

**CITY OF FARGO SPECIFICATIONS
CONCRETE PAVING AND CURBS & GUTTERS**

**PART 1
DESCRIPTION OF WORK**

The work to be done under this section of the Specifications and the accompanying plans consists of furnishing all labor, material, accessories, and plant necessary to complete the concrete curb and gutter and/or concrete paving of certain streets, avenues or alleys in the City of Fargo.

This section includes excavation, filling, and subgrade preparation in accordance with Section 2000 Excavation, Filling, and Subgrade Preparation and aggregate bases in accordance with Section 2070 Aggregate Bases. This section shall also include the furnishing and placing reinforcing steel, dowels, curb and gutter, valley gutters, furnishing and setting headers, constructing the type of paving designated, setting castings or valve boxes to grade, and all other work as may be necessary to properly complete the work in accordance with these Specifications and the accompanying plans.

PART 2 MATERIALS

2.1. CEMENTITIOUS

2.1.1. PORTLAND CEMENT

Cement shall meet the current specifications of one of the following ASTM's.

- ASTM C 150 Standard Specification for Portland Cement
- ASTM C 595 Standard Specification for Blended Hydraulic Cements
- ASTM C 1157 Standard Performance Specification for Hydraulic Cement

Different brands of cement, or the same brand of cement from different mills, shall not be mixed during use without approval of the Engineer. Cement shall be stored in a suitable manner to prevent moisture damage; cement which is partially set or which contains lumps or cakes shall be rejected. Cements shall meet the following requirements unless written approval is provided by the Engineer.

Specification	ASTM C 150	ASTM C 595*	ASTM C 1157
Requirement	Types I or II	Types GU, MS and HS	Types GU, MS or HS

* Slag cement and fly ash content shall be a maximum of 30% and a maximum total replacement of 40% with ternary cementitious mixtures.

All mixes shall include a maximum of 620 lbs. total cementitious content including fly ash or slag cement. At least 20% of the total cementitious content, by mass, shall be fly ash or slag cement. When approved by the Engineer, the fly ash and slag cement content may be reduced to 15%, by mass, between October 15 and April 15.

2.1.2. FLY ASH

Fly ash shall meet the requirements of ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete. Fly Ash will be allowed as a cement replacement on a 1:1 ratio, by mass, up to a maximum of 30%.

2.1.3. SLAG CEMENT

Slag cement shall meet the requirements of ASTM C 989 Standard Specification for Slag Cement for Use in Concrete and Mortars. For machine placed concrete with slumps less than 1.5 inches, slag cement will be allowed as a cement replacement on a 1:1 ratio, by

mass, up to a maximum of 40%. For all other concrete mixtures, slag cement will be allowed as a cement replacement on a 1:1 ratio, by mass, up to a maximum of 30%.

2.2. AGGREGATES

Aggregates for all concrete mixes shall be provided with gradations considered well-graded by specification as determined by the most current NDDOT Standard Specifications for Road and Bridge Construction for Well-Graded Aggregates for concrete. Optimization techniques will be used to prepare the final aggregate gradations for workability and coarseness factor considerations.

2.2.1. DELETERIOUS REACTIONS

A. Alkali Silica Potential

Aggregate data shall be provided for all aggregates to be used in the concrete mixture to mitigate the risk of Alkali Silica Reaction (ASR) occurring in the concrete. One or more of the following methods shall be submitted for review by the Engineer.

- i. Field history of the aggregate. This data shall represent at least 10 years of performance with similar cementitious materials and exposure.
- ii. ASTM C 1260 Standard Test Method for Potential Alkali Aggregate Reactivity (Mortar-Bar Method). This method shall be conducted with each aggregate separately to determine the potential reactivity. The maximum expansion shall be 0.1 percent. This data shall be current within 1 year from time of submittal.
- iii. ASTM C 1567 Standard Test Method for Determining the Potential Alkali Aggregate Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method). Fly Ash, Slag Cement, Silica fume or Lithium may be used to mitigate potential ASR. This method shall be conducted with each aggregate separately to determine the potential reactivity. The maximum expansion shall be 0.1 percent. This data shall be current within 1 year from time of submittal.
- iv. ASTM C 1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction. This method shall be conducted with each aggregate separately to determine the potential reactivity. The maximum expansion shall be 0.04 percent. This data shall be current within 3 years from time of submittal. If supplementary cementitious materials are used in this testing for the mitigation of ASR the result must be less than 0.04 percent at 2 years.

- v. ASTM C 295 Standard Guide for Petrographic Examination of Aggregates for Concrete. Petrographic analysis must indicate there is no risk of ASR occurring with the aggregate to be used in the mixture.
- vi. Limit the alkali content in the concrete to no more than 3 lbs per cubic yard Na_2O equivalent.

2.2.2. AGGREGATE MATERIAL PROPERTIES

Fine Aggregate properties shall meet the requirements of Section 802 of the most current NDDOT Standard Specifications for Road and Bridge Construction with exceptions, the maximum limits of lightweight pieces of aggregate shall not exceed 1%.

Coarse aggregate properties shall meet the requirements of Section 802 of the most current NDDOT Standard Specifications for Road and Bridge Construction with exceptions, the maximum percent weight of the plus No. 4 fraction of Shale shall not exceed 0.5%.

2.3. WATER

Water shall meet ASTM C 1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete or be potable.

2.4. ADMIXTURES

All admixtures shall be non-chloride and shall not have chlorides added during the manufacturing process.

2.4.1. AIR ENTRAINMENT

An air entrainment admixture shall meet ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete.

2.4.2. WATER-REDUCING ADMIXTURES

If water-reducing admixtures are utilized in the concrete mixture they shall meet the requirements of ASTM C 494 Standard Specification for Chemical Admixtures.

2.4.3. OTHER ADMIXTURES

No other admixture shall be used unless approved by the Engineer.

2.5. PROPORTIONS

Concrete shall be proportioned to meet the following properties:

Concrete Properties	Requirement
Compressive Strength at 28 days of age	4500 psi (minimum)
Water-to-Cementitious Ratio	0.40 maximum for all slip-form paving mix 0.42 maximum for all other placed mix
Air Content	* 5% to 8% target range by volume at placement
Slump	Maximum 4 inches

* For slip-form paving, the frequency of air contents will be tested at discretion of the Engineer from in-place concrete behind the paver to measure potential air loss after consolidation. The air content target range may be adjusted by the Engineer based on the test results. Engineer may test for potential air loss during other handling and consolidation operations and likewise make adjustments to the air content target range. The Contractor shall make a reasonable effort to work toward the mid-range value of the determined target air content range.

Aggregate gradation shall be optimized as such that the workability and coarseness factor plots inside the box in the figure below. Workability and coarseness factors are calculated as follows:

$$\text{Coarseness Factor} = \frac{\text{Cumulative Percent Retained on the } \frac{3}{8} \text{ Sieve}}{\text{Cumulative Percent on the No. 8 Sieve}} * 100$$

$$\text{Workability Factor} = \text{Percent Passing No. 8} + \frac{2.5 * (\text{Cementitious Content} - 564)}{94} * 100$$

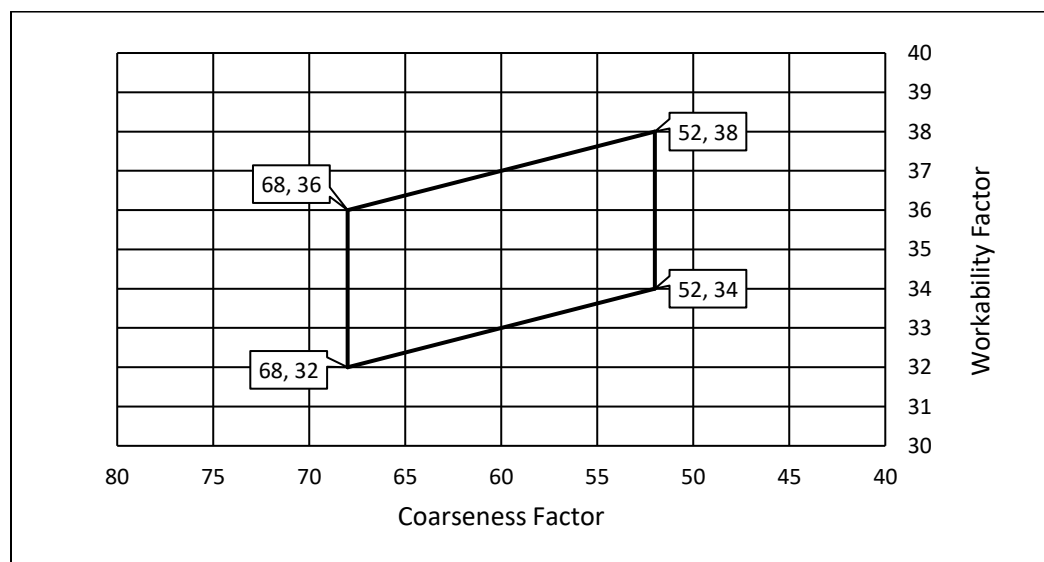


Figure 2.5.1 Coarseness and Workability

2.6. FAST-TRACK CONCRETE

When fast-track concrete mixes are specified, or upon request by the Contractor, the Contractor shall submit a concrete mix design for review and approval. The mixture shall meet the requirements in Section 2.5. Proportions, except the in-situ minimum compressive strength shall be 3,000 psi at 30 hours. The compressive strength of the placement can be measured by ASTM C 873 Standard Test Method for Compressive Strength of Concrete Cylinder Cast in Place in Cylindrical Molds and field cured.

Fast-track concrete mixes shall have optimized well-graded aggregate and shall include a maximum of 620 lbs. total cementitious content including fly ash or slag cement, at a minimum of 20% cement replacement, by mass. Non-chloride accelerators may be used for early strength, and may use hydration stabilizers to preserve workability en-route to the project.

At no time may concrete exceed 150°F in temperature while under blankets or other protection devices, nor fall below 60°F during the 30 hour period. The surface temperature shall be regulated to a gradual drop of no more than 50 degrees in a 24 hour period.

Contractor shall provide an environment to ensure that mixes will attain a field strength of 3000 psi compressive strength in 30 hours.

2.7. PLANT CERTIFICATION

All plants supplying concrete shall be certified by an approved plant certification program by the National Ready Mix Concrete Association, MNDOT or NDDOT (in the current construction season).

2.8. MIXING

Use of ready-mixed concrete shall meet all applicable requirements of ASTM C 94 Standard Specification for Ready-Mix Concrete with exceptions as noted in the plans and these Standard Specifications. The size of the batch shall not exceed the manufacturer's rated capacity as shown on a metal rating plate that shall be attached in a prominent place on the truck mixer. When mixing, the drum shall rotate at a mixing speed for not less than 70-100 revolutions. All concrete hauling equipment shall be operated to deliver and discharge the required concrete mixture completely without segregation. The drum shall be completely emptied before receiving the material for the succeeding batch.

Batch mix or job-site mixed concrete shall be mixed in a rotary batch mixer of a type acceptable to the Engineer and shall meet all requirements as specified in Section 155 of the most current NDDOT Standard Specifications for Road and Bridge Construction of Concrete Equipment. The volume of

the mixed material for each batch shall not exceed the manufacturers rated capacity of the mixer. The batch material shall be delivered to the mixer accurately measured to the desired proportions and shall be continuously mixed for not less than 90 seconds after all materials including water are in the mixer, during which time the mixer shall rotate at the speed recommended by its manufacturer.

Mix temperatures between batching and placement shall be maintained between 50°F and 90°F.

2.8.1. AGITATING TRUCK TIME LIMITATIONS

The concrete transported in an agitating truck shall be completely discharged within 90 minutes after the introduction of the mixing water to the dry materials when ambient temperatures are less than or equal to 80°F. This time is reduced to 60 minutes when temperatures exceed 80°F.

2.8.2. NON-AGITATING TRUCK TIME LIMITATIONS

The concrete transported in a non-agitating truck shall be completely discharged within 45 minutes after the introduction of the mixing water to the dry materials when ambient temperatures are less than or equal to 80°F. This time is reduced to 30 minutes when temperatures exceed 80°F.

2.9. FIELD ADJUSTMENTS TO MIXED CONCRETE

The table below illustrates potential field adjustments the Contractor may administer in the field under authorization of the Engineer before truck discharging occurs. The Engineer will test each subsequent load of concrete to determine the concrete is within the specified limits. Placement of concrete will not be allowed until the Engineer has determined the concrete is within the limits. If two consecutive tests fail, the load will be rejected. The Engineer reserves the right to reject any loads not meeting specified limits.

Problem	Resolution	Specified Limits
Slump too low	* Contractor may “add water” one time prior to start of concrete discharge from the truck (water to be added before testing).	Not to exceed 4” slump
Slump too high	If first test fails, immediately re-test a new concrete sample from same truck. If 2 nd test fails, reject load.	Not to exceed 4” slump

Problem	Resolution	Specified Limits
Air too high	If first test fails, immediately re-test a new concrete sample from same truck. If 2 nd test fails, reject load.	** Between 5% and 8%
Air too low	* If first test fails, Contractor may perform <u>one</u> adjustment by adding air entrainment to load. Obtain new sample from adjusted concrete and test. If the sample of adjusted concrete fails, immediately re-test a new concrete sample from same truck. If 2 nd test of the adjusted concrete fails, reject load.	** Between 5% and 8%

*Only one adjustment per load allowed. After adjustment, mixing must consist of at least 30 revolutions at mixing speed.

** See Section 2.5. Proportions.

2.10. EPOXY RESIN ADHESIVE

Epoxy resin shall meet or exceed the requirements of AASHTO M 235 Type IV, Grade III.

2.11. REINFORCEMENT STEEL, DOWEL BARS, AND TIE BARS

All material delivered to project site shall be tagged with a metal or plastic tag showing the manufacturer's heat number. Place the heat numbers on the tag in one of the following manners:

- Embossed numbers;
- Printed using waterproof ink; or
- Engraved numbers.

2.11.1. PLAIN SMOOTH AND DEFORMED STEEL BARS

Plain smooth or deformed steel bars shall be Grade 60, conforming to AASHTO M 31. Grade 60 tie bars shall not be bent or re-straightened during construction. Tie bars designated as Grade 40 conforming to AASHTO M 31 shall be used for construction requiring bent bars.

All tie bars shall be coated on all surfaces lengthwise with epoxy coating conforming to the requirements of ASTM A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars. Exposed ends resulting from saw cutting or shearing do not need to be coated.

2.11.2. DOWEL BARS

Dowel bars shall be smooth steel bars conforming to AASHTO M 31 or M 322 and shall be clean, straight, and free of loose material. Dowel bar deviation from true shape shall not exceed 0.04 inch in diameter of the dowel and shall not extend more than 0.04 inch from the end of the dowel. Before delivery to the construction site, steel dowel bars shall be coated on all surfaces lengthwise with epoxy coating conforming to the requirements of ASTM A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars with a minimum thickness of 8 mils. Exposed ends resulting from saw cutting or shearing do not need to be coated.

Dowel basket assemblies shall provide rigid support to prevent dowels from becoming misaligned during paving operations. Dowel bars shall have a uniform coat of Tectyl 506 applied by the manufacturer, field applied NLGI Grade #2 multipurpose lithium grease, or an approved equal that has been applied to the full length of the dowel bars.

All epoxy coated bars shall be protected from the sun's rays with tarps or other means if they are to be subjected to the sun's rays for more than 120 days. Exposure for periods longer than 120 days will result in the product being rejected from use. Bars carried over as excess from previous year's construction shall not be used on any project unless documentation of protection from the sun is provided to the Engineer. Bars showing rust through the coating shall be rejected for use.

*2.12. JOINT MATERIAL**2.12.1. EXPANSION/ISOLATION JOINTS*

Expansion/isolation joint material shall be made of rubber material and conform to the requirements of ASTM D 1752 Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction. The joint material shall be Reflex® Rubber Expansion or approved equal.

2.12.2. HOT POURED JOINT SEALANT

The material for sealing all expansion and concrete joints shall be hot poured elastic type and shall conform to the requirements of ASTM D 6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements, Type I. The material shall be composed of a homogeneous blend of virgin polymers, plasticizers, special fillers and asphalt cement specifically for sealing concrete pavement joints. The asphalt cement shall meet the requirements of AASHTO M 226. Meadows Safe-Seal 3405 is an approved substitute for the hot pour material.

2.12.3. SILICONE JOINT SEALANT

When silicone joint sealant is specified, the sealant shall be a Low Modulus Silicone Sealant meeting the requirements ASTM D 5893 Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

2.12.4. BACKER ROD

Backer Rod shall conform to the requirements of ASTM D 5249 Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints, Type 1 or Type 3.

2.13. CURING & SEALING COMPOUNDS

All curing compounds shall be applied in accordance with the manufacturer's recommendations.

2.13.1. ALL CONCRETE PAVING (INCLUDING ALLEY PAVING AND CURB & GUTTER SECTIONS)

White pigmented, liquid curing compound, conforming to the requirements of ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete Type 2, Class B with 100 percent poly-alpha-methylstyrene resin.

2.13.2. COLORED CONCRETE PAVEMENT

Transparent, non-yellowing, acrylic-based liquid curing & sealing compound, conforming to the requirements of ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete Type 1, Class A or B.

2.14. SUBMITTALS

At the Engineer's discretion, the Contractor may be required to submit representative samples of the materials he proposes to use prior to the delivery of the materials to the site of the work. On all projects, the Contractor shall provide the following to the Engineer at least 7 days prior to commencing any concrete placement or paving operations.

*2.14.1. REQUIRED SUBMITTALS**A. Project Concrete Mix Design*

Mix designs, including the per yard quantity of each material and the following information:

- i. Cement Mill Certificate
- ii. Fly Ash Mill Certificate
- iii. Slag Cement Mill Certificate
- iv. Aggregate sources including:
 - a. Gradations
 - b. Physical test results
 - c. Absorption and specific gravity
 - d. Deleterious reaction results
- v. Admixtures to be used and technical data sheets

B. Hot Weather Plan

C. Cold Weather Plan

D. Concrete Curing Plan

The concrete curing plan shall include the following information;

- i. An original certificate of compliance, project number, name of contractor, and name of the manufacturer and type of curing compound
- ii. The trade name of the curing compound
- iii. Statement that curing compounds meet all requirements of the Specifications
- iv. Equipment and methods used for applying curing compounds

E. Joint Sealant Certificate of Compliance

The type of backer rod shall be shown, along with an original certificate of compliance showing the following information for each type of joint sealant to be used on a project, as applicable:

- i. Project number and name of Contractor
- ii. Name of the manufacturer and type of joint sealant
- iii. The manufacturer's batch and lot number
- iv. The trade name of the material
- v. The weight, pouring temperature, and safe heating temperature
- vi. Statement that materials meet all requirements of the Specifications

F. Reinforcing Steel, Dowel Bars, and Tie Bars

Certified Mill Analysis from the Manufacturer shall include the following information:

- i. Producer name and address
- ii. Type and grade of reinforcement or dowel bar
- iii. Heat number
- iv. Authorized signature of person responsible for Quality Control
- v. List all chemical and physical test results
- vi. Date and location where steel was melted
- vii. Date reinforcement or dowel bars were rolled
- viii. Date document printed

PART 3

CONSTRUCTION

3.1. EXCAVATION, SUBGRADE PREPARATION, AND AGGREGATE BASES

Excavation and subgrade preparation shall meet the requirements of Section 2000 Excavation, Filling, and Subgrade Preparation and aggregate base shall meet the requirements of Section 2070 Aggregate Bases.

Aggregate base shall be fine graded to the shape and grade shown on the plans, allowing construction of the pavement to the thickness and cross section shown on the plans.

Aggregate base shall be smooth, uniformly compacted and proof rolled tested before placing steel and concrete.

3.2. CONTRACTOR FLATWORK CERTIFICATION

The Contractor(s) performing concrete work, are required to have at least two employees with a current ACI concrete flatwork technician or flatwork finisher certification, and at least one of those employees must be onsite performing quality control and guidance during all concrete forming, placement of reinforcement steel, dowel bars, and tie bars, pouring, finishing, and curing operations.

3.3. PLACING REINFORCING STEEL

All reinforcing steel shall be kept clean, free of rust, scale, and foreign material which would impair the bond between the steel and concrete. Contractor shall establish all reinforcing steel locations as shown on jointing and reinforcing layout in the plans. All reinforcing shall be set and secured in place a minimum two hours in advance of the concrete placing operation to allow the Engineer to inspect. Placement of reinforcing during and directly in front of paving operation will not be allowed unless approved by Engineer.

Reinforcing shall be overlapped a minimum of 20 inches and tied securely in place at all points where the bars cross. Reinforcing shall be positioned on supports of a design and material approved by the Engineer and of sufficient strength to hold the bars in place while the concrete is being placed.

Reinforcing shall be placed mid-depth of concrete thickness at dimensions shown on the reinforcing steel detail.

3.4. PLACING CONCRETE

Prior to setting forms or placing concrete, the base material shall be accepted by the Engineer for concrete placement. The base material shall be satisfactorily graded to within a tolerance of $\pm 0.02'$ (1/4") of final grade. The base material shall be smooth, uniformly compacted, clean and free from debris, ruts, waste concrete, frost, ice, and standing water. Concrete shall not be placed on frozen base material.

Manhole castings shall be installed with the paving operation or installed with each adjoining full concrete panel. Manhole isolation or box outs will not be allowed.

Use of tongue and groove configurations (keyway) between abutting slabs will not be allowed.

Curb & gutter shall be poured separate from adjacent concrete pavement.

All concrete pavement and curb and gutter shall be placed by slip-form operation. Fixed forms may be used in irregular areas, intersections, tapers, alleys, roundabouts, areas inaccessible to slip-form equipment or other areas approved by Engineer.

Trucks hauling concrete shall not drive over reinforcing bars or over previously deposited concrete.

Concrete placement shall be suspended when any equipment is leaking oil in a manner which allows the oil to contaminate the fresh concrete mixture. Contaminated concrete shall be removed at the Contractor's expense.

When concrete pumping is utilized, the truck booms shall be configured to minimize the free fall of concrete at the point of discharge to minimize segregation and the loss of air and slump.

Immediately prior to placing the concrete, the aggregate base shall be uniformly moistened with water and kept moistened during the duration of concrete placement. The concrete shall be placed so segregation and unnecessary re-handling is avoided. The mixed concrete shall be deposited on the aggregate base to the required depth and for a width not exceeding the direct reach of the mixer boom, in successive batches and in a continuous operation without the use of intermediate forms or bulkheads between joints.

If concrete placement is temporarily interrupted, with an elapsed time between placement loads of concrete greater than 45 minutes, a transverse construction joint shall be installed. This timeframe may be decreased if there is potential for a cold joint when adverse conditions are encountered such as in hot weather. While being placed, the concrete shall be uniformly vibrated so that the formation of a cold joint, voids, and/or honeycombing is prevented.

The Engineer reserves the right to halt any concrete placement if, in the judgement of the Engineer, the Contractor has failed to comply with any portion of the plans or these Standard Specifications.

3.4.1. COLD WEATHER POURING

A cold weather plan shall be submitted by the Contractor to the Engineer for approval. If the ambient temperature during placement or curing is predicted to fall below 40°F, the cold weather concrete plan shall be followed. The plan shall at a minimum include the following:

- Method for delivering concrete at a temperature above 55°F
- Method for protecting and measuring base temperature
- Method for measuring in-situ concrete temperature
- Method for maintaining concrete temperature above 50°F until concrete attains a compressive strength of 3000 psi.

Concrete placement shall not occur if the ambient temperature during placement is less than 30°F or the temperature of the base material is greater than 20°F below the plastic concrete temperature.

Calcium chloride, chemicals, or other materials may not be added to the concrete mix to prevent freezing. Concrete shall not be placed on a frozen base or subgrade. Use of combustion heaters shall be vented away from poured concrete. Any concrete damaged from cold weather shall be removed and replaced at Contractor's expense.

3.4.2. PROTECTING CONCRETE FROM RAIN DAMAGE

The Contractor shall not place concrete when rain conditions appear imminent. The Contractor shall possess, on the project site, sufficient waterproof material, and the means to rapidly place it, to cover all unhardened concrete surface or any other concrete surface that may be damaged by rain. Concrete shall not be placed during rain that results in any standing water on the surface of the fresh concrete surface.

Rain-damaged concrete shall be cored as directed by the Engineer and depth of damage determined by petrographic examination. When the depth of damage is 1/4 inch or less of the pavement thickness, if applicable, the damaged areas may be corrected by diamond grinding. Diamond grinding requirements are detailed in Section 2900 Pavement Milling or Grinding. Coring for petrographic examination, diamond grinding, and any other related activities shall be at the Contractor's expense. Engineer reserves right to reject any rain-damaged concrete.

If depth of damage is greater than 1/4 inch, the slab shall be considered defective and replaced at the Contractor's expense.

3.5. SLIP-FORM EQUIPMENT AND CONSTRUCTION

3.5.1. GENERAL

All equipment shall be self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement or curb section to grade, required thickness and cross-section in one complete pass without the use of side forms. The slip-form equipment shall vibrate or tamp the concrete for the full width and depth of the layer being placed. Equipment shall leave the pavement vertical edges square shaped, free of slumping and irregularities. The concrete shall be uniformly consolidated throughout its width and depth, free from honeycombed areas, tearing, and have a consistent void-free closed surface. If needed in isolated areas, the Contractor shall tool pavement edges to a 1/4 inch radius ensuring that edges are smooth and true to line. Operation of slip-form equipment shall be a continuous forward movement coordinating all operations of mixing, providing adequate concrete hauling, and spreading concrete to provide uniform progress with minimal stopping and starting of the equipment.

Track propelled equipment should be equipped with rubber protective pads on the crawler tracks, or the tracks shall travel on cushions of wood or belting.

Contractor shall use a tightly stretched string line to achieve the line and grade reference for operating the automatic equipment controls for base trimming, slip-form paving, and curbing operations. The string line shall be supported at intervals to maintain the established grade, vertical curves, and alignment shown in plans. Where specific vertical curves are not provided in the plans, the Contractor shall make reasonable effort, under guidance from the Engineer, to add vertical curvatures at all differing tangent grades.

3.5.2. SLIP-FORM PAVING

A. GENERAL

Unless otherwise allowed for in the plans, or approved by the Engineer, the use of Automated Machine Guidance (Stringless paving) will not be allowed.

The Contractor may, under discretion of Engineer, use a dampened burlap to be attached behind the slip-form paver. Dampening of this drag material will be accomplished through a uniform, fogging spray pattern. The addition of water to the

drag shall not produce unsatisfactory conditions such as puddling, dripping, or excessive slurry on the surface.

B. CONSOLIDATION VIBRATOR OPERATION

Operate internal vibrators within a frequency range of 4,000 to 8,000 vibrations per minute.

Operate surface vibrators within a frequency range of 3,500 to 6,000 vibrations per minute.

Reduce vibrator frequency when forward motion of the paver is reduced and stop vibrators when forward motion of the paver is stopped.

Contractor shall provide an electronic monitoring device meeting the following characteristics and requirements to display the operating frequency of each individual internal vibrator for concrete pavement placed by the slipform method:

- i. Contains a readout display near the operator's controls; visible to the paver operator and to the Engineer,
- ii. Operates continuously as the paving machine operates,
- iii. Displays all the vibrator frequencies with manual and automatic sequencing for each of the individual vibrators, and
- iv. Records the following at least every 25 foot of paving or at least every 5 min of time:
 - a. Clock time,
 - b. Station location,
 - c. Paver track speed, and
 - d. Operating frequency of individual vibrators, expressed as VPM.

Do not delete the data from the vibratory monitoring system until the records are in their final form and given to the Engineer. Contractor shall provide an electronic copy containing the daily record of data after each concrete paving operation or as directed by Engineer.

Provide a written explanation each week that details:

- i. Vibrator setting changes
- ii. Out of tolerance vibratory operations
- iii. Monitoring device malfunctions.

3.5.3. *SLIP-FORM CURBING*

A. AUTOMATED MACHINE GUIDANCE (AMG)

When acceptable by the Engineer, Automated Machine Guidance (AMG) operations may be an option in lieu of using string line to slip-form curb and gutter sections.

The Contractor shall submit an AMG operation plan containing the following items to the Engineer, for approval, a minimum 14 days prior to slip-form curbing. At a minimum, the following items must be included in an AMG operation plan:

- i. Locations on the project where AMG will be utilized.
- ii. The vertical and horizontal accuracies of the AMG.
- iii. The Contractor's past performance with AMG. This shall include project locations, the amount of curbing installed, and Owner and/or Engineer references that the City may contact.
- iv. The equipment manufacturer and type of equipment that would be used to operate the AMG system.

Contractor's Liability:

The Contractor is solely responsible and assumes all liability for the creation of the Contractor's model. The Contractor must verify the model reflects the plans, contract documents, and field conditions. Subsequently, any concerns relative to the design must be brought to the attention of the Engineer and resolved prior to the commencement of any AMG operations. The Contractor shall be responsible for all errors resulting from the use of AMG and shall correct deficiencies to the satisfaction of the Engineer at the Contractor's own expense. In the event that a design change is required, warranting a plan revision by the Engineer, the Contractor will be responsible for updating the Contractor's model at the Contractor's own expense. The Contractor shall provide and use a GPS rover unit to perform quality assurance checks during all AMG operations. AMG equipment shall accurately and efficiently complete construction activities to a tolerance of +/- 0.02 (1/4") foot vertically and +/- 0.04 (1/2") horizontally.

City's Involvement:

Upon request by the Contractor, the City will provide 2D line work representing the curb line (face of curb) alignment. The data can be provided in either .dwg or .dxf format and will be released to the Contractor upon receipt of a completed Hold Harmless Agreement. It will be the responsibility of the Contractor to further develop the data provided by the City into a format compatible with their AMG application.

Operation of AMG equipment shall not be considered a replacement for survey construction staking completed by the City. Upon request by the Contractor, the City will provide a network of control points with labeled X, Y, Z values. In addition, the City will provide conventional staking of finish grade at critical points, or as needed, for quality assurance. These stakes shall remain in place until completion of all curb and gutter installation unless otherwise allowed by the Engineer. The Contractor shall be responsible for verifying the control points and performing continuous quality assurance checks with conventional staking alignments and elevations to ensure accuracy of AMG operations.

3.6. FIXED FORM EQUIPMENT AND CONSTRUCTION

Forms shall be metal, made of shaped steel, with sections that interlock and are at least 10 feet in length. In special cases, such as irregular shapes and short sections, wood forms shall be permitted. The forms shall be of the same thickness as the concrete to be placed against them and shall have a base width of at least $\frac{2}{3}$ their height. They shall have at least 3 stake pockets for every 10 feet of length and the bracing and support must be able to withstand the pressure of the concrete and weight and thrust of the machinery operating on the forms. Forms shall be mortar and dirt free and shall be checked with a 10-foot straightedge and any variation in excess of $\frac{1}{8}$ inch shall be corrected or forms shall be rejected by the Engineer. Forms shall be set upon the compacted aggregate base to exact line and grade a minimum two hours in advance of the concrete placing operation to allow the Engineer to inspect. A form release agent shall be used on all metal forms before depositing the concrete against them.

Approved flexible or curved forms of proper radius shall be used on curves having a radius 150 feet or less. Straight forms longer than 10 feet shall not be used on any curved line unless approved by the Engineer.

If the pavement is being placed adjacent to previously finished pavement or curb and gutter, such finished pavement or curb and gutter may serve as a side form if approved by the Engineer.

Concrete finishing machines shall be adjustable to the specified crown and elevation. The forms shall be filled and concrete brought to the established grade. The machines shall be capable of striking-off, consolidating, and finishing the concrete. Consolidation shall either be done by the same machine, or if Engineer allows, in a separate operation by hand-operated single spud internal vibrators capable of consolidating concrete pavement adjacent to forms, joints, or fixtures. The hand operated vibrator shall produce a minimum of 3600 impulses per minute. Concrete shall be uniformly consolidated with no segregation, honeycombing, or voids. The screed shall extend the full width of the slab. Roller screeds will be allowed if there is no visible deflection or bounce of

the tube. Contractor shall straightedge the tube for variations prior to using. All finishing equipment shall be kept in good repair and their use subject to the approval of the Engineer.

3.7. AUXILIARY FINISHING EQUIPMENT

The Contractor shall provide the following auxiliary equipment:

- Footbridge (when applicable): A footbridge shall be provided and so designed that it can be readily transported from place to place and span the width of the slab.
- Straight Edge: A minimum (10) foot straight edge of an approved type shall be used. Extra blades shall be provided and used when previously used edges become wavy and warped.
- Floats: Approved long-handled floats, each having a blade at least 3 feet in length and 6 inches in width.
- Master Straight-Edge: All straight edges shall be tested by the master straightedge before use and frequently during their use.
- Brooms: Brooms shall be of an approved push type not less than 18 inches wide and made from good quality bass or bassine fiber not more than five (5) inches in length. The handle shall be at least one foot longer than one-half the pavement width and shall be readily adjustable.

All hand finishing tools shall be constructed of aluminum, magnesium, or wood. Use of steel hand finishing tools will not be allowed.

3.8. JOINTS AND SAWING

3.8.1. GENERAL

Joints in concrete pavement shall be constructed at the spacing and locations shown on jointing and reinforcing layout in the plans. Where a specific jointing and reinforcing layout is not provided, jointing shall be constructed per typical details. Under guidance from the Engineer, the Contractor shall be responsible for establishing all joint, dowel, and tie bar locations. The location of each joint shall be marked in a manner satisfactory to the Engineer prior to placement of the concrete and the markings shall be transferred to the fresh concrete as soon as the final finishing operations have been completed. The use of marking by spray paint will not be allowed.

3.8.2. TRANSVERSE CONTRACTION JOINTS

Transverse contraction joints shall extend across the entire width of paving and through curb and gutter adjacent to pavement. When the pavement abuts existing pavement,

driveways, or curb and gutter, if applicable, the transverse joints shall be placed in locations matching existing joints.

When specified, contraction joints shall include dowel bars as shown in the transverse contraction joints detail. Dowel bars shall be secured and held in position by basket assemblies in transverse contraction joints to within placement tolerances listed below. Dowel bar assemblies shall be secured with approved anchors to hold the dowel bars in the correct position and alignment while preventing movement during concrete placement. Dowels shall be painted or coated with an approved bond breaker. All dowel bar basket assemblies shall be set and secured in place a minimum two hours in advance of the concrete placing operation to allow the Engineer the ability to inspect. Placement of dowel bars during and directly in front of paving operation will not be allowed unless approved by Engineer.

Dowel Bar Placement Tolerances:

- Alignment placement: Within 1/8 inch in both the horizontal and vertical planes.
- Longitudinal shift: 1/2 inch.
- Vertical placement: Placed at midpoint of slab.
- Do not use (splice) more than two dowel bar assemblies in any one doweled joint in each lane width.

3.8.3. *LONGITUDINAL JOINTS*

All longitudinal joints shall be tied together with epoxy-coated deformed bars as shown in the longitudinal joints detail. Tie bars may be bent at right angles against the side of the first lane constructed and straightened into final position before the adjacent concrete is placed. Tie bar installation shall be completed by inserting into the side of plastic concrete during slip-form paving operation, inserting through accurately positioned holes in side forms, drilling into hardened concrete, or by other approved methods. Drilling method shall meet the requirements of construction joints as specified below. Tie bars that are loose or easily rotated after hardening of concrete shall have additional tie bars drilled and installed as directed by the Engineer.

The tie bars shall be positioned on supports of a design and material approved by the Engineer and sufficient in strength to hold the bars in place while the concrete is being placed.

Tie-Bar Placement Tolerances:

- Longitudinal shift: 3 inches
- Vertical placement: 1 inch
- Tie bars or tie bar baskets shall be placed so that they are not within 15 inches of the transverse joint.

3.8.4. TRANSVERSE AND LONGITUDINAL CONSTRUCTION JOINTS

Transverse and longitudinal construction joints shall be constructed whenever the placing of the concrete is suspended for more than 45 minutes or at the end of each pour. Construction joints shall only be constructed at planned transverse and longitudinal joint locations. A construction joint shall be formed by securely staking in place at right angles to the sub base and centerline of the pavement, a bulkhead of wood or metal cut to the cross-section of the pavement. Dowel and tie bars shall be installed with the construction joint by either inserting bars into plastic concrete or later drilled in place. If dowels are installed in plastic concrete, dowels shall be secured and held in place midway across the joint, parallel to both the surface and the centerline of the slab by a self-supported dowel sleeve, or other supporting device approved by the Engineer.

Concrete accumulated in the grout box of the paver at end of each pour shall not be incorporated into the construction joint. Concrete contained in the grout box shall be removed from the project.

Drilling holes for placement of dowel and tie bars may be completed after concrete has gained sufficient strength to prevent spalling or damage to new concrete. The diameter of the drilled holes shall be drilled 1/8 to 1/4 inch larger than the diameter of the bars. Gang-mounted rigs shall be used for drilling holes for dowel bars and shall be capable of drilling holes at proper alignment without excessive chipping and spalling. Hand-held drills will only be allowed for drilling tie bars. The drilled holes shall be blown out with compressed air at a working pressure of at least 90 psi using a device that will reach to the back of the hole to ensure all debris and/or loose material is removed prior to epoxy injection. An epoxy resin adhesive shall be used to anchor the bars in the drilled hole. Prior to insertion of the bars, drilled holes shall be filled with epoxy resin 1/3 to 1/2 full, or as recommended by the manufacturer. Each bar shall be rotated during installation to eliminate voids and to ensure complete bonding occurs. Bar insertion by the dipping method will not be allowed.

Exposed ends of the dowels shall be painted or coated with an approved bond breaker.

The dowel bars and tie bars shall be installed to within the tolerances specified above.

3.8.5. EXPANSION AND ISOLATION JOINTS

When specified, expansion joints shall be spaced as specified or shown on the plans. Expansion material shall extend entirely through the depth and width of the concrete joint.

All expansion joints, unless specified otherwise, shall have epoxy coated smooth bars installed for load transfer across expansion joints. They shall be held in place midway across the joint face, parallel to both the surface and the centerline of the slab by an approved supporting device or drilled in place. The “free” end of the smooth bar shall be coated with an approved lubricant and covered with an approved non-corrosive metal or plastic dowel cap or sleeve. The expansion material shall be accurately pre-punched to fit tightly around the smooth bars.

The expansion material shall be accurately and firmly staked or fastened to the concrete face before pouring concrete. The top edge of all expansion material shall be set flush with the concrete surface and tight against the vertical faces. When installed as specified, hot pour sealant will not be required. Where the expansion material is not installed flush with concrete surface or tight against concrete faces, the Engineer will determine whether removal and replacement is required, or allowing the expansion material to be cut down 1/2" below concrete surface. The joint faces shall then be cleaned by sandblasting and sealed with hot pour sealant 1/8" below to flush with the concrete surface.

3.8.6. SAWING

All non-construction joints shall have weakened planes created by sawing to the required dimensions shown on the saw joint detail. Sawed joints shall be extended through adjacent curb and gutter sections. All joints shall be sawed along a true and straight line established by the Contractor and shall not deviate at any point by more than 1/2 inch from the established line. Tooling of joints in lieu of sawing will not be allowed unless approved by the Engineer.

The initial sawing shall be accomplished as soon as the condition of the concrete will permit without raveling and before random cracking occurs. The sequence of initial sawing shall be the Contractor's responsibility. The sawing shall be immediately delayed if any raveling occurs. Water under nozzle pressure shall be used to remove the sawing residue from each joint and the pavement surface immediately after completing the sawing of the joints. At least one backup saw shall be available for use if a breakdown occurs during

initial saw cutting operations. An inventory of at least two saw blades shall be on-site during initial saw cutting operations

Widening of the joints to full width, as per dimensions shown on the saw joint detail, shall not be performed until the concrete has cured for at least 24 hours and shall be delayed longer when the sawing causes joint raveling.

Self-propelled wet cutting saws with automated depth control shall be used for all joint establishment and widening operations. The early entry dry saw "Soff-Cut" method of sawing will only be allowed with the Engineer's approval for the initial saw-cutting.

If joint raveling is present, the Engineer will categorize the degree of raveling and determine whether a contract price adjustment to the pavement bid item or rejection of pavement will be administered. The Engineer will determine the degree of raveling by using the table below and areas of contract price adjustments by measuring the defective areas in square yards. Price adjustments will be deducted from monies due or to become due to the Contractor. Engineer reserves the right to reject any concrete with joint raveling present.

Joint Raveling Deduct Adjustments (Percent of Contract Unit Price)	
Degree of Raveling	% Deduct per SY
No Raveling: 0" to 1/4"	(0%)
Light Raveling: 1/4" to 3/8"	(15%)
Moderate Raveling: 3/8" to 1/2"	(25%)
Severe Raveling: 1/2" +	Remove and Replace

3.8.7. UNCONTROLLED CRACKING

Concrete pavement in which uncontrolled cracks occur shall be removed to the nearest planned longitudinal and transverse joints. The removal and replacement method shall be approved by Engineer and at the Contractor's expense. The work shall include the complete removal and replacement of a quantity of pavement, to include dowel bar assemblies when applicable, as is determined necessary for acceptance of the pavement by the Engineer. Any damage caused during the removal and replacement process shall be restored at the Contractor's expense (including but not limited to base or subgrade). All removal and replacement work shall be in accordance with the requirements of these Specifications.

3.9. CONCRETE FINISHING

Concrete shall be consolidated, leveled, finished, and cured within 45 minutes of it being placed on the grade.

The addition of water to the surface of the concrete to assist in finishing operations is not allowed and will result in non-payment, replacement, and/or repair of the wetted area as determined by the Engineer. Failure to take acceptable precautions to prevent surface drying of the concrete will be cause for shut down of placing operations. Evaporation retarders shall not be used as a finishing aid.

Forms shall be left in place for at least 15 hours after placing the concrete, and the method of removing them shall not damage or mar the concrete.

The finished surface of the pavement and curb & gutter shall conform to the grade, alignment, dimensions, and contour shown on the plans and typical sections. Immediately following the floating operation, the Contractor shall test the slab surface for trueness with a 10-foot straightedge. The straightedge shall be placed parallel to the pavement centerline and be passed over the slab to reveal any high or depression areas. The high or depression areas shall be cut or filled as necessary with the long handled floats and the area checked again with the straightedge. Successive advances of the straightedge shall overlap by 1/2 the length of the straightedge. The entire surface shall be checked until all variations have been eliminated.

All curb and gutter surfaces shall be finished true to line and grade without any irregularities of surface noticeable to the eye. The curb and gutter shall not depart from more than 1/4 of an inch from a 10 foot straight edge, placed on the curb parallel to the center line of the street, nor shall any part of the exposed surface present a wavy appearance.

Any concrete areas with segregation, honeycombing, and/or voids shall be removed and replaced at the Contractor's expense

3.10. FINAL SURFACE FINISH

After surface irregularities have been removed, the pavement shall be uniformly textured using a seamless strip of artificial grass-type carpet, or by using broom bristle sections. The artificial grass-type carpet shall have a molded polyethylene pile face with a blade length of 5/8 inches to 1 inch, a minimum weight of 70 ounces per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.

The texturing material shall be pulled longitudinally and be mounted to a self-propelled support system, operated off of the paving string line, and shall not deviate visually from the established alignment. Other approved texturing methods will be allowed if Engineer determines it is not

feasible to use a self-propelled system or string line. All texturing material shall apply a uniform texture with 1/16 to 1/8 inch deep striations. The width of the texturing material shall be in full uniform contact over the full width of the pavement. The texturing material shall be in good repair and shall be cleaned as often as necessary to remove hardened particles or debris that would otherwise scar the surface.

With formed paving only, brooms shall be drawn across the surface at right angles to the centerline of the pavement, with the stroke of the broom overlapping by 2 inches of adjacent strokes. Brooms shall be washed and dried at frequent intervals during the pour. Any long or coarse bristles that may cause surface irregularities shall be trimmed or cut out, and any brooms that have become worn out shall be discarded.

The final surface texture shall be uniform in appearance and free of rough or porous spots, irregularities, depressions, and other objectionable features.

Areas of pavement surfaces showing deficient or non-uniform texture shall be re-textured by diamond grinding. Diamond grinding shall be performed in accordance to Section 2900 Pavement Milling or Grinding of these Specifications. The Engineer will test the “mean texture depth” achieved by the carpet drag or broom material in accordance with ASTM E 965 Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique and the NDDOT *Field Sampling and Testing Manual*. The Engineer will determine the test locations.

3.11. CURING CONCRETE

Concrete curing compound shall be applied to the surface of the concrete within 45 minutes after being placed on the grade. The finished surface shall be sprayed with a curing compound on all exposed faces. The curing compound shall be applied to form a uniform coverage at the rate of not less than one (1) gallon per two-hundred (200) square feet of surface area, unless the manufacturer recommends a heavier application. Curing compounds shall be applied using mechanically-pressurized spray equipment with multiple atomizing spray nozzles mounted on a self-propelled frame that spans the paving lane. Handheld sprayers shall be limited to small areas inaccessible to span framed style equipment or other areas approved by Engineer. Curing compound shall be immediately reapplied to any surfaces exposed or repaired within the curing period. After application of the curing compound, the surface of the concrete shall be as white as a sheet of paper.

Colored concrete pavement shall be cured with transparent curing and sealing compound. Curing and sealing procedures shall follow the manufactures recommendations.

Failure to provide the required amount of approved curing compound in specified time period shall be cause for immediate shutdown of concrete placing operations and/or rejection of placed concrete.

3.12. JOINT SEALING

All concrete pavement joints shall be sealed using a hot pour sealant. Joints shall be sealed before opening to construction and public traffic and no more than 10 days after placement of concrete. Prior to sealing joints, the Contractor shall keep newly-placed concrete clean of loose aggregate and debris at all times. The Contractor shall not seal joints until they have been inspected and approved by the Engineer. Failure to comply will result in complete removal of the sealant material to allow inspection by the Engineer, at the Contractor's expense. The joints shall not be sealed when the air temperature is below 40°F.

All vertical joint faces shall be cleaned by sandblasting, or if approved by the Engineer, water blasting may be allowed. The minimum working pressure of sandblasting shall be a minimum of 100 psi and water blasting shall be a minimum of 2000 psi. Oil, asphalt, slurry, curing compound, paint, rust, and other foreign materials shall be completely removed. Just before the joints are sealed, the Contractor shall clean the joints with compressed air at a working pressure of at least 100 psi. All joints shall be dry before applying joint sealant.

Backer rod shall be used in all transverse joints to control the depth of the sealer material, achieve the desired shape of the material, and support the material against indentation and sag. The backer rod shall be compatible with the hot pour sealant and not subject to the absorption of water.

Any joints filled above or below the specified level shall be corrected at the Contractor's expense. Any excess sealant spilled on the pavement surfaces shall be removed.

3.12.1. SEALANT APPLICATION

A. Hot Pour Sealant

All joints shall be sealed with hot pour sealant. The hot pour sealant shall be forced into the joint with a pressure type applicator capable of filling the joint from the bottom up to a height approximately flush to 1/8" below the pavement surface, without any overflow or spillage onto the pavement surface.

B. Silicone Sealant

When allowed by the Engineer, silicone joint sealer may be used in lieu of hot sealant. The sealant shall be tooled to produce a slightly concave surface approximately 1/8 inch below the pavement surface.

3.13. PROTECTION OF PAVEMENT

The newly-placed concrete with insufficient strength shall be protected from traffic by employing watch persons, if necessary, and by the erection and maintenance of barricades, fences, warning signs and lights, pavement bridges, and cross-overs. The newly-placed concrete shall be kept clean of loose aggregate, dust, and debris at all times during construction activities. Any part of the pavement damaged from traffic or other causes occurring prior to the acceptance of the pavement shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

When bituminous pavement or colored concrete is placed adjacent to concrete pavement, the adjacent concrete pavement shall be protected from spills and smears. Discolored concrete pavement shall be cleaned at the Contractor's expense. The concrete pavement shall not be used to stockpile or mix any material unless approved by the Engineer. Contractor shall use a "pickup" type power sweeper equipped with adequate dust storage capacity to keep the newly constructed pavement clean of loose aggregate, dust, and debris at all times during construction activities.

The Contractor will be subject to an hourly charge for failure to keep the pavement surface clean. If the Contractor does not make an effort to clean the surface within (1) hour of being notified, the Contractor will be assessed \$200.00 per hour until which time the Engineer determines that the Contractor has complied.

3.14. OPENING TO TRAFFIC

Newly constructed pavement shall not be opened to Contractor or public traffic until the concrete has attained a compressive strength of 3,000 psi. This strength may be measured by one of the following methods; field cured cylinders in accordance with ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field or concrete maturity in accordance with ASTM C 1074 Standard Practice for Estimating Concrete Strength by the Maturity Method. Newly constructed concrete pavement shall not be opened to any traffic until all joints have been sealed and the pavement has been swept clean of loose aggregate, dust, and debris.

3.15. PAVEMENT SURFACE SMOOTHNESS

This section describes the methods for locating areas of localized roughness and measuring the smoothness of final concrete surface, and provisions for corrective action. The Engineer may direct Contractor to use the 10 foot straightedge method, the profiler method, or both to determine surface smoothness. All pavement smoothness testing and corrective measures, if required, shall be at the Contractor's expense.

All Concrete Pavements shall meet the following thresholds of localized roughness and smoothness:

Concrete Pavement Categories	Methods of Measuring Localized Roughness and Smoothness			
	MRI Threshold	ALR Threshold	RSE Threshold (Excluded Areas)	10' Straight edge Threshold (Excluded Areas)
> 30 mph	120 in/mile	160 in/mile	0.25 inch deviation per 25 ft. segment	1/8-inch deviation
All others	140 in/mile	180 in/mile	0.25 inch deviation per 25 ft. segment	1/8-inch deviation

Definitions:

IRI – International Roughness Index

MRI – Mean Roughness Index

ALR – Areas of Localized Roughness

RSE – Rolling Straight Edge

3.15.1. 10 FOOT STRAIGHTEDGE METHOD

Where directed by Engineer, the Contractor shall furnish an approved 10 foot straightedge, depth gauge, and operator to aid the Engineer in testing the pavement surface. Areas showing high or low spots of more than 1/8 inch but not exceeding 1/4 inch in 10 feet shall be ground with diamond grinding equipment to an elevation within the 1/8 inch tolerance. When the deviation exceeds 1/4 inch high or low, the Contractor shall submit a corrective action plan that includes either grinding or removal and replacement of the pavement. If the corrective action plans contains grinding, the pavement must be ground to within the 1/8 inch tolerance. The Engineer will determine what corrective action shall be implemented.

3.15.2. PROFILER METHOD

A. Inertial Profiler

The Contractor shall furnish an Inertial Profiler capable of measuring International Roughness Index (IRI) in dual wheel paths, producing a profilogram, and exporting raw profile data in an unfiltered electronic Engineering Research Division (ERD) file format. The Contractor shall furnish current proof of profiler calibration and certification from MnDOT, or other approved agency, to the Engineer prior to performing profiling operations. The profiler shall meet all requirements and specifications found in AASHTO M 328 Standard Specification for Inertial Profiler.

B. Operator Certification

Contractor shall provide an operator trained in the operation of the Inertial Profiler and knowledgeable in the use of the required Profile Analysis Software (ProVal). Operators shall be certified by MnDOT, or other approved agency, and provide documentation of operator certification to the Engineer.

C. Profiler Operation

Contractor shall clean and prepare the surface of pavement for accurate testing. All traffic control costs associated with profiling shall be incidental to other bid items.

All mainline concrete pavement shall be profiled for smoothness and ALR evaluation. Profiles shall be reported in 0.1 mile segments, measured in each wheel path per lane and shall be reported based on the Mean Roughness Index (MRI), the average IRI values from both wheel paths. A “wheel path” is defined as the 2.5 feet from the edge of the travel lane or as directed by the Engineer.

Pavement areas listed below shall be excluded from MRI smoothness and ALR evaluation, however, if directed by the Engineer, these areas shall be profiled to identify bumps or dips using the Rolling Straight Edge Method (RSE) in ProVal, and/or measured by 10 foot Straight Edge Method. The Engineer will evaluate and determine which method type measuring will be required for the excluded pavement areas listed below.

- i. Intersections (PC to PC)
- ii. Roundabouts (circular portion)
- iii. Parking lanes
- iv. Turn lanes
- v. Interchange Ramps and Loops

D. Evaluation.

The Contractor shall utilize the most current version of ProVal and use the program to calculate the MRI from the Engineering Research Division (ERD) files. A copy of the ERD files shall be sent to Engineer upon completion of the data collection. The low- and high-pass filters shall be set to zero.

i. Determining Areas of Localized Roughness.

Identify areas of localized roughness using the Smoothness Assurance Module (SAM) within the current version of ProVal. Use the following settings in the SAM:

- Ride Quality Index set to MRI.
- The base length:
 - Short continuous - 25 feet.
 - Long continuous - 528 feet.
 - Fixed interval - 528 feet.
- Ride Quality Threshold of 160 in/mile for 30 mph or greater.
- Ride Quality Threshold of 180 in/mile for less than 30 mph.

Apply a 250 mm filter to the file being analyzed.

The localized roughness shall be calculated in inches per mile at the short continuous interval of 25 feet.

ii. Determining MRI.

Identify areas of localized roughness using the Smoothness Assurance Module (SAM) within the current version of ProVal. Use the following settings in the SAM:

- Ride Quality Index set to MRI.
- The base length:
 - Short continuous - 25 feet.
 - Long continuous - 528 feet.
 - Fixed interval - 528 feet.
- Ride Quality Threshold of 120 in/mile for 30 mph or greater.
- Ride Quality Threshold of 140 in/mile for less than 30 mph.

Apply a 250 mm filter to the file being analyzed.

The localized roughness shall be calculated in inches per mile at the long continuous interval of 528 feet.

MRI numbers recorded in inches per mile will be established for each 528 foot section for each travel lane of the finished pavement. If the last segment is greater than 250 feet and less than 528 feet, the segment shall be measured as an

independent segment. If the last segment is 250 feet or less, the profile for that segment shall be included in the evaluation for the previous segment.

- iii. Determining Roughness in excluded pavement areas as directed by the Engineer.

Identify areas of roughness using the Rolling Straight Edge (RSE) within the current version of ProVal. Use the following settings in the RSE:

- Straightedge length – 25 feet.
- Deviation Threshold – 0.25 inches

Dips and bumps in excess of 0.25 inches shall be corrected.

3.15.3 CORRECTIVE ACTION

Methods to correct areas which do not meet the required ride quality thresholds for either MRI, ALR, or RSE shall be diamond ground, remove and replace, or other methods approved by the Engineer. Diamond grinding shall be performed according to Section 2900 Pavement Milling or Grinding of these Specifications, except that diamond grinding shall be conducted in increments no smaller than one driving lane width and two panel lengths. Ridges left during grinding shall be feathered and day lighted out with additional passes. Joint sealant damaged in corrective grinding areas shall be removed and replaced at Contractor's expense.

The Contractor shall submit a detailed corrective action plan using the ProVal and SAM data, 5 working days in advance of grinding. Contractor shall generate grinding simulations in ProVal with multiple grinding depths, varying equipment, and multiple pass patterns and include the grinding simulations with the corrective action plan. Any corrective action performed shall not reduce the integrity or durability of the pavement that is to remain in place, and in any case, the pavement thickness shall not be reduced by more than 1/4 inch less than the thickness shown in the Plans, unless approved by the Engineer. Based on Contractor's corrective action plan, the Engineer will determine what extent of the corrective action shall be implemented. The Contractor shall locate and perform all required pavement surface corrective work, with the approval of and in the presence of, the Engineer. Corrective work may also be required for any additional combination of bumps, dips, chatter, or other roughness that, in the opinion of the Engineer, produces an objectionable ride.

On pavement areas where corrections are necessary, second profiler runs shall be performed to verify that corrections have produced thresholds within acceptable limits. In addition, any concrete panels replaced after completed initial smoothness testing and corrective action shall meet the smoothness requirements.

3.16. PAVEMENT SURFACE POP OUT TOLERANCE

Definition of a Pop Out - A hole or crater in the concrete surface, ranging in size from 1/4 inch to several inches in diameter that results from the fracturing of unsound aggregate particles due to expansion pressures. Usually caused by porous aggregate having a high rate of absorption.

3.16.1. POP OUT TOLERANCE CONTRACT PRICE ADJUSTMENTS

The contract price adjustment for each lot will be determined by multiplying the determined lot size by the contract unit price for concrete pavement and the appropriate Contract Price Adjustment Factor shown in the Table below. Price adjustments will be deducted from monies due or to become due to the Contractor. In the event that a contract price adjustment results in an overpayment, the Contractor shall repay overpayment monies within 30 days of notice. No price adjustments will be made for lots with 15 or less pop outs per one square yard.

A. Lot Establishment

The Engineer will select random test locations for determining the number of visual pop outs present in all pavement and curb and gutter sections. The Engineer will mark a square yard perimeter and visually count pop outs 1/2 inch or greater in diameter located within the perimeter. Lot sizes will be determined by considering each separate pour as a separate lot size based on project records.

For lot sizes less than 1000 square yards, the Engineer will test three random locations and average the number of pop outs counted in each location to determine the number of pop outs per one square yard for pay adjustments.

For lot sizes greater than 1000 square yards, the Engineer will test one random location per 1000 square yards, or a minimum of three random locations, whichever is greater, and average the number of pop outs counted in each location to determine the number of pop outs per square yard for pay adjustments.

Pop Out Deduct Adjustments (Percent of Contract Unit Price)	
Number of Pop Outs per One Square Yard	Total Deduct per Defined Lot Size
0-15	0%
16-25	(5%)
26-35	(15%)
*36 or more	To be determined by Engineer

* Engineer reserves the right to determine deduct amounts and/or reject any concrete exceeding 36 or more pop outs per square yard.

3.17. FINAL ACCEPTANCE OF PAVEMENT

At the time of final acceptance, the concrete pavement shall be free of random cracks, surface scaling, flaking, spalling, or any other related defects or damages. The concrete shall be swept clean of all debris. Any defects or damage to concrete pavement before final acceptance, including damage from freeze thaw cycles or use of deicers, shall be repaired or removed and replaced at the Contractor's expense to the satisfaction of the Engineer.

3.18. LOCATION OF EXISTING UTILITIES

Existing manholes, gate valves, and stop boxes have been shown to direct the Contractor's attention to their existence. The Contractor is cautioned that not all utilities have been shown and their location is not guaranteed. The Contractor is responsible for determining the exact location of existing utilities that affect the installation of the paving.

3.19. CASTING TO GRADE (ALL)

Floating manhole castings as shown in the typical details are required on all manholes structures located in concrete pavement.

This item includes all labor, materials and equipment necessary to adjust the various castings to the proper line and grade. Note that wood shims to adjust rings and castings are not allowed. Changes in grade shall be made as follows:

Height adjustment of manholes and inlets within the paving section shall be performed using either engineered polymer rings or precast reinforced concrete rings.

When using precast reinforced concrete rings, the rings shall be free from cracks, voids, and other defects. Interior I/I Barrier, manufactured by Strike Products or approved equal, shall be used when height adjustment is performed utilizing round precast reinforced concrete rings. The casting and between each ring shall be sealed with a minimum 1/2" x 1/2" double bead of butyl rubber sealant in caulking form. Preformed butyl tape is not allowed. Precast reinforced concrete rings shall be wrapped with nonwoven geotextile fabric, secured around the outside of the rings from three (3) inches below the top of the manhole/inlet structure to the top of the rings. When minor shimming is required, the voids shall be filled with concrete. All precast reinforced concrete rings shall receive a four (4) inch wide concrete encasement placed around the outside of the rings from three (3) inches below the top of the structure to the frame casting.

All engineered polymer rings shall be properly sealed in accordance with the manufacturer's recommendations.

Height adjustment of manholes and inlets is limited to a maximum of 12" of adjustment and no more than 4 adjusting rings. Taller rings shall be used where required to limit adjustment to 4 adjusting rings. When caused by the negligence of the Contractor, a new structure requiring adjustment greater than 12" shall be reconstructed to limit adjustment to 12" and shall be at the Contractor's expense.

Care shall be taken to adjust the casting to the proper grade so the final riding surface is smooth and free of bumps and it conforms to the alignment and grade of the adjoining concrete. Any castings not satisfying these requirements shall be redone to the satisfaction of the Engineer. Castings should be set flush to 1/16 inch below the finished pavement surface.

The casting to grade item also includes cleaning all construction debris or dirt from the manhole or inlet bottom and installing a wiped mortar finish around the inside circumference of the precast concrete adjusting rings.

3.20. GATE VALVES TO GRADE

This item shall include all labor, material, and equipment necessary to raise or lower water gate boxes to the final grade. Care shall be taken to adjust the valve box to the proper grade so the final riding surface is smooth and free of bumps and that it conforms to the grade of the adjoining concrete. The alignment shall be checked to ensure that the box is straight and that the valve is operable. Any valve boxes not satisfying these requirements shall be redone to the satisfaction of the Engineer. Valve boxes should be set flush to 1/16 inch below the finished pavement surface. The gate box to grade item also includes cleaning all construction debris or dirt from the box, verifying that the box is straight, undamaged, and that the valve is operable.

3.21. TESTING

The Concrete shall be tested at least once per day of placement or at the discretion of the Engineer. This testing shall include; Slump, Air Content, Temperature, Compressive strengths (1 cylinder at 7 days and 3 cylinders at 28 days) and gradations and property tests on aggregates. Changes to this frequency of testing may be altered by the Engineer. The Contractor shall cooperate in the making of such tests to the extent of allowing free access to the work for the selection of samples. The Contractor shall be responsible for all costs of quality control testing. The City shall be responsible for all costs of quality assurance testing.

Samples shall be obtained and tested in accordance with the latest ASTM methods of tests. Testing labs will supply reports to the Engineer, Contractor, and concrete supplier.

3.22. SIDEWALKS AND DRIVEWAYS

The construction of sidewalks, driveways, and impressed concrete shall be performed in accordance with Section 2300 Concrete Sidewalks and Driveways.

PART 4
GUARANTEE, MEASUREMENT & PAYMENT

4.1. GUARANTEE

The guarantee shall be per the contract.

4.2. MEASUREMENT AND PAYMENT

Payment for concrete paving and castings and gate valves to grade shall be full compensation for all labor, material, equipment and miscellaneous items necessary for constructing these items in place.

4.2.1. EXCAVATION AND SUBGRADE PREPARATION

Paid under Section 2000 Excavation, Filling, and Subgrade Preparation contract bid items.

4.2.2. UNDER-STRENGTH CYLINDERS

Payment for Concrete Bid Items specified herein will not be made until the Engineer is satisfied that the material will meet the specified strength requirements. When test cylinders show under-strength concrete, cores shall be taken in the field and tested. The number and location of the cores will be at the discretion of the Engineer. All costs for coring and retesting will be deducted from the Contractor's payment. All concrete found to be under-strength shall be removed and replaced at the Contractor's expense.

4.2.3. CONCRETE PAVEMENT

Concrete pavement shall be paid for at the unit price bid per square yard. Concrete pavement shall include the area of paving only and does not include the area of the curb or gutter section.

4.2.4. CONCRETE CURB AND GUTTER

Curb and gutter will be measured along the curb face and be paid for at the contract unit price per linear foot.

4.2.5. CONCRETE VALLEY GUTTERS

Valley gutters will be measured and paid for at the unit price bid per square yard.

4.2.6. *CONCRETE SIDEWALKS, DRIVEWAYS, AND IMPRESSIONED CONCRETE*

Sidewalks, driveways, and impressioned concrete shall be in accordance with Section 2300 Concrete Sidewalks and Driveways.

4.2.7. *CASTING TO GRADE*

This bid item shall include all work to adjust the casting with up to 4 rings (12 inches), including all sealant, wrap, or chimney seals as specified herein. Adjustments to inlets and manholes located in the pave shall be paid for under the “Casting to Grade – w/Conc” bid item. Adjustments to inlets and manholes located outside the pave shall be paid for under the “Casting to Grade – Blvd” bid item.

4.2.8. *VALVE BOXES TO GRADE*

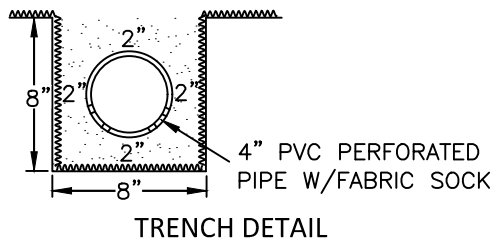
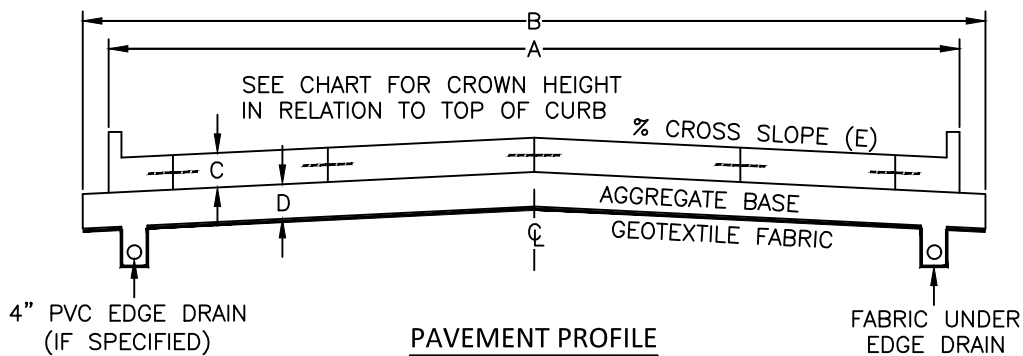
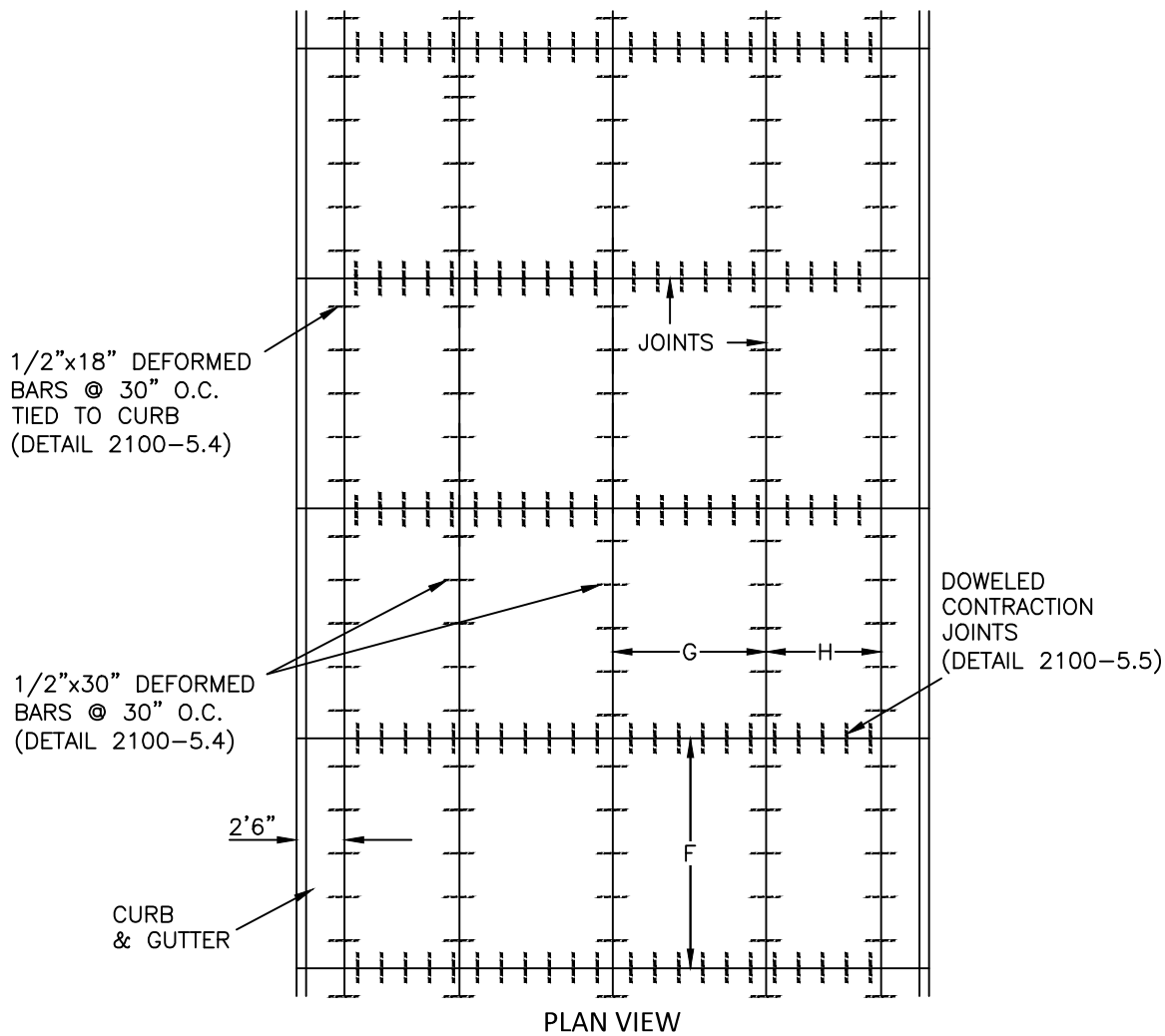
Adjustments to valve boxes located in the pave shall be paid for under the “GV Box to Grade – w/Conc” bid item. Adjustments to valve boxes located outside the pave shall be paid for under the “GV Box to Grade – Blvd” bid item.

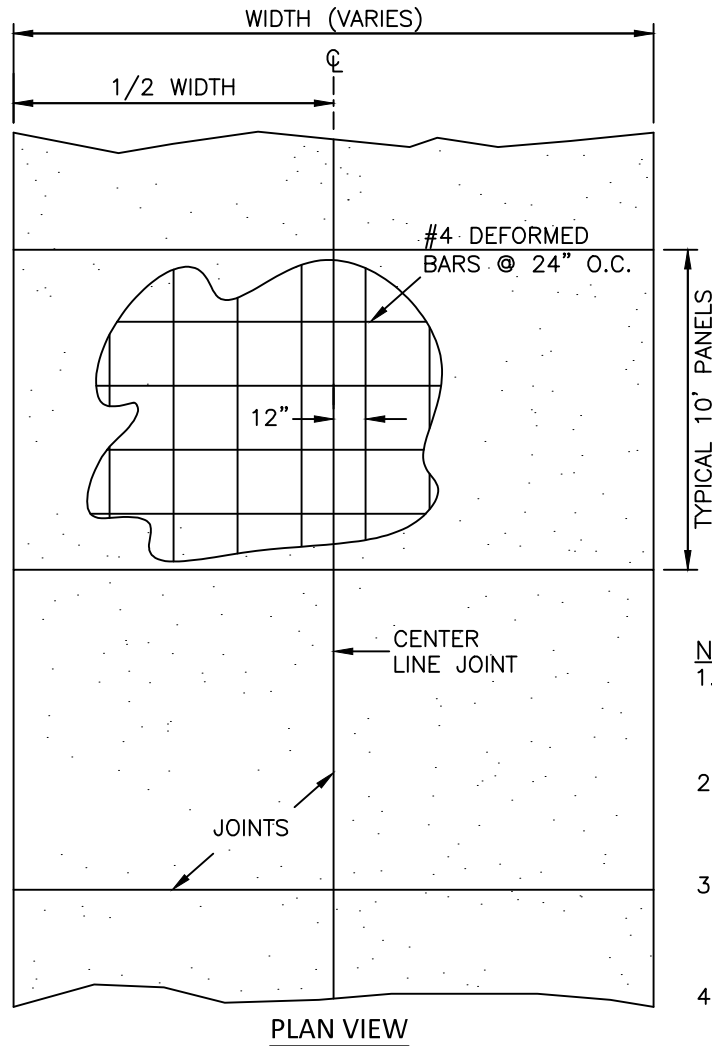
4.2.9. *OTHER COSTS*

All costs of dowels, reinforcing steel, sawing, curing and protection, jointing and joint filling/sealing, and all other costs of work necessary to properly complete the work specified herein shall not be bid items; the costs shall be charged to other items unless a bid item is included on the bid sheet.

NOMINAL STREET WIDTH	CONCRETE PAVEMENT WIDTH	BACK-BACK WIDTH	GRAVEL BASE WIDTH	SLAB THICKNESS	GRAVEL THICKNESS	% CROSS SLOPE	CROWN HEIGHT ABOVE OR BELOW TOP OF CURB		PANEL HEIGHT	CENTER PANEL WIDTH-G	OUTSIDE PANEL WIDTH-H	GEOTEXTILE FABRIC
							STANDARD	MOUNTABLE	F			
32'	28'	33'	35'	9"	10"	2.35%	1-1/2" BELOW	1/2" ABOVE	10'	8'	6'	WOVEN
36'	32'	37'	39'	9"	10"	2.30%	1" BELOW	1" ABOVE	10'	10'	6'	WOVEN
40'	36'	41'	43'	9" OR 10"	10"	2.30%	1/2" BELOW	1-1/2" ABOVE	12'	10'	8'	WOVEN
52'	48'	53'	55'	10"	12"	2.30%	1" BELOW	1" ABOVE	15'	12'	12'	WOVEN
63'	59'	64'	66'	10"	12"	2.25%	2-1/2" ABOVE	N/A	15'	11'	12'	WOVEN

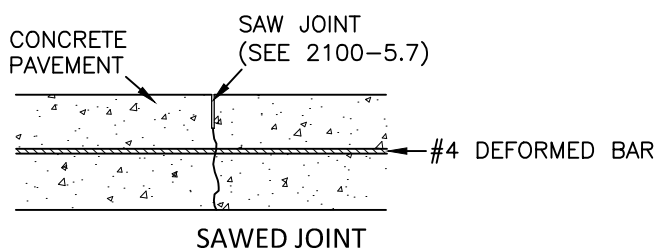
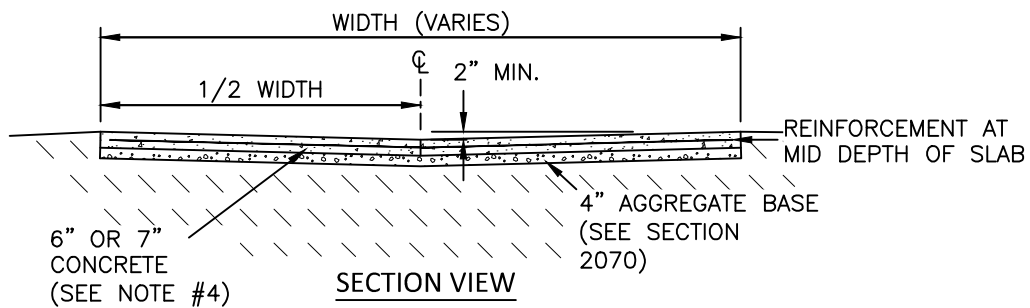
*NOTE: CENTER PANEL IS CENTERED ON R/W, TOTAL OF 4-12' AND 1-11' PANELS

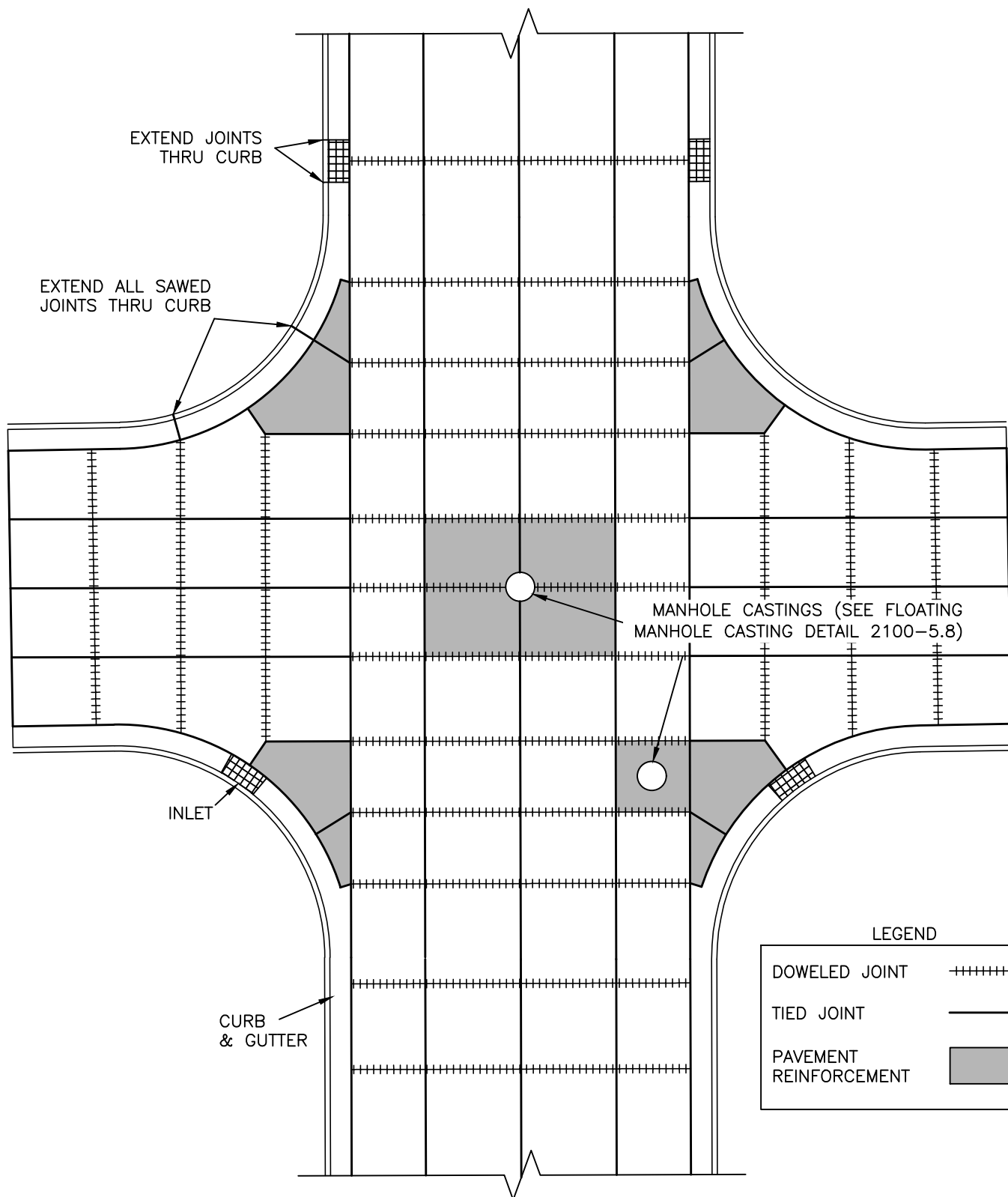




NOTES:

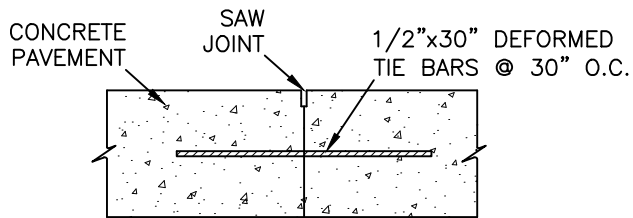
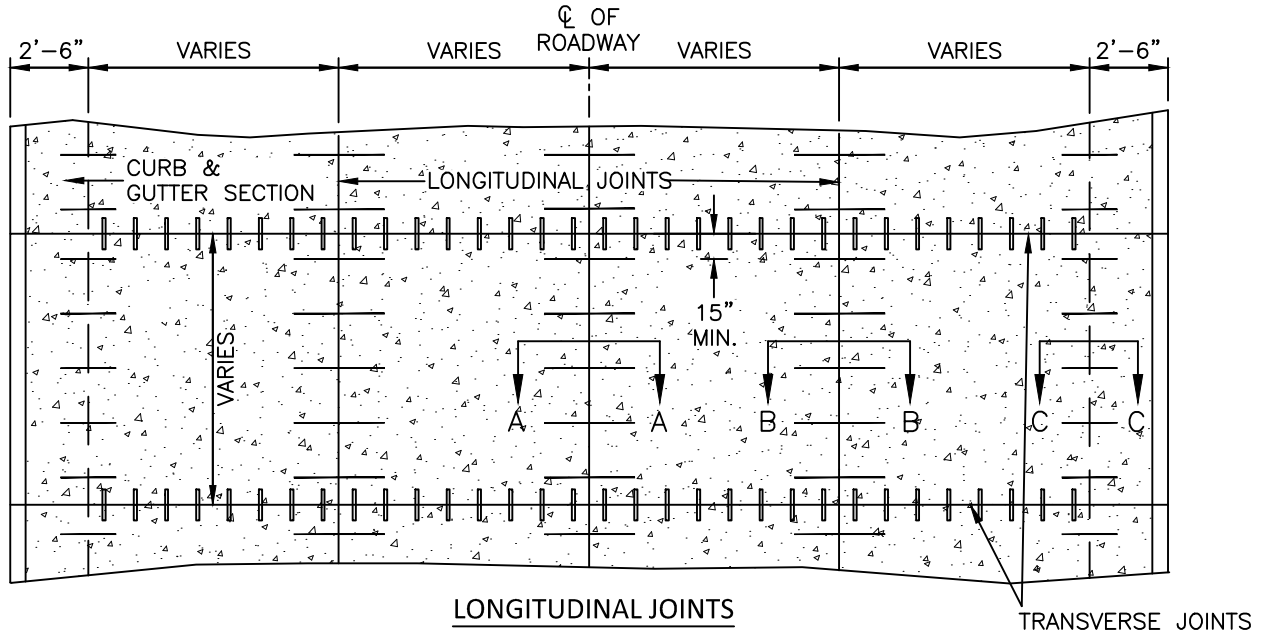
1. JOINTS SHALL BE SAW CUT AND SEALED AS PER SAW JOINT DETAIL 2100-5.7.
2. 4" AGGREGATE BASE SHALL BE INCLUDED IN THE CONCRETE PAVEMENT BID ITEM.
3. ALL CONSTRUCTION JOINTS SHALL BE TIED WITH #4 X 18" DEFORMED BARS @ 24" O.C.
4. 6" RESIDENTIAL THICKNESS
7" COMMERCIAL THICKNESS
5. AGGREGATE BASE SHALL BE INSTALLED 1' MIN. WIDER THAN CENTERLINE FORMS



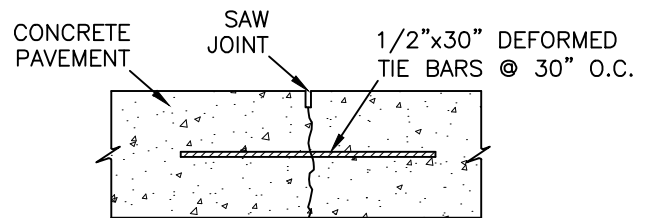


NOTES:

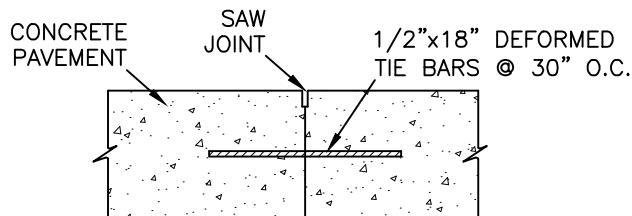
1. ALL DIMENSIONS ARE VARIABLE, SEE JOINTING PLANS AND CONCRETE PAVEMENT DETAILS FOR DIMENSIONS.
2. CURB AND GUTTER SHALL BE POURED SEPARATE FROM ADJACENT CONCRETE PAVEMENT.



SECTION A-A
LONGITUDINAL CONSTRUCTION JOINT



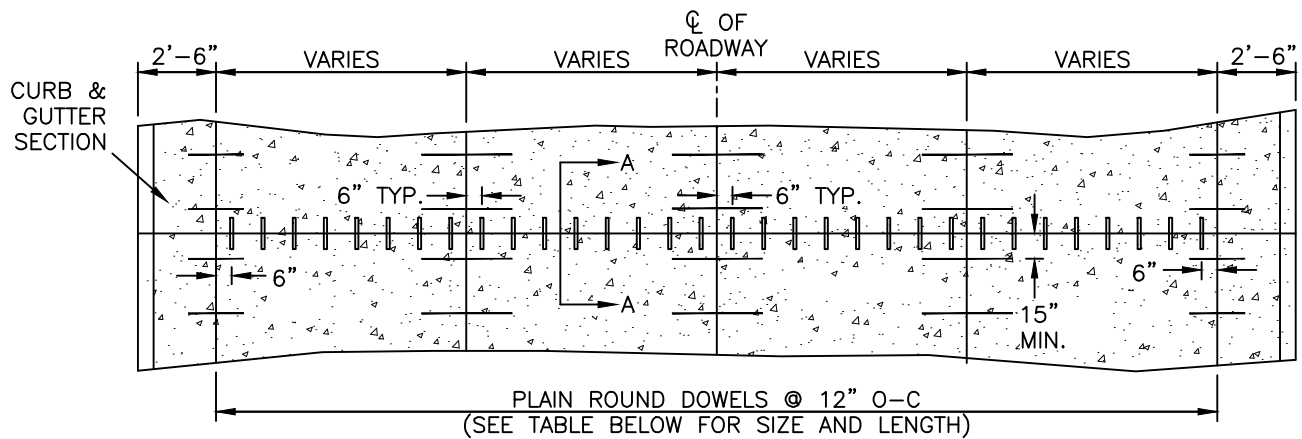
SECTION B-B
SAWED LONGITUDINAL JOINT



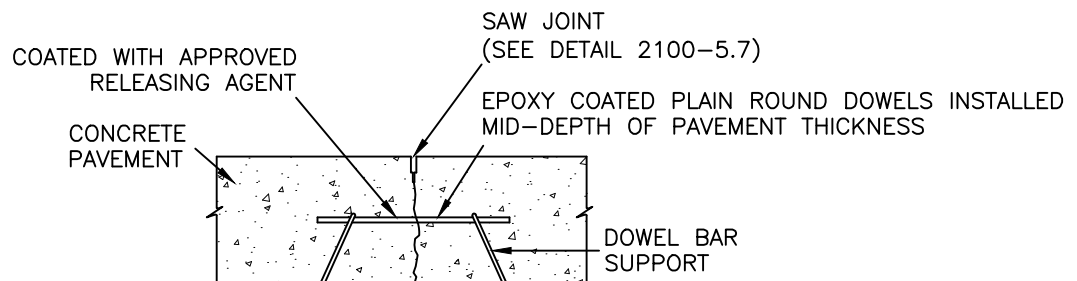
SECTION C-C
LONGITUDINAL CONSTRUCTION JOINT

NOTES:

1. ALL LONGITUDINAL JOINTS SHALL BE TIED
2. SEE SAW JOINT DETAIL 2100-5.7
3. WHERE TIE BARS ARE INSTALLED AND LATER STRAIGHTENED, GRADE 40 STEEL SHALL BE USED
4. ALL TIE BARS SHALL BE EPOXY COATED IN ACCORDANCE WITH ASTM A 775



TRANSVERSE CONTRACTION JOINT DOWEL ASSEMBLY

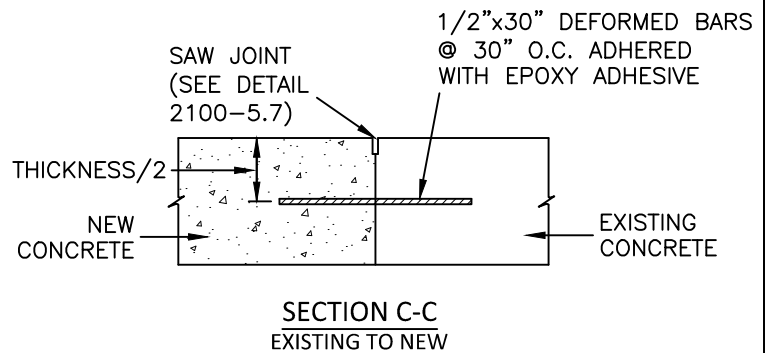
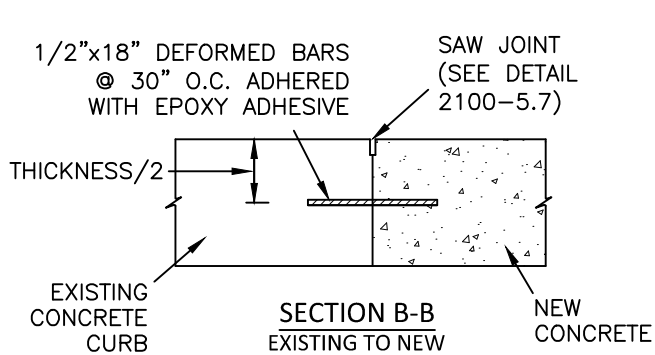
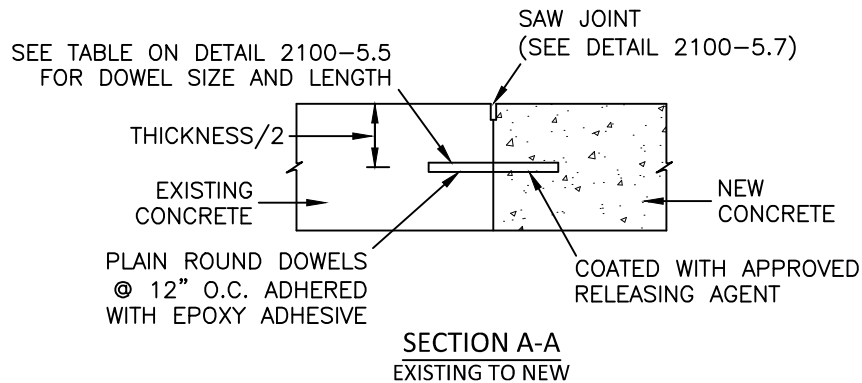
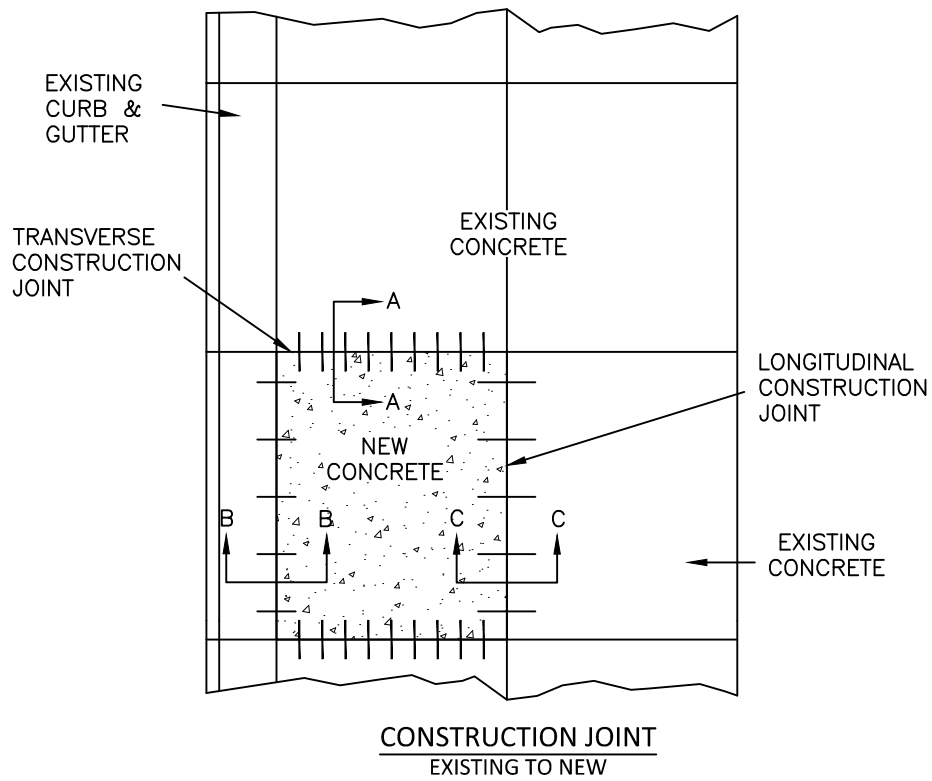


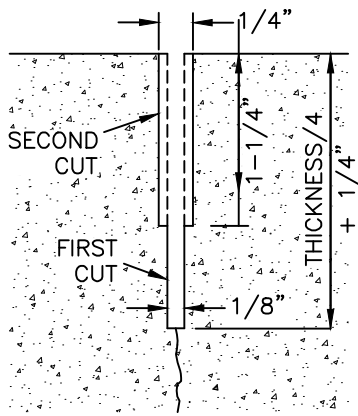
SECTION A-A DOWEL ASSEMBLY

NOTE:

1. ALL DOWELS SHALL BE EPOXY COATED IN ACCORDANCE WITH ASTM A 775, EXCEPT EXPOSED ENDS RESULTING FROM SAW CUTTING OR SHEARING.

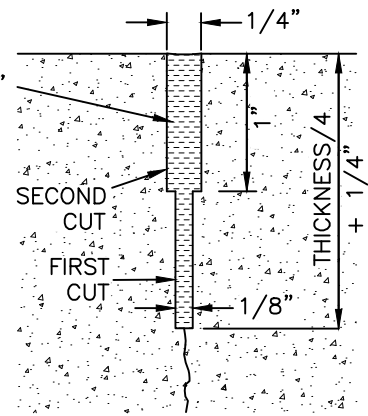
DOWELED JOINTS		
PAVEMENT THICKNESS	DOWEL BAR SIZE	TOTAL DOWEL LENGTH
7"	1"	18"
8 - 10"	1- $\frac{1}{4}$ "	18"
10.5 - 12"	1- $\frac{1}{2}$ "	18"
NOTE: ALL DOWELS ARE TO BE SPACED AT 12" O.C.		



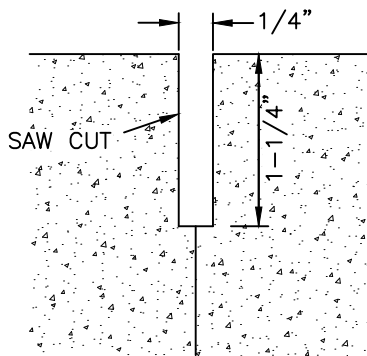


TRANSVERSE SAWED JOINT
(SEE JOINT SEALANT DETAIL)

HOT POUR JOINT SEALANT
INSTALLED FLUSH TO 1/8"
BELOW TOP OF CONCRETE
PAVEMENT

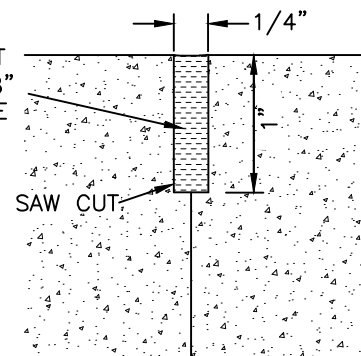


LONGITUDINAL SAWED JOINT



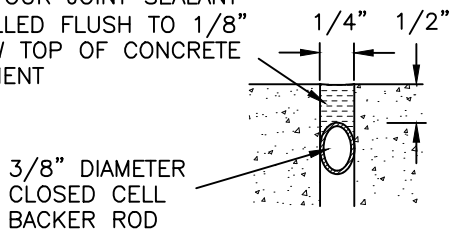
TRANSVERSE CONSTRUCTION JOINT
(SEE JOINT SEALANT DETAIL)

HOT POUR JOINT SEALANT
INSTALLED FLUSH TO 1/8"
BELOW TOP OF CONCRETE
PAVEMENT



LONGITUDINAL CONSTRUCTION JOINT

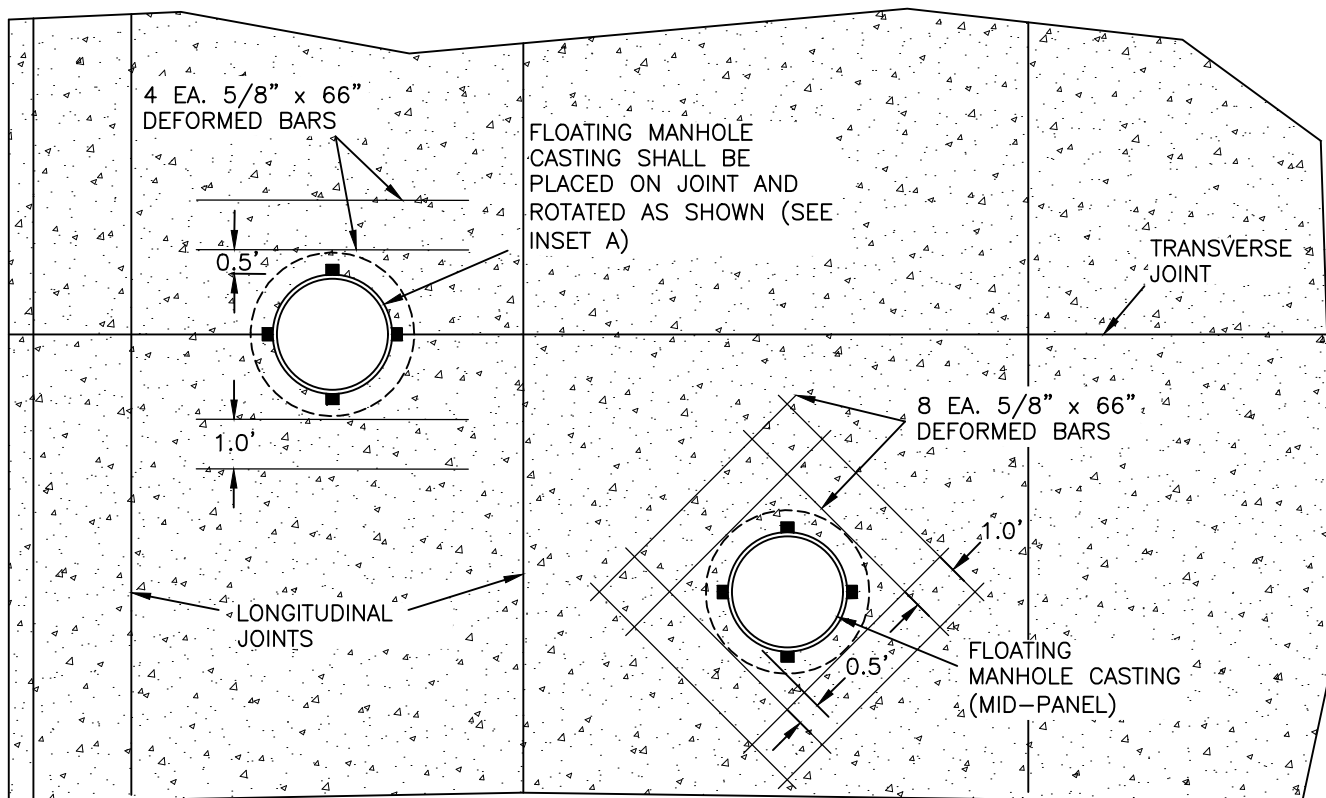
HOT POUR JOINT SEALANT
INSTALLED FLUSH TO 1/8"
BELOW TOP OF CONCRETE
PAVEMENT



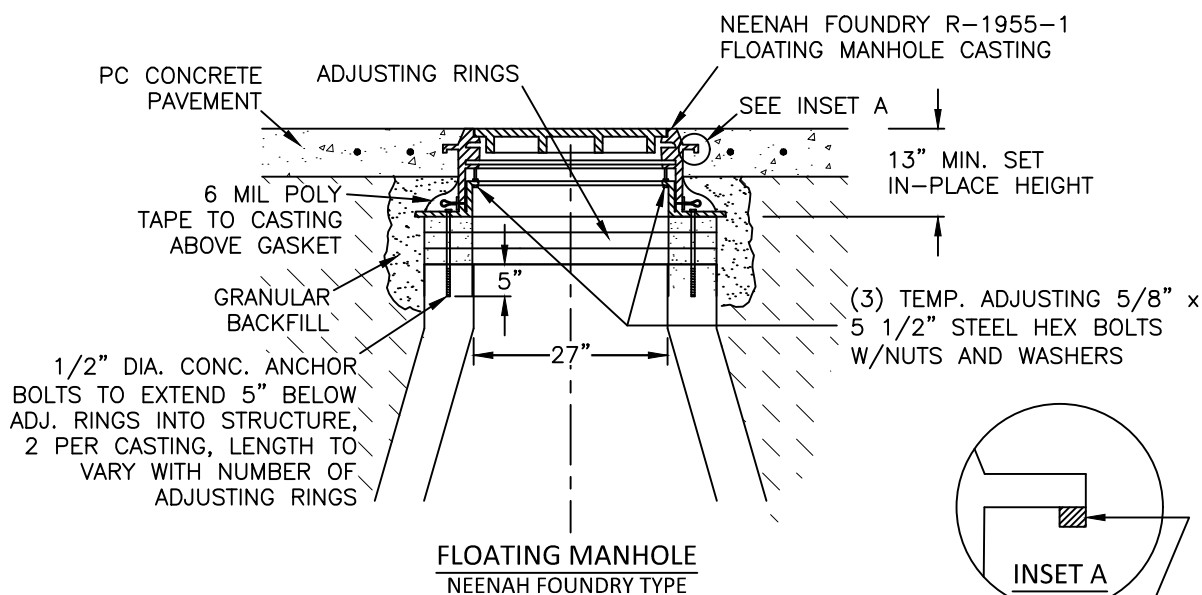
JOINT SEALANT DETAIL
ALL TRANSVERSE JOINTS

NOTES:

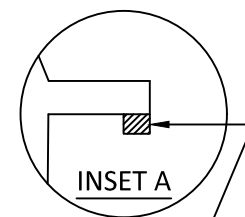
1. ALL LONGITUDINAL AND TRANSVERSE JOINTS SHALL BE FILLED WITH HOT POUR.
2. TRANSVERSE SAWED JOINTS, BACKER ROD AND JOINT SEALANT SHALL EXTEND THROUGH ENTIRE CURB & GUTTER SECTION.
3. ALL CONCRETE JOINT SEALANT AND BACKER ROD SHALL BE IN ACCORDANCE WITH SPECIFICATIONS.



PLAN VIEW



FLOATING MANHOLE
NEENAH FOUNDRY TYPE



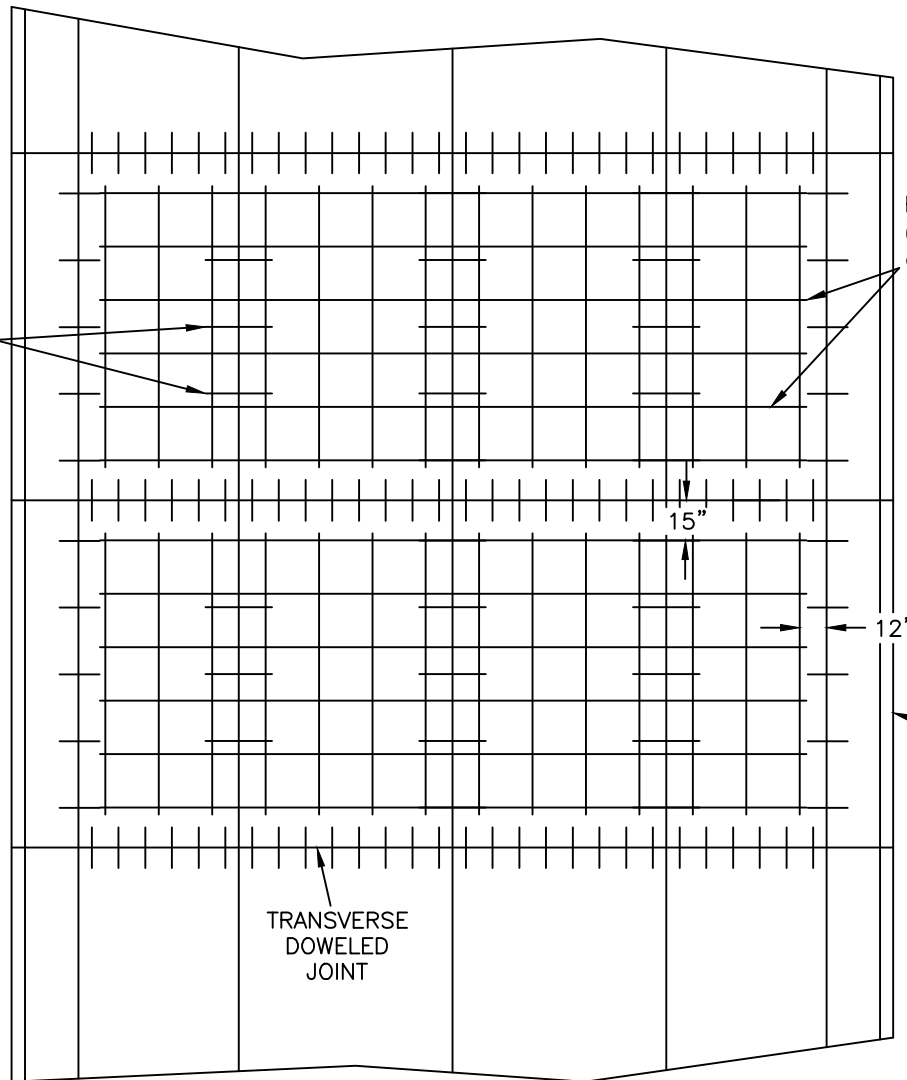
REMOVE ALL FOUR (4) LOWER
HOOK PORTIONS FROM THE
FLANGES WHEN CASTING IS
PLACED ON TRANSVERSE JOINTS
AND COAT OUTER SURFACE OF
CASTING W/APPROVED RELEASING
AGENT

NOTES:

1. THIS DETAIL APPLIES TO ALL MANHOLES LOCATED WITHIN THE CONCRETE PAVING SECTION.
2. SEE SECTION 1200 AND 1500 FOR CASTING LID TYPES.

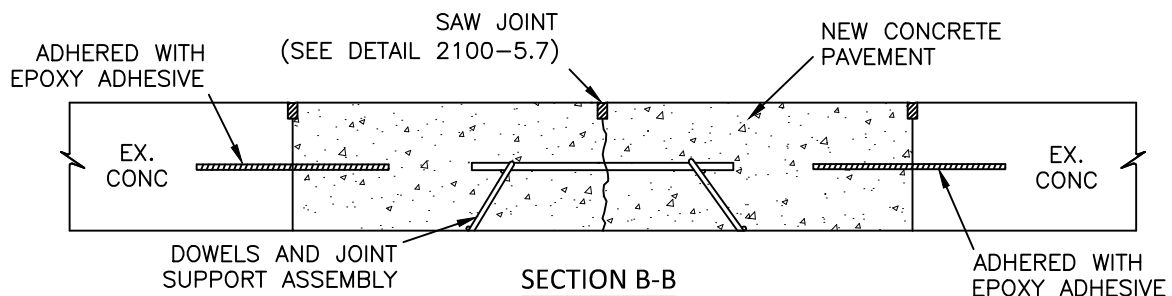
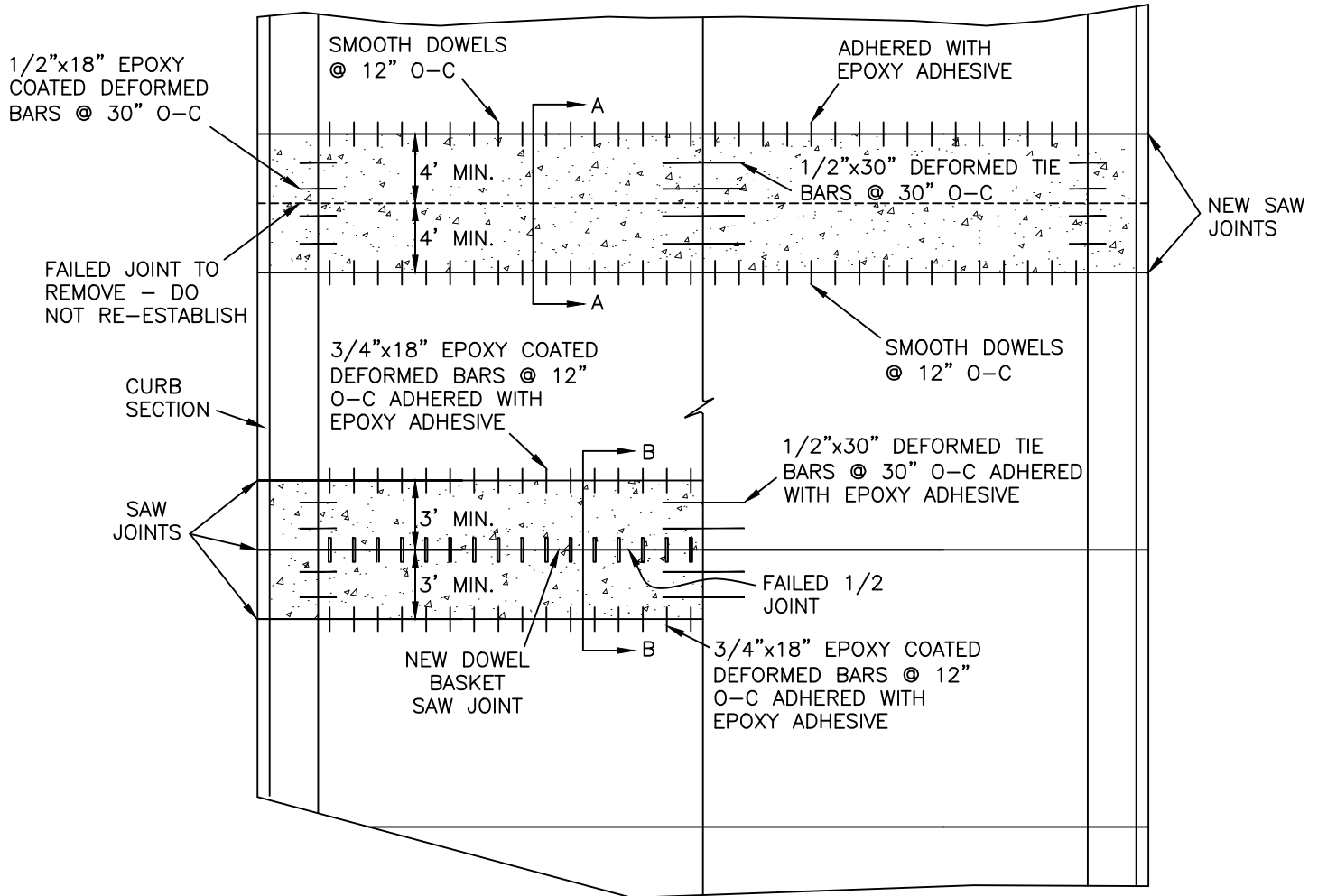
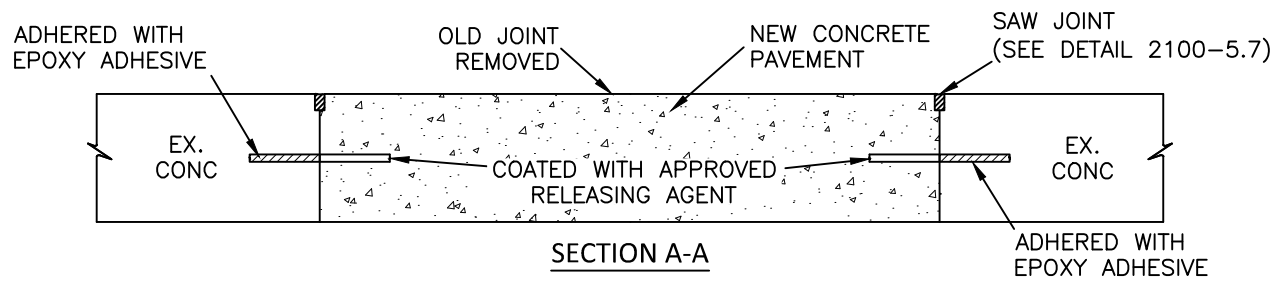
1/2"x30" #4
EPOXY COATED
DEFORMED BARS
@ 30" O.C. TIED
TO MATS

PANEL REINFORCEMENT
(#4 DEFORMED BAR
@ 24" O-C)



NOTES:

1. AREAS FOR REINFORCEMENT SHALL BE DETERMINED BY THE ENGINEER USING THE PLAN SHEETS AS A GUIDELINE. PAYMENT FOR REINFORCEMENT SHALL BE INCIDENTAL TO THE PRICE OF THE CONCRETE PAVEMENT.
2. REBAR MATS SHALL BE SECURED FROM HORIZONTAL MOVEMENT AND SUPPORTED BY CHAIRS AT THE MID-DEPTH POINT OF THE SLAB.
3. REBAR SHALL STOP WITHIN 15" OF THE DOWELED CONTRACTION JOINT.



NOTES:

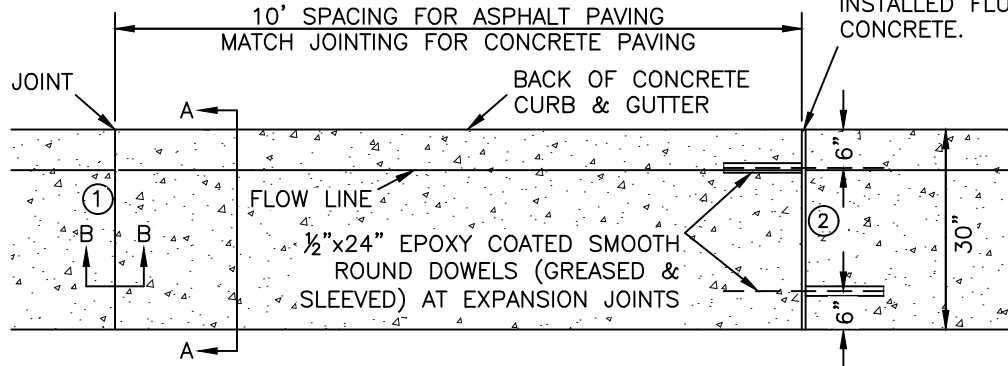
1. SMOOTH DOWELS - SEE CHART ON TRANSVERSE CONTRACTION JOINTS DETAIL 2100-5.5 FOR SIZE AND LENGTH.
2. SEE SAW JOINT DETAIL 2100-5.7.
3. THIS DETAIL SHALL ONLY APPLY TO REHABILITATION PROJECTS WHERE DESIGNATED ON THE PLANS.

① ASPHALT PAVING: SAW CUT OR TOOLED JOINTS AT 10' SPACINGS.

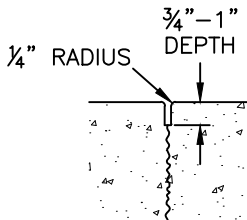
② PLACE 1" EXPANSION JOINTS AT P.C.'S AND AT 250' MAX. SPACINGS FOR ASPHALT PAVING

CONCRETE PAVING: SAW CUT JOINTS TO MATCH CONCRETE PAVEMENT JOINT SPACINGS.
SEE SAW JOINT DETAIL 2100-5.7.

1" EXPANSION JOINT MATERIAL SHALL BE PREMOLDED TO MATCH CURB DIMENSION AND INSTALLED FLUSH WITH TOP OF CONCRETE.

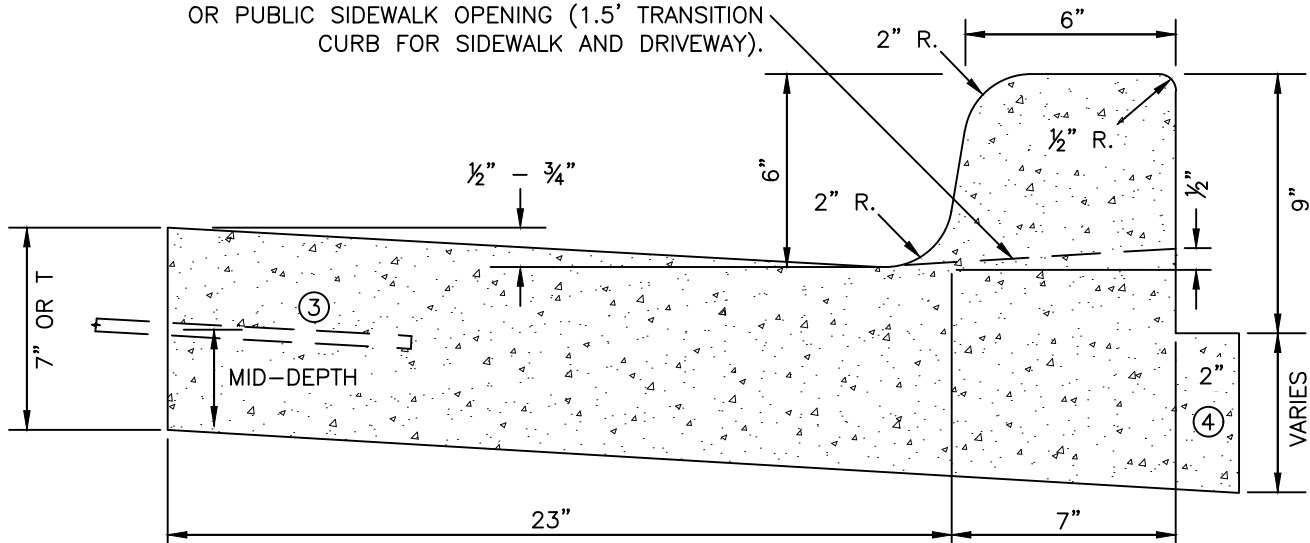


CURB & GUTTER PLAN



TOOLED JOINT DETAIL
SECTION B-B

CURB SECTION WHEN DROPPED FOR DRIVEWAY OR PUBLIC SIDEWALK OPENING (1.5' TRANSITION CURB FOR SIDEWALK AND DRIVEWAY).



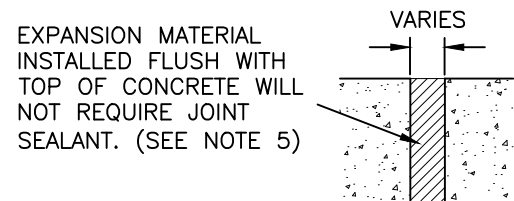
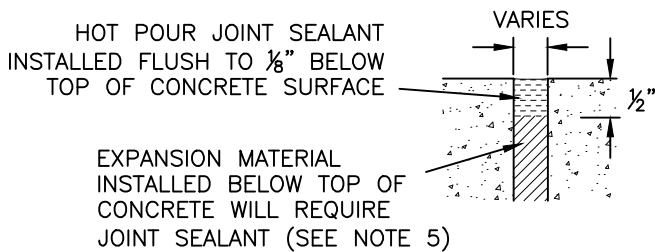
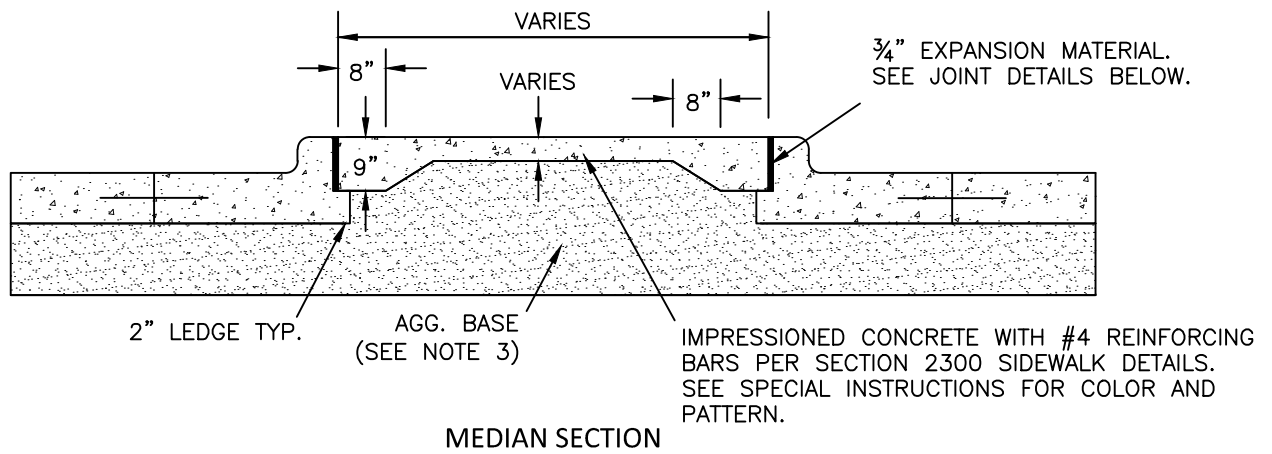
③ 1/2" x 18" DEFORMED BARS AT 30" O.C. REQUIRED WHEN ADJOINING CONCRETE PAVEMENT

④ 2" LEDGE REQUIRED WHEN ADJOINING DRIVEWAYS, MEDIAN CONCRETE, OR SIDEWALKS.

SECTION A-A

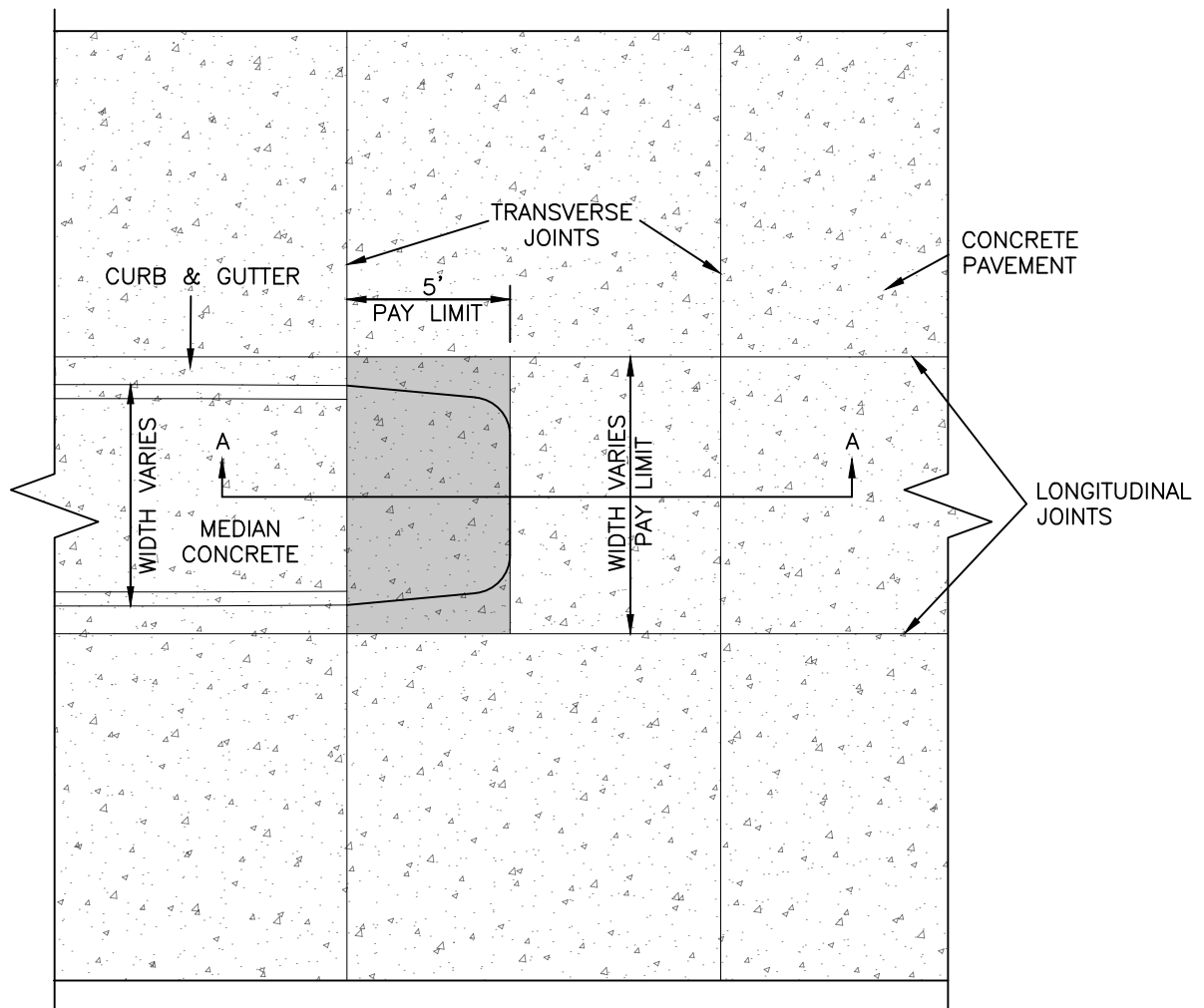
NOTES:

1. DIMENSION "T" SHALL MATCH THE THICKNESS OF THE ADJOINING CONCRETE PAVEMENT
2. WHEN OUTFLOW CURB IS SPECIFIED SLOPE SHALL BE 1/4" PER FOOT

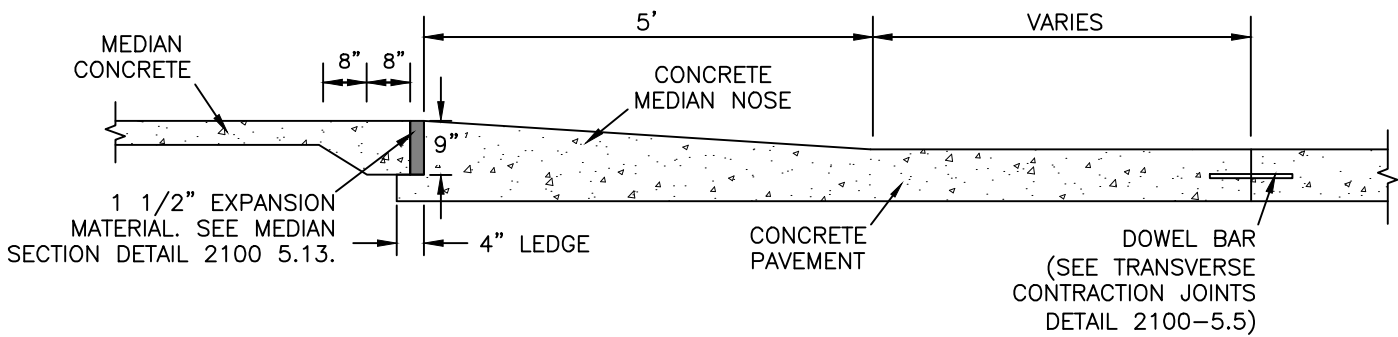


NOTES:

1. JOINTS SHALL BE SAWCUT AND MATCH THAT OF ADJACENT PAVE.
2. SEE MOUNTABLE (TYPE I) AND STANDARD (TYPE II) CURB & GUTTER DETAILS (2100-5.11 & 5.12) FOR 2" LEDGE DIMENSIONS. LEDGE INCIDENTAL TO CURB & GUTTER.
3. ADDITIONAL AGGREGATE BASE USED TO BRING MEDIAN IMPRESSIONED CONCRETE TO GRADE SHALL BE INCIDENTAL TO OTHER ITEMS.
4. TRANSVERSE 3/4" EXPANSION JOINTS SHALL BE PLACED AT 250-FOOT INTERVALS OR AS DIRECTED BY ENGINEER.
5. ALL EXPANSION MATERIAL SHALL BE INSTALLED FLUSH WITH THE TOP OF CONCRETE AND TIGHT AGAINST THE VERTICAL FACES. WHEN INSTALLED AS SPECIFIED, HOT POUR SEALANT WILL NOT BE REQUIRED. SEE SECTION 3.8.5. EXPANSION AND ISOLATION JOINTS IN STANDARD SPECIFICATIONS.



CONCRETE MEDIAN NOSE DETAIL

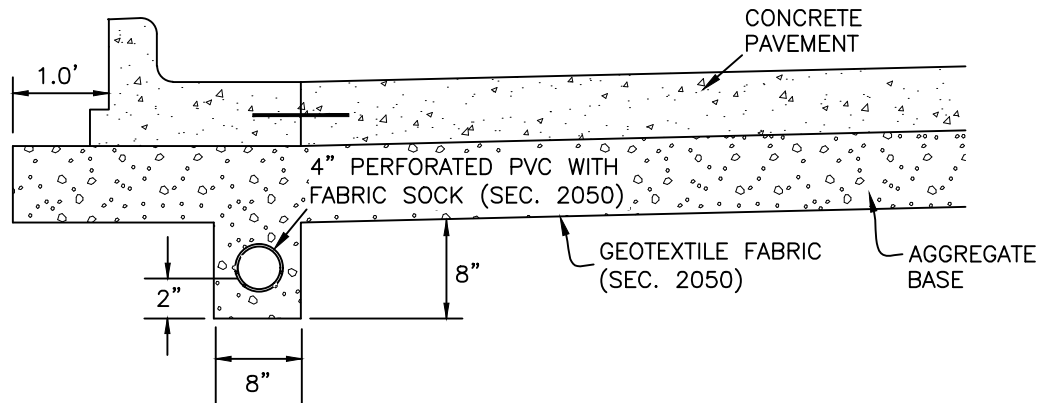


SECTION A-A

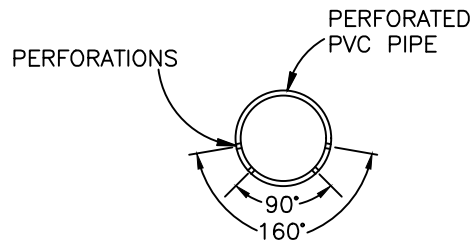
NOTE:
PAID AS "MEDIAN NOSE - CONCRETE"



- VALLEY
GUTTER**



EDGE DRAIN PLACEMENT



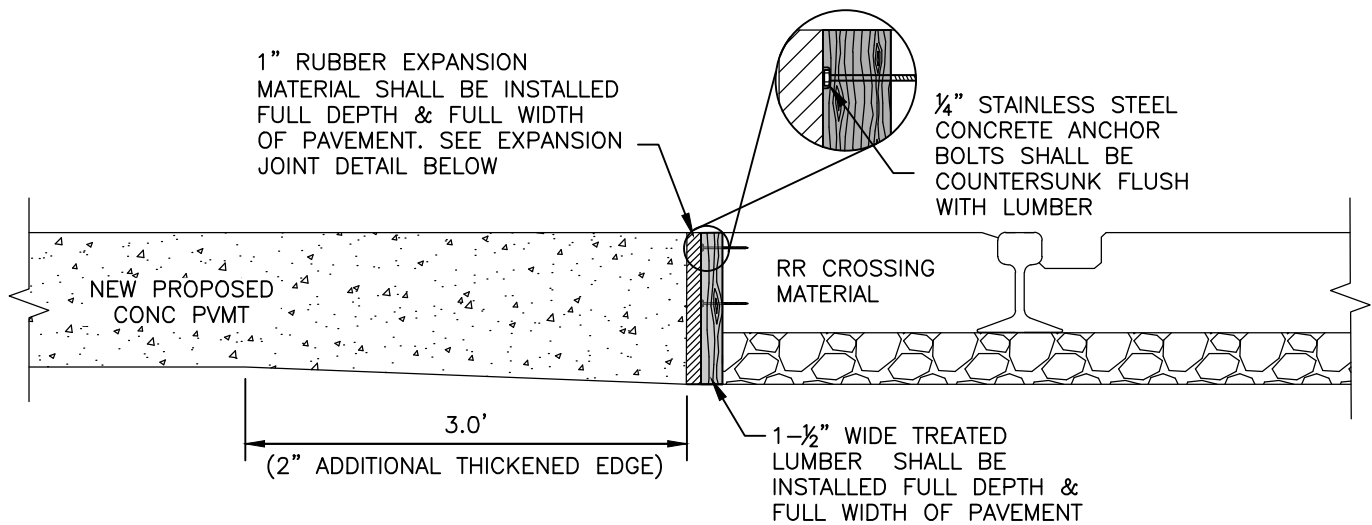
4" PVC PIPE DETAIL

TYPE OF PIPE:

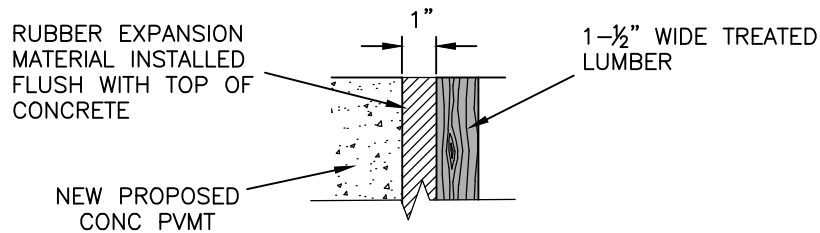
1. THE PIPE SHALL BE POLYVINYL CHLORIDE SCHEDULE 40 SEWER PIPE WITH SOLVENT CEMENTED JOINTS AS SPECIFIED IN ASTM SPEC. NO. F-758.
2. PERFORATIONS SHALL BE CIRCULAR AND $1/4" \pm 1/16"$ IN DIAMETER. THEY SHOULD BE ARRANGED IN ROWS PARALLEL TO THE AXIS OF THE PIPE AND SHALL BE SPACED APPROXIMATELY 3" CENTER TO CENTER ALONG THE ROWS. THE SPIGOT END OF THE PIPE SHALL BE UNPERFORATED FOR A LENGTH EQUAL TO THE DEPTH OF THE SOCKET. THE PLACEMENT AND TOTAL NUMBERS OF THE ROWS SHALL BE AS SHOWN ABOVE WITH AN ALLOWABLE TOLERANCE OF $\pm 10^\circ$.
3. MOLDED FITTINGS SHALL BE IN ACCORDANCE WITH ASTM SPEC NO. D 2665 OR F1866. COST OF FITTING AND INSTALLATION TO BE INCLUDED IN THE PRICE BID FOR 4" PVC EDGE DRAIN.
4. THE PERFORATED PVC SHALL BE ENCASED IN A GEOTEXTILE FABRIC PER SECTION 2050. COST OF FABRIC TO BE INCLUDED IN THE PRICE BID FOR 4" PVC EDGE DRAIN.
5. PIPE SIZE: 4" DIAMETER IPS SCH 40
6. ROWS OF PERFORATIONS: 4
7. HOLE SIZE: $1/4"$
8. HOLE SPACING PER ROW: 3"

NOTES:

1. SEE STORM INLET/PVC DRAIN PIPE DETAIL IN SECTION 1500 FOR ADDITIONAL DETAILS.



RAILROAD EXPANSION JOINT DETAIL - CONCRETE
NOT TO SCALE



EXPANSION JOINT DETAIL

NOTE:

1. ALL WORK AND MATERIAL SHOWN IN DETAIL SHALL BE INCIDENTAL TO PAVEMENT BID ITEMS.