleed.

4. Furthermore, HP concrete for bridge deck shall not be placed when the air temperature in the shade is above 80^{o}F. Unsuitable climatic conditions may require that concrete placement be made at night. Adequate lighting shall be provided by the contractor subsidiary to other items of work for which direct payment is made.

5. Quality control of fresh concrete shall be the responsibility of the contractor. During placement of HP concrete in the bridge deck, the contractor shall make concrete cylinders to establish compressive strength at 1, 7, 14, 28, and 56 days. Five 6"x12" and five 4"x8" cylinders shall be made for each load of concrete placed. One 4"x8" and one 6"x12" cylinder shall be tested at 1, 7, 14, 28, and 56 days. Acceptance at 56 days shall be based upon the average strength of all 4"x8" cylinders provided no cylinder is greater than 5.00% below the required strength.

6. Air and slump tests must be taken for every set of cylinders.

7. Prior to opening for traffic, the new deck will be examined by the engineer, using visual techniques. All areas that display a significant number or size of cracks will be repaired. All small cracks that are not significant enough to require removal shall be filled completely with an approved high viscosity epoxy or methyl methacrylate crack filler in accordance with the manufacturer's recommendations. The cracks designated to be filled will be gravity fed, repeatedly as necessary, to refusal. All costs associated with the repair shall be borne by the contractor.

Method of Measurement and Basis of Payment:

Subsection 711.10 shall be void and superceded by the following:

1. Basis of payment shall be in accordance with State of Nebraska 1985 Standard Specifications for Highway Construction.

CONCRETE COMPRESSIVE STRENGTH

Compressive strength of high performance concrete shall be tested according to ASTM C39. Molds shall be rigid metal or rigid plastic. Cylinders shall be 4" diameter x 8" long or 6" diameter x 12" long. Ends shall be capped with high strength capping compound if the design strength is over 10,000 psi. Cylinders should capped 24 hours prior to testing.

All control cylinders shall be cured under the same conditions as the structural component which they represent.

CURING OF HIGH PERFORMANCE (HP) CONCRETE

Proper curing is critical to ensuring the quality and performance of HP concrete. HP concrete mix usually results in higher than normal levels of heat of hydration, and improper curing could lead to formation of cracks. The contractor must give special consideration to curing procedures to prevent these cracks.

Curing of HP Concrete used in precast prestressed girders:

The precast concrete subcontractor is cautioned that the very high heat of hydration of HP concrete could result in concrete cracking upon form stripping and prior to prestress release. Proper curing must be employed to prevent these cracks. Curing steam temperatures shall not exceed 160 degrees Fahrenheit. The maximum temperature at the centroid of the bottom flange shall not exceed 160 degrees Fahrenheit.

Curing HP Concrete used for bridge deck:

The Contractor shall inform the Engineer of the methods proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have the proposed methods, equipment and material approved by the Engineer prior to placing concrete. Immediately prior to placing the concrete, the Contractor shall demonstrate to the Engineer the initial curing procedure, described below, for the Engineers approval. Inadequate curing and/or facilities shall be cause for the Engineer to delay all concrete placement on the job until remedial action is taken.

All concrete shall be cured for a period of eight (8) curing days. A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above 50^{o}F for at least 19 hours, or on colder days if satisfactory provisions are made to maintain the temperature of all surfaces of

the concrete above 40°F for the entire 24 hours. The required curing period shall begin when all concrete therein has attained its initial set.

All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as specified in Section 1004—Water for Concrete. Water which stains or leaves an unsightly residue shall not be used. The following methods are permitted for curing bridge deck HP concrete. Water curing will be required for the upper surfaces of bridge roadway and median.

(1) Water Curing.

(a) Initial Curing. Immediately after the concrete is finished, the entire surface of the concrete shall be kept continuously damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. Such initial curing shall be continued until the concrete has attained its initial set, but for a period not less than five (5) hours.

(b) Wet Mat Curing. Wet mat curing shall immediately follow the initial curing. This curing method shall consist of keeping the concrete surfaces continuously wet by maintaining wet burlap blankets in direct contact with the concrete for the required curing time. The burlap blankets may be placed dry and wetted down immediately after they are placed. The blankets shall be weighted down adequately to provide continuous contact with all concrete where possible.

Surfaces which cannot be cured by direct contact shall be covered with mats forming an enclosure well anchored to the forms or ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

Polyethylene sheeting, burlap-polyethylene blankets, laminated mats or insulating curing mats placed in direct contact with the slab will be required when the air temperature is expected to drop below 40°F during the first 72 hours of the curing period. These curing materials shall be weighted down with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and/or wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature.

(2) Form Curing. When forms are left in contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.

INSTRUMENTATION

Researchers will instrument four girders in the plant prior to casting and the concrete slab deck prior to pour. These instruments will be used to monitor behavior of the bridge prior to, during, and after construction. Long-term monitoring will continue at least three years following the completion of the construction.

Appendix A gives detailed information on the instrumentation plan. This section of the provision provides the general aspects of the instrumentation. It is crucial that both the precast contactor and the bridge contractor take necessary steps to prevent damage to instrumentation and cooperate with the research team during installation of the sensors and data collection. It is not anticipated that these activities will cause delays or work stoppages.

Four girders will be instrumented in the plant following placing of strands and pretensioning (maximum 2000 pounds per strand). This instrumentation will consist of vibrating wire gages, short reinforcing bar segments with electrical gages attached to them, and thermocouples placed along the length and depth of the girders. Gage wires will exit the girder by protruding from the girder surface. During casting of the girder, the contractor shall take adequate measures to prevent damage to instruments and wires. Researchers will remain at the plant for a period of 48 hours following casting to collect data and survey girder camber. The contractor shall provide a record of the prestressing force applied to the strands. During the shipping of the girder and until the construction is complete, instrumentation wires should be protected to prevent damage.

At the job site, prior to casting of the deck, sensors in the form of vibrating wire gages, thermocouples and electrical gages attached to short segments of reinforcing bars will be placed at different locations. Locations of this instrumentation are included in Appendix A

Wires will be permanently stored in a box attached to the bents. During placement and curing of deck concrete and subsequent removal of formwork, the contractor is responsible for preventing damage to instrumentation and wires. After removal of the formwork, sensors to measure the bridge deflection will be installed. The contractor will be responsible for preventing damage to these instruments as well.

Following casting of the concrete deck, researchers will routinely take readings from sensors over a period of approximately three months. It is anticipated that readings will be taken several times each day for the first week and at longer time intervals thereafter. Each reading is expected to take approximately one hour. At the time each reading is taken, the contractor shall remove any heavy equipment from the bridge.

SECTION 1095 -- EXPANSION BEARINGS. FIXED AND TFE TYPE

Subsection 1095.01 in the Supplemental Specifications to Standard Specifications for Highway Construction is void and superseded by the following:

SUBSECTION 1095.01 -- DESCRIPTION

The fixed and TFE type bearings for the structure shall consist of the upper and lower assemblies as shown on the plans and described herein. Prior to fabrication, the contractor shall submit shop drawings to the Engineer for his review.

(1) Fixed Bearings. The top assembly shall consist of a sole plate conforming to the requirements of ASTM A709 Grade 36 steel. The lower assembly shall consist of an elastomeric bearing pad conforming to the requirements of the current AASHTO Standard Specifications for Highway Bridges.

(2) Expansion Bearings, TFE Type. The top assembly shall consist on an ASTM A240 Type 304 stainless steel plate (minimum of 0.070 inch to a maximum of 0.080 inch thick) attached to a sole plate conforming to the requirements of ASTM A709 Grade 36 steel. The stainless steel plate shall be polished or rolled as necessary to provide the surface finish required in the current AASHTO Standard Specifications for Highway Bridges. The attachment shall be made by welding around the full perimeter. Welding may be done with the Shielded Metal Arc Welding Process using an AWS E308L-15 electrode, the Gas Metal Arc Welding Process using an AWS ER308L electrode or the Gas Tungsten Arc Welding Process using and AWS ER308L filler metal. The welded attachment shall not extend into the area of contact between the upper and lower assemblies.

The lower assembly shall consist of an elastomeric bearing pad with a 3/32" low friction virgin unfilled TFE sheet bonded to the upper surface. Bonding of the TFE shall meet the peel test requirements (ASTM D903) for 25 pounds per inch in 180 degrees. Bonding must be complete without air gaps under the TFE sheet to seal out moisture and provide a smooth, flat slide surface. The elastomeric bearing pad and the TFE sheet shall conform to the requirements of the current AASHTO Standard Specifications for Highway bridges.

Flatness of the bearing surfaces shall be determined by the following method:

(a) A precision straight edge, longer that the nominal dimension to be measured, shall be placed in contact with the surface to be measured as parallel to it as possible.

(b) Select a feeler gage equal to the tolerance allowed, having an accuracy of $\pm$0.001", and attempt to insert it under the straight edge.

(c) Bearing surfaces are "acceptable" if the feeler gage does not pass under the straight edge.

(d) Flatness tolerances shall be as follows:

TFE sheet, 0.0005" x "Nominal Dimension"
Stainless Steel Plate, 0.0005" x "Nominal Dimension"

(e) "Nominal Dimension" shall be interpreted as the actual dimension, in inches, under the straight edge where the straight edge is not parallel to any plan dimension of the sheet or plate being measured.

The assemblies shall be suitably packaged to prevent damage during shipment and storage.

All components for the TFE type bearing assemblies shall be fabricated, assembled and certified by the manufacturer for the complete assembly. This certification shall include all required test reports indicating that the static and kinetic coefficient of friction between the sliding surfaces does not exceed 0.08 at a pressure of 500 psi and shall also state that all materials used in the fabrication of the bearing assemblies comply with the requirements of the Special Provisions. Testing shall be in accordance with AASHTO Standard Specifications for Highway Bridges. The Engineer shall be permitted to witness all testing and approve the testing agency or other parties involved in the testing operation.

STANDARD SPECIAL PROVISIONS

G3 STRIP SEALS

G4 PILES AND PILE DRIVING

G11 STEEL DIAPHRAGMS

G13 EXCAVATION FOR STRUCTURES

G17 PORTLAND CEMENT CONCRETE

J8 COMPOSITION OF CONCRETE FOR BRIDGE CURB

J13 EQUIPMENT FOR HANDLING AND MIXING PORTLAND CEMENT CONCRETE

J17 EXPANSION BEARINGS, FIXED AND TFE TYPE

J24 CLASS "47BD" CONCRETE

APPENDIX A

DETAILS OF THE BRIDGE INSTRUMENTATION PLAN

1. Prestressed Girder

Two girders on the west span and two girders for the middle span of the bridge will be instrumented. For each of these spans, one exterior and one interior girder will be instrumented. Surface and embedded sensors will be used to monitor behavior of the girder from time of casting to several years after completion of construction. Instrumentation of the four girders will consist of the following sensors:

a. Thermocouples to measure (1) level of heat of hydration during curing process. (2) temperature gradient in the girder after bridge construction, and (3) temperature correction during data reduction.

Figure 1 gives location of the thermocouple for each of the four girders that will be instrumented.

Each girder will be instrumented using 12 thermocouples. six at the midspan and six at the quarter span. These thermocouples will be placed in the girders prior to casting.

b. Vibrating Wire Strain Gages - Vibrating wire strain gages will b used to measure long-term deformations. Each girder will be instrumented using four gages at midspan and four gages at quarter span of the girder at locations shown in Figure 2. These gages will be placed prior to casting concrete.

c. Electrical Resistance Strain Gages - Glueable type strain gages attached to #3 reinforcing bars, 600 mm long will be placed horizontally, approximately at the same location as vibrating wire strain gages. These gages will be used to collect "signature" of the structure prior to opening to traffic and thereafter using truckloads. These gages will be places prior to casting girders.

d. Mechanical Strain Gages - Surface strain at the ends of the girder to measure transfer length will be accomplished using Demec points. These gages will be placed on side surfaces of the bottom flange in the interval spanning from girder end to approximately 1500 mm from the end. These gages will be installed following the form removal and prior to releasing the strands. Time required for instrumenting each girder with Demec points will be approximately four hours.

e. Girder Camber - Prior to removal of the form, the girder camber will be measured using surveying. This will be accomplished by placing reference points at the two ends of the girder in the form of embedded bolts. Girder camber using this technique will be measured prior to and after releasing the strand and at some time interval thereafter.

Following the form removal, the girder camber will be measured using a combination of taut wire and pulley system. Piano type wire with low coefficient of thermal expansion will be used. Girder camber using this system will be measured at least once simultaneously with the surveying technique.

f. Tiltmeter - To measure girder rotations, uniaxial tiltmeters will be installed near girder ends after placing the girder on supports and pouring the end diaphragms.

g. Prestressing Force - Attempt will be made to measure the prestressing force using load cells. Prestressing force will be measured for at least three strands using load cells. Load cell readings will be collected prior to stressing the strand and continue to the time of release.

h. Control Specimens - Several control specimens instrumented using Demec points and vibrating wire gages will be made using the same concrete placed in girders. These specimens will be stored by the girders and readings will be taken for a sufficient time period. This data will be used to provide information on free shrinkage strain behavior of the concrete and converting long-term strains to stress. At least 12 control specimens will be prepared. This same exercise will also be carried out for concrete used in slab deck portion of the bridge, to be described next.

2. Concrete Slab Deck

Concrete slab deck will be instrumented for monitoring its behavior from time of casting to several years after completion of the construction.

Figure 3 shows general location of the slab that will be instrumented. Figure 3 refers to several locations in the concrete slab referred to as "cluster". At these cluster points, more than one type of sensor could be installed. Figure 3 shows total of 12 cluster points. Cluster points 1 through 4 are directly above the first exterior girder. Cluster points 5 through 8 are directly above the first interior girder. Cluster points 9 through 12 are located midway between first exterior and interior girders. Further, cluster points 1 through 8 are directly above the sections of the girders that are instrumented. The following paragraphs describe

the sensors for each cluster point and additional instrumentation to measure influence of diaphragms on behavior of the girders.

Cluster points # 1, 2, 5, 6, 9 and 10 - At each one of these cluster points, three thermocouples - located one near the top surface, one near the bottom surface and one at the mid-depth of the slab deck, will be installed.

Cluster points #1-4, 7-8 and 11-12 - At each one of these cluster points, two vibrating wire strain gages parallel to direction of the traffic, one near the top and another near the bottom surface of the slab deck, will be placed prior to casting concrete.

Cluster points 5 and 9 - At these cluster points, one vibrating wire strain gage parallel to bridge skew will be placed at mid-depth of the slab, prior to casting the slab deck.

Cluster points 1 through 12 - At each cluster point, glueable strain gages attached to short #3 bars will be placed parallel to traffic direction near the mid-depth of the slab deck. These sensors will be used to conduct live load tests in Phase III of the project.

Cluster points 1, 5, 9 and 4, 8, 12 - At each one of these cluster points, two short #3 bars with glueable strain gages attached to them will be placed one near the top surface and another near the bottom surface. These bars will be placed parallel to bridge skew. These sensors will be used to conduct live load tests in Phase III of the project.

Diaphragms - At the south end, the side vertical face of the diaphragms over bent No. 1 and 2 will be instrumented using Demac points. These mechanical gages will be used to collect long-term deformation of the diaphragms at these locations resulting from creep of the girder.

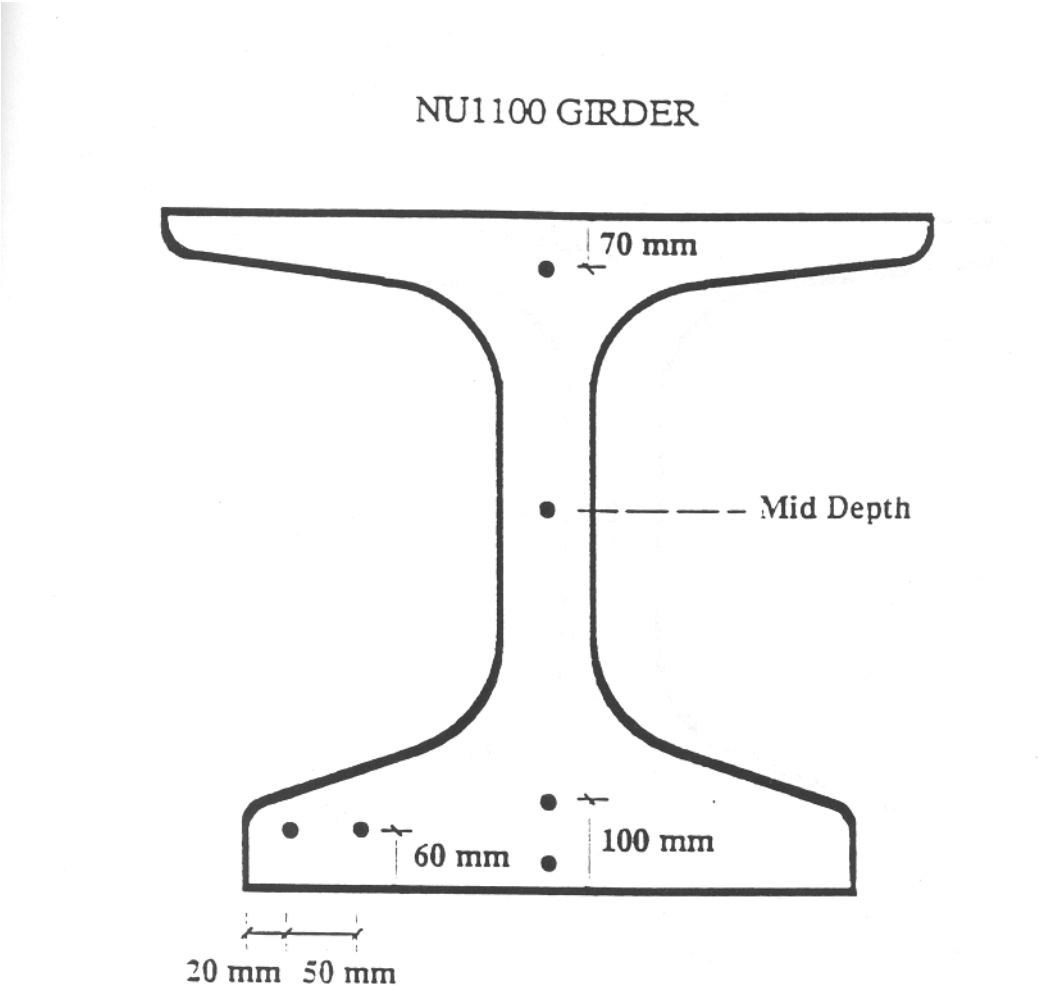


Fig. 1 LOCATION OF 6 THERMOCOUPLES AT EACH SECTION

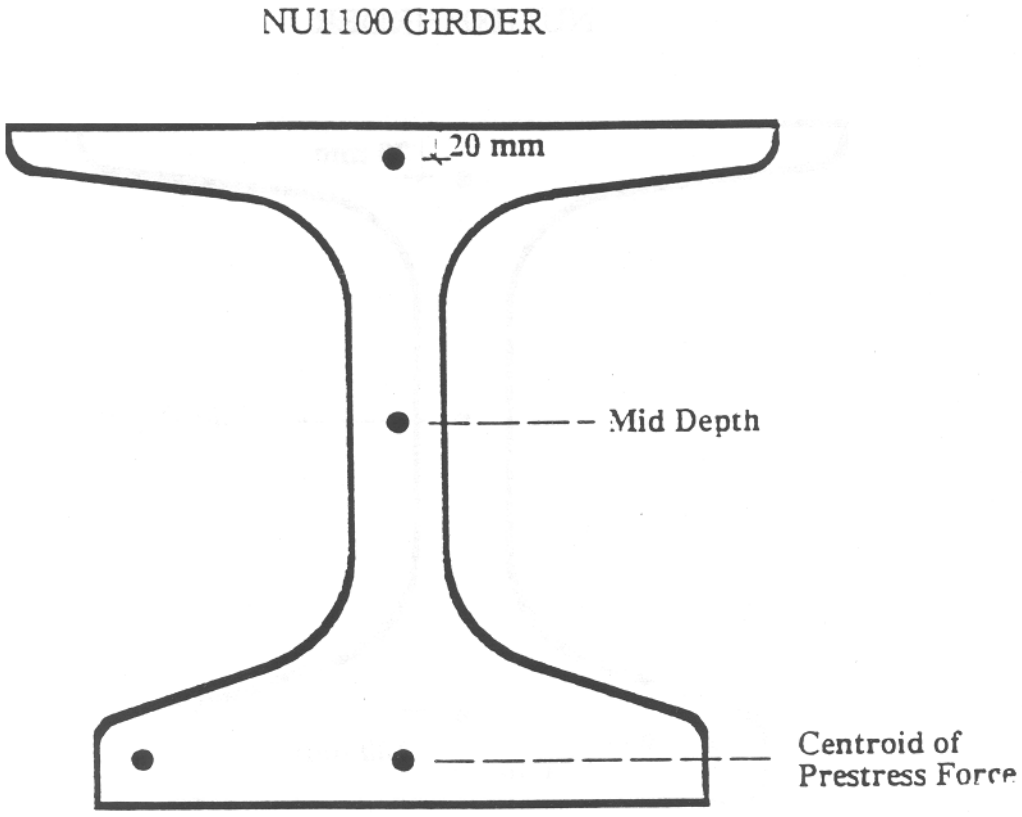


Fig. 2 LOCATION OF VIBRATING WIRE STRAIN GAGES

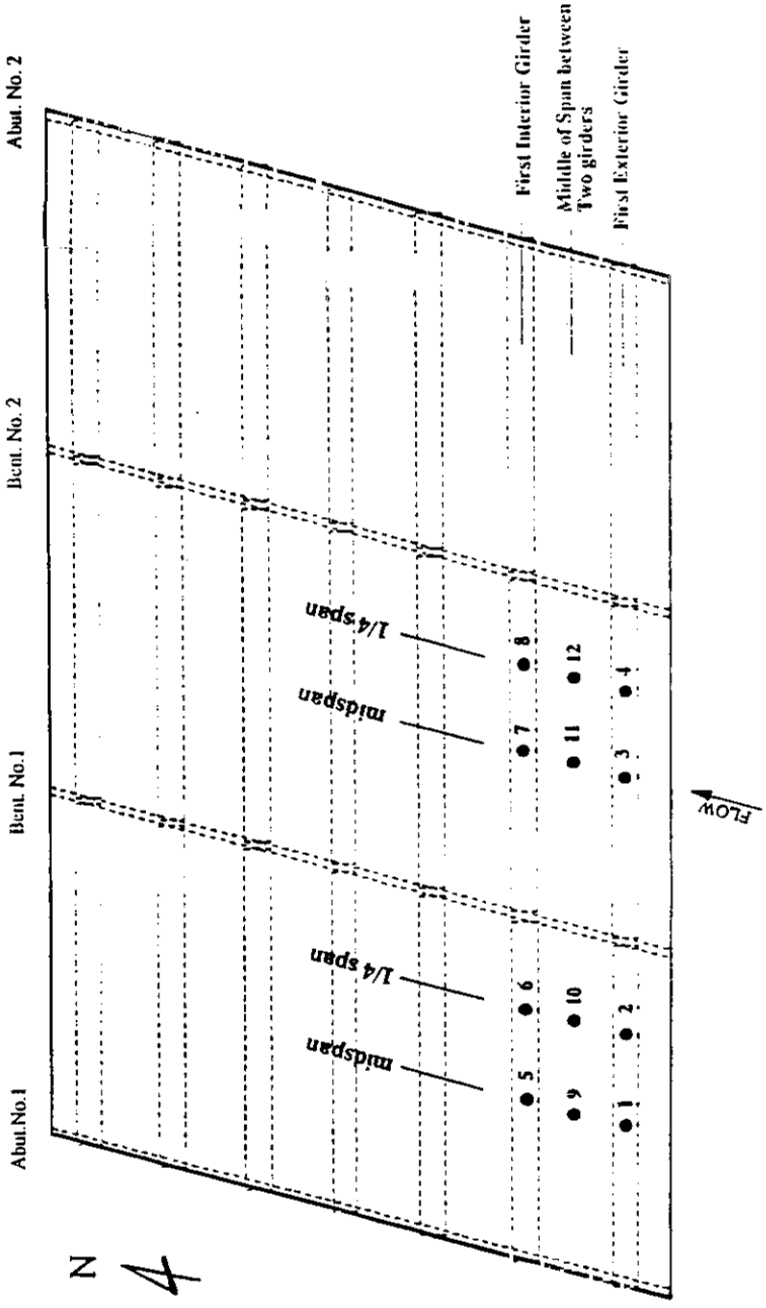
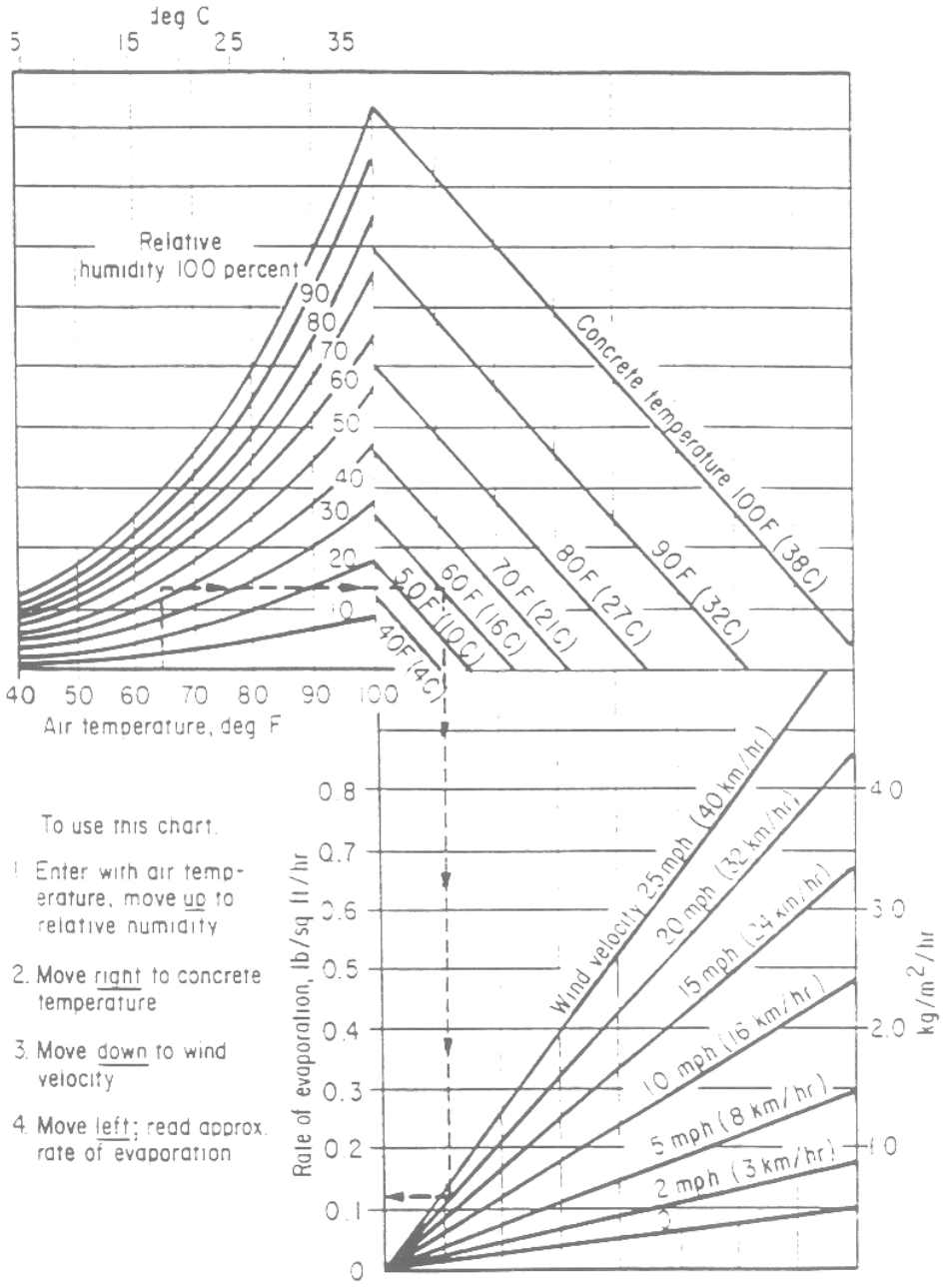


Fig. 3 INSTRUMENTATION LOCATION FOR SLAB AND DECK

APPENDIX B

EVAPORATION NOMOGRAPH



Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chard, follow the four steps outlined above. If the rate of evaporation approaches 0.15 lb/ft^2/hr, precautions against plastic shrinkage cracking are necessary.

APPENDIX C

THE FOLLOWING TABLES REGARDING HIGH PERFORMANCE CONCRETE ARE INCLUDED FOR INFORMATION ONLY. . .

Grades of Performance Characteristics for High Performance Concrete (Table 2)
Details of Test Methods for Determining HPC Performance Grades (Table 3)
Recommendations for the Application of HPC Grades (Table 4)

TABLE 2

GRADES OF PERFORMANCE CHARACTERISTICS FOR HIGH PERFORMANCE CONCRETE[1]

PERFORMANCE CHARACTERISTIC[2]	STANDARD TEST METHOD	FHWA HPC PERFORMANCE GRADE[3]			
		1	2	3	4
FREEZE/THAW DURABILITY[4] (x = relative dynamic modulus of elasticity after 300 cycles)	AASHTO T 161 ASTM C 666 Proc. A	60 ≤ x < 70%	70 ≤ x < 80%	80 ≤ x < 90%	90% ≤ x
SCALING RESISTANCE[5] (x = visual rating of the surface after 50 cycles)	ASTM C 672	3 ≥ x > 2	2 ≥ x > 1	1 ≥ x > 0	0 = x
ABRASION RESISTANCE[6] (x = avg. depth of wear in mm)	ASTM C 944	2.0 > x ≥ 1.0	1.0 > x ≥ 0.5	0.5 > x ≥ 0.25	0.25 ≥ x
CHLORIDE PERMEABILITY[7] (x = coulombs)	AASHTO T 277 ASTM C 1202	3000 ≥ x > 2000	2000 ≥ x > 1000	1000 ≥ x > 500	500 ≥ x
SHRINKAGE[8] (x = microstrain)	ASTM C 157	700 ≥ x > 600	600 ≥ x > 500	500 ≥ x > 400	400 ≥ x
CREEP[9] (x = microstrain/pressure unit)	ASTM C 512	75 ≥ x > 60/MPa (0.52 ≥ x > 0.41/psi)	60 ≥ x > 45/MPa (0.41 ≥ x > 0.31/psi)	45 ≥ x > 30/MPa (0.31 ≥ x > 0.21/psi)	30/MPa ≥ x (0.21/psi ≥ x)
STRENGTH (x = compressive strength)	AASHTO T 22 ASTM C 39	40 ≤ x < 55 MPa (5800 ≤ x < 7980 psi)	55 ≤ x < 70 MPa (7980 ≤ x < 10150 psi)	70 ≤ x < 100 MPa (10150 ≤ x < 14500 psi)	100 MPa ≤ x (14500 psi ≤ x)
ELASTICITY[10] (x = modulus of elasticity)	ASTM C 469	30 ≤ x < 35 GPa (4350 ≤ x < 5080 ksi)	35 ≤ x < 40 GPa (5080 ≤ x < 5800 ksi)	40 ≤ x < 50 GPa (5800 ≤ x < 7250 ksi)	50 GPa ≤ x (7250 ksi ≤ x)

[1] This table does not represent a comprehensive list of all characteristics which good concrete should exhibit. It does list characteristics which can quantifiably be divided into different performance groups. Other characteristics should be checked. For example, HPC aggregates should be tested for detrimental alkali-silica reactivity according to ASTM C 227, cured at 38°C and tested at 23°C and should yield less than 0.05% mean expansion at 3 months and less than 0.10% expansion at 6 months (based on SHRP C-342, p. 83). Due consideration should also be paid to (but not necessarily limited to) acidic environments and sulfate attack.

[2] All tests to be performed on concrete samples moist or submersion cured for 56 days. See Table 3 for additional test information.

[3] A given high performance concrete mix design is specified by a grade for each desired performance characteristic.. For example, a concrete may perform at Grade 4 in strength and elasticity, Grade 3 in shrinkage and scaling resistance, and Grade 2 in all other categories.

[4] Based on SHRP C/FR-91-103, p. 3.52.

[5] Based on SHRP S-360.

[6] Based on SHRP C/FR-91-103.

[7] Based on *PCA Engineering Properties of Commercially Available High-Strength Concretes.*

[8] Based on SHRP C/FR-91-103, p. 3.25.

[9] Based on SHRP C/FR-91-103, p. 3.30.

[10] Based on SHRP C/FR-91-103, p. 3.17.

TABLE 3

DETAILS OF TEST METHODS FOR DETERMINING HPC PERFORMANCE GRADES

PERFORMANCE CHARACTERISTIC	STANDARD TEST METHOD	NOTES[1]
Freeze/Thaw Durability	AASHTO T 161 ASTM C 666 Proc. A	1. Test per standard test method. 2. Acoustically measure dynamic modulus after 300 cycles.
Scaling Resistance	ASTM C 672	1. Test per standard test method. 2. Perform visual inspection after 50 cycles.
Abrasion	ASTM C 944	1. Concrete shall be tested at 3 different locations. 2. At each location, 196 Newtons, for three, 2 minute, abrasion periods shall be applied for a total of 6 minutes of abrasion time per location. 779 3. The depth of abrasion shall be determined per ASTM C ~~799~~ Procedure B.
Chloride Permeability	AASHTO T 277 ASTM C 1202	Test per standard test method.
Shrinkage	ASTM C 157	Shrinkage measurements to be taken after a drying period of 180 days.
Creep	ASTM C 512	Creep measurements to be taken after a creep loading period of 180 days.
Strength	AASHTO T 22 ASTM C39	1. Molds shall be rigid metal or rigid plastic. 2. Cylinders shall be 4" in diameter x 8" long or 6" in diameter x 12" long.. 3. Ends shall be capped, ground parallel, or placed onto neoprene pads per AASHTO specifications for concretes up to compressive strengths of 70 Mpa. For concretes with higher compressive strengths, ends shall be ground parallel.
Elasticity	ASTM C 469	Test per standard test method.

[1]See footnote to Table 1 for the curing period to be used before testing.

TABLE 4

RECOMMENDATIONS FOR THE APPLICATION OF HPC GRADES

PERFORMANCE CHARACTERISTIC	CRITERIA AND RECOMMENDATIONS				
Freeze/Thaw Durability					
Exposure (x = F/T cycles per year)[1]	$x < 3$	$3 \leq x < 25$	$25 \leq x < 50$	$50 \leq x < 70$	$70 \leq x$
Recommended HPC F/T Grade	N/A[2]	1	2	3	4
Scaling Resistance					
Applied Salt[3] (x = tons/lane-mile-year)		$0.5 \leq x < 1.0$	$1.0 \leq x < 2.5$	$2.5 \leq x < 5.0$	$5.0 \leq x$
Recommended HPC Scaling Resistance Grade	N/A	1	2	3	4
Abrasion Resistance					
(x = average daily traffic, studded tires allowed)			$x < 50{,}000$	$50{,}000 \leq x$	
Recommended HPC Abrasion Resistance Grade	N/A	1	2	3	4
Chloride Permeability					
Applied Salt[3] (x = tons/lane-mile-year)	$x < 1$	$1.0 \leq x < 2.5$	$2.5 \leq x < 5.0$	$5.0 \leq x < 7.0$	$7.0 \leq x$
Recommended HPC Chloride Permeability Grade	N/A	1	2	3	4

[1] F/T stands for "freeze/thaw". A freeze/thaw cycle is defined as an event where saturated concrete is subjected to an ambient temperature, which drops below 2.2°C (28°F) followed by a rise in temperature above freezing.

[2] N/A stands for "not applicable" and indicates a situation in which specification of an HPC performance grade is unnecessary.

[3] As defined in SHRP S-360.

26

.

ADDENDUM NO. 1
to the Bidding Documents for
Giles Road HPC Bridge in Sarpy County
Project No. RS-BRS-STP-TMT-3790(1)
Control No.: 20682
Structure No. C0077 20430
TSA Project No. 316907
April 5, 1995

This addendum consists of 14 items which are revisions to the special provisions.

Item No. 1
On page 2 under High Performance (HP) Concrete for Use in Precast Prestressed Girders, the second sentence of the first paragraph shall be revised to read as follows:

> Concrete for use in precast prestressed girders shall be HP concrete and shall comply with the 1985 Standard Specifications and Supplemental Specifications except as amended by these Special Provisions.

Item No. 2
On page 3 under Subsection 707.04, paragraph 6.d, item "a" should read as follows:

> a.) 56-day compressive strength (ASTM C39), based upon a minimum of sixty (60) 4"x8" cylinders;

Item No. 3
On page 4, under Subsection 707.09, the second sentence of paragraph 4 shall be revised to read as follows:

> During casting of HP concrete girders, the fabricator shall make concrete cylinders to establish the compressive strength at release and at 7, 28, and 56 days.

Item No. 4
On page 4, under Subsection 707.09, paragraph 4, item "d", revise the last three sentences to read as follows:

> A minimum of four 4"x8" cylinders shall be made from each load of concrete placed. No fewer than eight 4"x8" cylinders shall be made for any one day. One 4"x8" cylinder from each load or a minimum of two (2) cylinders shall be tested at release and at 7, 28, and 56 days.

Item No. 5
On page 5 under High Performance (HP) Concrete for Bridge Deck, the second sentence of the first paragraph shall be revised to read as follows:

> Concrete for use in bridge deck, curb, and median shall be HP concrete and shall comply with the 1985 Standard Specifications and Supplemental Specifications except as amended by these Special Provisions.

Item No. 6
On page 5 under High Performance (HP) Concrete for Bridge Deck, item "a" should read as follows:

> a.) 56-day compressive strength (ASTM C39), based

upon a minimum of sixty (60) 4"x8" cylinders;

Item No. 7
At the top of page 7, omit the words "High Density Low Slump" from the first item. The item should read, "Coarse Aggregate for Concrete . . . 1006 & 1015".

Item No. 8
On page 9, delete paragraph 2 in its entirety.

Item No. 9
On page 9, the following two revisions should be made to paragraph 3. The first sentence of paragraph 3 should be revised to read as follows:

> Placement of concrete shall be in accordance with State of Nebraska 1985 Standard Specifications and Supplemental Specifications for Highway Construction.

The fifth sentence of paragraph 3 which reads, "The forward speed . . . uninterrupted as possible." should be deleted.

Item No. 10
On page 9, delete paragraph 4 in its entirety including subparagraphs "a" and "b".

Item No. 11
On page 9, under paragraph 5, change the reference from "Subsection 711.06, Paragraph 4" to "Subsection 708.03, Paragraph 7".

Item No. 12
On page 10, delete paragraph 1 in its entirety.

Item No. 13
On page 10 under Limitations of Operations, paragraph 5 should be deleted and replaced by the following:

> 5. Sampling of fresh concrete will be the responsibility of the owner's inspector. During placement of HP concrete in the bridge deck, the owner's inspector will make concrete cylinders to establish compressive strength at 3, 7, 28, and 56 days. Eight 6"x12" and eight 4"x8" cylinders will be made for each 100 cubic yards or portion thereof placed. The first set of cylinders will be taken near the start of placement at the discretion of the owner's inspector. Two 4"x8" and two 6"x12" cylinders from each 100 cubic yards or portion thereof will be tested at 3, 7, 28, and 56 days. Acceptance at 56 days will be based upon the average strength of all 4"x8" cylinders provided no cylinder is greater than 5.00% below required strength.

Item No. 14
On page 11, delete the first paragraph beginning with "Method of Measurement and Basis of Payment" in its entirety including subparagraph 1.

ADDENDUM NO. 2

to the Bidding Documents for
Giles Road HPC Bridge in Sarpy County
Project No. RS-BRS-STP-TMT-3790(1)
Control No.: 20682
Structure No. C0077 20430
TSA Project No. 316907
April 18, 1995

This addendum consists of 5 items which are revisions or additions to the special provisions.

Item No. 1
On page 2 of Addendum No. 1 under Subsection 707.04, paragraph 6.d should read as follows:

> 6.d. The manufacturer is responsible to submit the mix design for the high performance concrete to the Nebraska Department of Roads Materials and Tests Division. The Nebraska Department of Roads and researchers from the Center for Infrastructure Research will review the submittal and provide comments to the contractor. This submittal will not form a basis for acceptance or rejection of the mix design. The mix design shall be submitted no less than 30 days prior to casting the girders and in sufficient detail to be reproducible in the laboratory. Both the proportion and source of the components shall be provided. No proprietary mixes will be accepted. The mix design shall be submitted with the following test results:

Note that items a) through h) should follow with no correction.

Item No. 2
On page 4 of Addendum No. 1, subparagraph 4.d.(2) should be revised to read as follows:

> (2) Acceptance at release and 56 days shall be based upon the average of one days pour provided no single cylinder is greater than 5.00% below the required strength and the average compressive strength is greater than or equal to the sum of the required strength and 1.34 times the standard deviation.

Item No. 3
On page 8 of Addendum No. 1 under Limitation of Operations, the last sentence of subparagraph 4 should be revised to read as follows:

> Acceptance at 56 days shall be based upon the average strength of all 4'x8" cylinders provided no single cylinder is greater than 5.00% below the required strength and the average compressive strength is greater than or equal to the sum of the required strength and 1.34 times the standard deviation.

Item No. 4
The following new item should be added to the Special Provisions:

> AGE OF GIRDERS AT INSTALLATION
>
> As specified in the contract documents, the prestressed concrete girders shall be 30 days old before they are installed on the bridge substructure. The word "installed" shall mean the time at which the girders are cast into the concrete diaphragms over the abutments or piers.

Item No. 5
The following new item should be added to the Special Provisions:

ALTERNATE CONCRETE TEST RESULTS

1. The contractor may, at his option, submit 28 day test results for the compressive strength of the HP concrete provided the 28 day compressive strength is equal to or greater than 95% of the required 56 day compressive strength. Determination of the compressive strength shall be as defined in the special provisions. Such 28 day compressive strength results will be accepted in lieu of 56 day compressive strength results in all cases referred to in these special provisions for the HP concrete.

2. The contractor may, at his option, submit 28 day test results for the chloride permeability for the HP concrete for the bridge deck provided the chloride permeability at 28 days is less than 1,900 coulombs. Such 28 day test results will be acceptable in lieu of the 56 day test results.