

STANDARD SPECIFICATIONS

for the

CONSTRUCTION OF CONCRETE PAVEMENT

City of La Crosse, Wisconsin

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**STANDARD SPECIFICATIONS
for the
CONSTRUCTION OF CONCRETE PAVEMENT**

1. SCOPE OF WORK:

The work shall consist of a pavement of Portland cement concrete, with or without reinforcement as shown on the plans, constructed on a prepared subgrade, and in conformity with the lines, grades, thickness, and typical cross sections as shown on the plans for streets, alleys, and/or as specified. The concrete shall consist of a mixture of cement, fine aggregate, coarse aggregate, and water proportioned and mixed in accordance with the specifications.

2. CEMENT:

The cement shall be air-entrained Portland cement conforming to A.S.T.M. Designation C-175. Normal Portland cement conforming to A.S.T.M. Designation C-150 may be used, in the event air-entrained cement is not available, with the addition of an air-entraining agent approved by the Engineer and added in amounts designated by the manufacturer. Approval for use of air-entraining additives, if extended, shall be considered conditional only and contingent upon actual experience with the use of the material. Approval may be revoked at any time should unsatisfactory results be encountered.

3. WATER:

Water shall be used and paid for by the Contractor under the rules and regulations of the La Crosse Water Department and shall be clean, free from oil, acids, alkali or vegetable matter.

4. FINE AGGREGATE:

Fine aggregate shall consist of sand, or sand stone with similar characteristics, or combination thereof. It shall meet requirements of the State Department of Transportation of Wisconsin, Section 501.3.6.3 of the Standard Specifications for Highway and Structure Construction, current edition.

The fine aggregate shall be well graded from coarse to fine and shall conform to the following requirements:

<u>Sieve Size</u>	<u>% Passing</u>
3/8"	100%
No. 4	95 – 100%
No. 16	45 – 80%
No. 50	10 – 30%
No. 100	2 – 10%

5. COARSE AGGREGATE:

Coarse aggregate shall consist of clean, hard, durable gravel, crushed gravel, crushed boulders, or crushed stone. It shall meet the requirements of the State Department of Transportation of Wisconsin Section 501.3.6.4 of the Standard Specifications for Highway and Structure Construction, current edition.

Coarse aggregate shall be well graded between the limits specified in the following:

<u>Sieve Size</u>	<u>% by Weight Passing</u>	
	<u>Size No. 1</u>	<u>Size No. 2</u>
2"	-----	100
1"	100	20 – 55
3/4"	90 – 100	0 - 15
3/8"	20 – 55	0 - 5
No. 4	0 – 10	-----
No. 8	0 – 5	-----

The Contractor shall furnish coarse aggregate conforming to either Size No. 1 & 2, unless otherwise specified.

6. PROPORTIONING:

The following table sets forth the master limits of the job mix for the several grades of concrete, and designates the quantities of materials and relative proportions for each grade of concrete. For Air-Entrained High-Early-Strength Concrete, as required or permitted when High-Early-Strength Cement is used, the proportions shall be as given in the table.

The quantities of aggregates set forth in the tabulations are for oven dry materials having a bulk specific gravity of 2.65. For aggregates having a different specific gravity, the weights shall be adjusted in the ratio that the specific gravity of the material used bears to 2.65.

MASTER LIMITS OF JOB MIX

Concrete Grade & Class	Nominal Cement Factor (SKs./Cu. Yd.)	Water-Cement Ratio (Gals./Sk.)		Total Cem. (Lbs.)	Total Agg. Fine & Coarse (Lbs.)	Fine Agg. (% of Total Agg.)	Max. Mix Water (Gals.)
		Design	Max. Alld.				
A Air-Entrained	6.0	5.1	6.0	565	3050	30-45	36
B Air-Entrained	4.25	6.8	8.0	400	3220	30-45	34
C Air-Entrained	7.0	5.1	6.0	660	2850	35-45	42
D Air-Entrained	6.5	5.0	5.5	610	2960	30-45	36

*A "nominal" one cubic yard is defined as one having the above-prescribed quantities of cement and total aggregate, the "design" quantities of mixing water and an air-content of 6.0 percent.

The quantity of coarse aggregate shall be the difference between the total aggregate and the fine aggregate. The total quantity of coarse aggregate thus determined shall be proportioned between the two sizes as necessary to secure suitable workability and shall generally be within the range of 35-65 percent of Size No. 1 with Size No. 2 comprising the remainder, except when only one size is required.

The above mix is designed to produce a minimum 28-day compressive strength 3500 p.s.i. In the event that the test cylinders show strengths inconsistent with the desired strength, the City reserves the right to alter the design mix to achieve such results. Grade A concrete shall be used for concrete pavements.

7. JOB MIX:

Prior to the start of construction, the successful contractor or his suppliers shall have an independent testing and engineering laboratory prepare a design mix under Section 501 of the Standard Specifications, State of Wisconsin, Department of Transportation. Any costs for setting up the design shall be borne by the Contractor. The design mix shall be submitted to the City Engineer for his approval.

From the master limits of the job mix adjusted as necessary for the specific gravities of the aggregate furnished, the independent testing and engineering laboratory will determine the job mix, using the lowest quantity or percentage of fine aggregate within the range shown therefore which, without exceeding the maximum quantity of water permitted, will yield a mix possessing the necessary workability.

The difference between the amount of fine aggregate so determined and the total aggregate shall be coarse aggregate so proportioned between the two sizes within the limits set therefore, except when only one size is required, as necessary to yield the proper workability. In the event the characteristics of the aggregates proposed for use on the job by the Contractor are such that a workable mix cannot be produced with the maximum limits of fine aggregate and water set forth in the tabulation, the quantity of total aggregates shall be reduced sufficiently and the mix repropportioned so that a workable mix will be produced without exceeding the maximum permitted quantity of water.

The amount of water permitted shall include the free moisture in the aggregates, exclusive of the absorbed moisture determined as indicated in AASHO Designations: T 84 and T 85. The amount of water to be introduced into the batch shall be just that portion of the maximum, which in the opinion of the Engineer will produce a mixture of the consistency, plasticity and workability meeting the requirements for the class of work being built. The Engineer will designate, as the work progresses, the amount of water to be introduced into each batch and adjustments shall be made only by him or at his direction. Determination of stockpile moisture of the aggregates or absorption of moisture by aggregate during the period of mixing and handling will be made by the Engineer throughout the construction period as job conditions warrant, and the Engineer will make such corrections in aggregate weights for moisture as are necessary. Within the limitations designated, the relative proportions of fine and coarse aggregate may be varied from the initial determination, as the characteristics of the aggregate necessitate, in order to maintain workability.

Except as hereinbefore set forth, no adjustments in the mix or its proportions shall be made, nor shall the quantity of total aggregate adjusted as necessary for the specific gravities and moisture content shown in the tabulation be exceeded.

No guarantee of yield is expressed or implied by anything contained in these requirements.

The specified amounts of aggregate shall be measured by weight into each batch. Equipment for weighting shall be approved by the Engineer. Cement in sacks may be proportioned by volume. Cement in bulk shall be proportioned by weight.

A uniform consistency shall be continuously maintained in consecutive batches of concrete. Slipformed pavement concrete and formed pavement concrete consolidated by vibration shall have a slump of 1 to 2 inches.

Formed concrete pavement, placed and consolidated by machine methods without vibration, shall have a slump of 1 ½ to 3 inches, except that when the Contractor elects to place Ready-Mixed Concrete and discharges the concrete directly upon the subgrade from truck mixers or agitators by use of spouts, the slump shall be from 1 to 2 ½ inches.

Pavement concrete placed and consolidated by hand methods may have a slump not exceeding 3 inches.

Slump tests of concrete shall be made in accordance with the Method of Test for Slump of Portland Cement Concrete, AASHO Designation: T119.

8. AIR-ENTRAINMENT:

Air-Entrained Concrete shall be produced, as previously set forth, by the use of Air-Entraining Portland Cement, by an admixture used with Nonair-Entraining Portland Cement or by a combination of an admixture with Air-Entraining Portland Cement under the circumstances hereinafter delineated.

The Contractor will be required to follow an approved procedure for adding the specified amount of air-entraining admixture to each batch and will be held responsible for its uniform operation during the progress of the work.

Except as otherwise specifically provided, Air-Entrained Concrete shall contain 6.0 percent air, plus or minus 1.5 percent. The quantity of admixture to be used shall be sufficient to provide such percentage.

Field or commercially prepared solutions of the air-entraining admixture shall be added to the batch as prescribed in the Department of Transportation Standard Specifications, current edition.

For stationary or truck mixers the air-entraining agent shall be measured and introduced into the batch by an approved mechanical dispenser capable of being pre-set to deliver a specified quantity of admixture to each batch.

In the event the Contractor uses air-entraining cement and the quantity of entrained air is outside of the range specified to the degree that it cannot be corrected by slightly varying the ratio of sand to coarse aggregate or the mixing procedures, and the amount of air is beyond the maximum permitted, the cement causing such excess air will be rejected. The mixing time in no event shall be reduced below the minimum required elsewhere in the specifications. In the event insufficient air is entrained, which cannot be corrected as set forth in the above, the Contractor may increase the amount of air produced, by the addition of a sufficient amount of the admixtures previously described as are approved by the Engineer as compatible with that originally interground, to yield the desired results.

Tests for air-entrainment will be made throughout the progress of the work with such frequency and at such intervals as the Engineer may deem necessary to assure compliance with the requirements therefore.

The field determination of entrained air in the concrete shall control in the matter of acceptability of the Air-Entraining Portland Cement or other materials over the laboratory tests determining the potential properties of the respective materials themselves.

The tests for air-entrainment will be made on the freshly produced concrete.

In making the tests the Engineer may employ such accepted procedure as will measure the volume of air directly. Such tests, however, shall be subject to a check test at the request of the Contractor in the event of dispute or controversy over the method otherwise selected by the Engineer for these purposes, which check test shall be performed in accordance with the Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASSHD Designation: T 152.

9. SUB-GRADE:

The street or alley shall be graded to the proper subgrade. After the forms have been set, the subgrade shall be tested by means of a templet. The templet shall be so constructed to indicate correctly locations where the subgrade does not conform to specified elevation and section. High areas shall be trimmed and low areas brought to proper elevation. A subgrade planer shall be used immediately before concrete is placed as a final check. The planer shall have a cutting edge set to conform to subgrade. It shall be mounted on rollers or wheels and shall be of sufficient weight to shave off high spots.

Concrete shall not be deposited on a dry subgrade. The subgrade shall be well sprinkled with water in advance of the paver.

10. FORMS AND FORM SETTING:

Side forms shall be of wood or metal, of approved cross section, of minimum depth equal to the thickness of the pavement, and without horizontal joints. For curves of less than 100 ft. radius, wood, or flexible forms shall be used. Forms with battered top surfaces and bent or twisted forms shall be staked by using not less than 3 pins for each 10 ft. section. Such pins shall be driven in the stake pockets of the forms and the forms shall be securely fastened to each pin by adequate locking devices. Form sections shall be tightly joined by a locked joint free from play or movement in any direction. In no case shall the base width of form be less than 8" for forms 8" or more in height. Forms shall be cleaned and oiled each time they are used. Forms shall be set at least 500 ft. in advance of the point where concrete is being placed. Old asphalt shall be removed from contact surfaces of all fixtures, existing curb and gutter, and concrete pavement.

Forms shall be set upon the prepared subgrade to proper line and grade and firmly staked in position. The fine grading shall then be completed and the subgrade thoroughly compacted by hand tamping. Before placing any concrete, the contact surfaces of the forms shall be oiled.

Before placing concrete, the forms shall be finally checked in the presence of the Engineer as to proper line and grade.

SLIP FORM PAVING:

The Contractor may, elect to use a machine for placing, forming, and consolidating concrete pavement. The resulting concrete pavement shall be of such quality, and as per standard details, to equal or exceed that produced by method herein before described.

11. SITE MIXED CONCRETE:

The Contractor and/or supplier may use site mixed concrete and must demonstrate to the Engineer that such concrete produced with such equipment in such plant will meet all the requirements for uniformity and quality contemplated under these specifications. The Engineer reserves the right to test scales at such plants or require that they be tested by an authorized testing firm or agency. In any case, however, when bulk cement is used it shall be weighed on a scale separate from those used for weighing other materials and in a hopper entirely free and independent of the hoppers used for weighing the aggregates. Concrete shall be mixed in a batch mixer of approved type and capacity for a period on not less than one minute. The mixer shall be equipped with an approved timing device to insure proper mixing time.

In the event equivalent results are not realized with the equipment on hand, such concrete will not be accepted from such plant unless and until the equipment is brought up to meet the requirements previously set forth.

12. READY-MIXED CONCRETE:

Ready-mixed concrete may be used in lieu of Site-Mixed Concrete. Ready-Mixed Concrete shall be construed to include central-mixed, transit-mixed and shrink-mixed concrete, described as follows:

Central-mixed concrete is concrete, which has been completely mixed in a stationary mixer and transported to the point of delivery with or without mechanical agitation in the transporting vehicle.

Transit-mixed concrete is concrete, which has been completely mixed in a truck mixer.

Shrink-mixed concrete is concrete, which has been mixed partially in a stationary mixer with the mixing completed in a truck mixer.

Except as hereinafter provided all of the requirements of the specifications will be applicable to Ready-mixed concrete.

Ready-mixed concrete shall be delivered at a rate that will assure reasonably continuous progress in the placing and finishing operations. In the event the time intervals between successive loads or batches are such as to cause a partial drying of previously placed concrete, the Contractor shall provide additional equipment of the kind necessary to preclude such delays. Failing in this the use of Ready-mixed concrete shall be discontinued and Site-mixed concrete shall be used.

Unless otherwise provided in the contract, concrete pavement, except continuously reinforced pavement, constructed with Ready-mixed concrete may be placed in either single-lane or double-lane widths in a single construction operation, provided that when the Contractor elects to place such concrete in double-lane widths, facilities for the production and delivery are such as to assure placement at a uniform rate of not less than 80 cubic yards per hour.

Ready-mixed concrete shall be delivered to the site of the work and be completely discharged from the transporting vehicle, other than non-agitating types, within the following time limits commencing with the introduction of the mixing water to the cement or the cement to the aggregates:

For Class C concrete, ---- 1 hour.

For Class A and B concrete, and for Class D concrete for use in seals, when the atmospheric temperature at time of placement is 60F or higher ---- 1 ½ hours.

For Class A and B concrete, and for Class D concrete for use in seals, when the atmospheric temperature at time of placement is 60F or higher ---- 1 hour.

These times may be reduced by the Engineer or Inspector under conditions contributing to quick stiffening of the mix, or during cold weather when loss of heat occurs to such an extent that the concrete will not be at the proper temperature when placed.

Except during the mixing revolutions, the drum or agitator of the vehicle shall operate at agitating speed until discharge of the mix.

The concrete at the time of delivery shall be uniform in composition, of the required consistency and shall have the required air content.

Non-agitating type truck haulage of concrete is not permitted.

Mixers may be stationary mixers or truck mixers and shall be of the revolving drum type or, subject to and with the written approval of the Engineer; they may be of other types specifically designed by the manufacturer for mixing purposes.

Agitators may be truck mixers or truck agitators. Each stationary mixer, truck mixer or truck agitator shall have attached in a prominent place, by the manufacturer, a metal plate on which is plainly marked the various uses for which the equipment is designed, the capacity of the drum or container in terms of volume of mixed concrete and speed of rotation of the mixing drum or blades.

When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers having a rated capacity of one cubic yard or less shall be not less than one minute; for mixers having a rated capacity greater than one cubic yard, the mixing time shall be not less than one minute, provided that plant operating procedures are reasonably stabilized and controlled and that apparent blending of materials during charging is achieved to the satisfaction of the Engineer. Should such stabilization, control and blending not be so accomplished, the right is reserved by the Engineer to increase the mixing time to 75 seconds.

The maximum mixing time for stationary mixers shall not exceed the minimum hereinbefore specified for the respective size of mixer, by more than 60 seconds.

Transfer time in multiple drum mixers shall be counted as part of the mixing time.

For stationary mixers, the total volume of mixed concrete shall be computed on the basis of the nominal cubic yard of concrete as provided under paragraph 6, "Proportioning", and shall not exceed the manufacturer's rated maximum mixing capacity as given, for the type and volume of mixer used, in the latest edition of the Concrete Plant Mixer Standards of the Concrete Plant Manufacturer's Bureau.

When concrete is mixed in a truck mixer, each batch shall be mixed not less than 70 nor more than 110 revolutions of the drum or blades at the rate of rotation designated by the mixer manufacturer as mixing speed. Additional revolutions, if any, shall be at the speed designated by the manufacturer as the agitating speed. All materials, including mixing water, shall be in the mixer drum before mixing revolutions are started.

The mixing water shall be added at the batching plant but if additional mixing water is required to obtain the specified slump, water may be added with the permission of the Engineer. The total of all free and added water shall not be in excess of that permitted elsewhere in these specifications. If additional water is added at the site of the work, a minimum of 20 revolutions of the truck mixer at mixing speed will be required before discharge of any concrete. The additional water shall be added and the additional mixing done at the site of the work within 45 minutes after the introduction of the mixing water to the cement or the cement to the aggregates. This time may be extended, by the Engineer, to 75 minutes for those classes of concrete mixed under the conditions described in Subsection 501.8.2 for which the delivery time limit is 1-½ hours. When additional revolutions at mixing speed are required because of water added at the site, the total revolutions at mixing speed shall not exceed 110.

When a truck mixer or truck agitator is used for transporting concrete, which has been completely mixed in a stationary mixer, the drum or agitator shall rotate during transportation and until discharge at the agitating speed.

Truck mixers shall be equipped with an approved revolution counter and, unless equipped with an accurate and dependable device which will indicate and control the number of revolutions at mixing speed, the mixing shall be done at the job-site or at the batching plant and the mixing unit shall be operated at agitating speed between the plant and the job-site.

The foregoing requirement for a counter which records only at mixing speed or in lieu thereof mixing only at the plant or job site shall not apply to truck mixers operating from plants erected for the sole purpose of supplying concrete to highway projects when the delivery time is short enough so that the maximum number of revolutions for mixing cannot be exceeded in transit.

When a stationary mixer is used for partial mixing of the concrete (shrink-mixing), the mixing time in the stationary mixer may be reduced to the minimum required (about 30 sec.) to intermingle the ingredients.

When a truck mixer is used to finish the partial mixing done in a stationary mixer (shrink-mixing), each batch shall be mixed not less than 50 nor more than 110 revolutions of the drum or blades at the rate of rotation designated by the mixer manufacturer as the mixing speed.

For truck mixers, the total volume of concrete mixed per batch shall be computed on the basis of nominal cubic yard of concrete as provided under Paragraph 6, "Proportioning", and shall not exceed the manufacturer's rated capacity nor the following percentages of the gross volume of the drum.

For complete mixing, 63 percent.
Partial mixing, initial (shrink) mixing done
in stationary mixer, 70 percent.

13. PLACING CONCRETE:

No concrete shall be placed around castings and frames of manholes and inlets or around joints and other fixtures until such castings, frames, joints, and fixtures have been accurately adjusted and set to the required alignment and grade.

Concrete shall be placed immediately after mixing and in no case shall concrete be used which does not reach its final position in the form or slab, within 30 minutes after the time that the water is first added to the batch, except as specified under Ready-mixed concrete. The method and manner of placing shall be such as to minimize the possibility of segregation or separation of the aggregate.

Concrete retempered by adding water, or by any other means, shall not be used, except as herein stated in Paragraph 12.

The operation of proportioning, mixing, placing and finishing concrete for any monolithic unit shall, except as otherwise specifically provided, be as nearly continuous as possible.

The operation of depositing and consolidating the concrete shall conform to the pertinent requirements specified under the specific contract items and, in general, shall be conducted so as to form a compact, dense, impervious, artificial stone of uniform texture which shall show smooth faces on all exposed surfaces.

In case of a temporary shutdown, the concrete at the unfinished end of the slab shall be covered with wet burlap. When a delay of more than 30 minutes occurs, a construction joint shall be installed. Sections of pavement less than 10 feet in length between joints will not be permitted.

14. TEST SPECIMENS:

The Engineer reserves the right to cast test cylinders. Four such cylinders (2-7 day, 2-28 day) may be cast for each day's pour. The Contractor shall have these cylinders tested at an independent test laboratory and is responsible for all shipping, testing, and container charges.

15. CONSOLIDATING AND FINISHING:

The sequence of operations shall be – strike-off, consolidation, screeding, float finishing, straight edging, joint finishing, edging, and final surface finish.

a. Strike-off and Consolidation:

The machine method of strike-off and consolidation shall be employed except that area where slab width is variable, or lanes of pavement less than 9 ft. in width, and other areas where in the opinion of the Engineer the use of machine methods is impractical, then hand methods may be allowed.

The machine equipment shall be of the screeding and troweling type, designed and operated both to strike off and to consolidate. The machine shall go over each area of pavement as many times as necessary to give the proper compaction and to leave a surface of uniform texture, true to grade and contour. At least three trips shall be required but if necessary, additional screeding shall be done. The concrete near the forms shall be vibrated or hand spaded.

All equipment operating over fresh concrete shall have adequate drip pans beneath the motors to protect the concrete from spillage of oil.

When the hand method is permitted, the entire surface shall be tamped until the required compaction and reduction of surface voids is secured. The strike-off or tamping templet shall be of steel or wood shod with metal. No less than four men shall be engaged in the exclusive work of strike-off.

Surface type vibratory screeds may be used for hand strike-off and consolidation, provided equivalent or better results are produced.

b. Longitudinal Floating:

Following the final trip of the finishing machine, the surface of the pavement shall be floated by an approved mechanical longitudinal float or by means of a hand-operated float. The float shall be rigid 10-16 ft. long, made of 2" X 6" metal shod plank. The float shall be operated with a sawing motion parallel to the road centerline with its bottom in full contact with the pavement, and pass gradually from one side of the pavement to the other. Floats of other designs may be used where found effective and approved by the Engineer. Advancing movements along the pavement shall be in increments of not more than one-half the length of the float.

c. Straight edging:

After the longitudinal floating has been completed, the slab surface shall be made smooth and tested for trueness by dragging a 10 ft. straightedge. The straightedge shall be placed at the center of the slab with the blade parallel to the centerline and pulled slowly and uniformly to the edge.

The advance along the road shall be made in stages not more than one-half the length of the straightedge. Any depressions found shall be filled and projections struck off.

d. Final Surface Finish:

The pavement shall be given a surface finish by brooming or burlap drag as set forth in Standard Specifications for Highway and Structure Construction, Dept. of Transportation, current edition.

e. Edging:

After final surface, but before the concrete has taken its initial set, the edges of the slab and the expansion joints shall be finished with an edger having a radius of not more than 1/4" and the pavement left smooth and true to line.

f. Surface Test:

After the concrete has hardened, the surface of the pavement shall be tested with a 10 ft. straightedge. Any portion of the pavement which shows a variation or departure from the testing edge of more than 1/8 inch will be plainly marked and shall be removed or reduced by the Contractor by rubbing with a carborundum brick and water. Rubbing shall be discontinued as soon as the contact with the coarse aggregate is made. In no case shall the rubbing be done in such manner that the bond between the mortar and particles of coarse aggregate will be broken.

16. CURING:

Immediately after finishing operations have been completed, the entire surface of the concrete shall be sealed by spraying thereon an impervious membrane. The liquid curing compounds shall conform to the requirements of the Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete, AASHTO Designation, M-148, Type 2, White Pigmented. Unless a greater rate of coverage is specified by the manufacturer, it shall be at 200 square feet per gallon of curing agent. Within 30 minutes after the forms are removed, the edges of the pavement shall be coated with curing compound.

17. REMOVING FORMS:

Forms shall not be removed until the concrete has set for at least 12 hours, unless authorized by the Engineer. Forms shall not be dropped or stacked on pavement, which is less than seven days old.

18. COLD WEATHER:

Concrete operations shall not be continued when a descending air temperature in the shade falls below 40°F., nor resumed until an ascending air temperature in the shade reaches 35°F. except on written authorization. The Contractor shall conform to State Standard Specifications for Highway and Structure Construction, current edition.

The Contractor shall assume entire responsibility for the proper protections and final satisfactory condition of all concrete placed during cold weather or exposed to cold weather within the required protection period, and this responsibility shall extend to adequacy of all equipment and methods necessary to conform to the requirements of the contract. Any concrete which in the judgment of the Engineer shall have been damaged by lack of proper protection shall be removed and replaced, upon order of the Engineer, with satisfactory concrete at the Contractor's cost and expense.

If necessary, the water or aggregates or both may be heated. When the aggregates are frozen or contain frost, they shall be heated. Aggregates may be heated by steam or by other means in a manner which will heat the mass uniformly and preclude the possible occurrence of overheated areas. Mixing water shall be heated in such a manner that its temperature is accurately controlled.

The temperature of either the mixing water or the aggregates shall not be in excess of 100°F. when placed together with the cement in the mixer, and the temperature of the water and the aggregates shall be such that the temperature of the batch of mixed concrete will be not less than 50°F. nor more than 80°F. If either the aggregate or the mixing water is heated to a temperature in excess of 100°F., the water and the aggregates shall first be mixed together in such a way that the resulting temperature of the combined water and aggregates is not in excess of 100°F. before being mixed with the cement.

The Contractor shall take all precautions necessary to prevent freezing of the concrete and to produce quality concrete.

Where High-Early-Strength Concrete is used, the above required periods for covering may be reduced to not less than four days.

Where removal of the coverings is necessary to saw joints or to perform other required work, such removal shall be done as directed by the Engineer and for the minimum time required.

Regardless of the precautions taken, the Contractor shall be responsible for the protection of the concrete placed, and any concrete damaged by freezing or frost action during the first 7 days following its placement shall be removed and replaced by the Contractor at his expense.

Heating of cement will not be permitted. The addition of salt or chemical admixtures to the concrete mix to prevent freezing will not be permitted. Concrete shall not be placed on a frozen subgrade.

Concreting operations shall be discontinued due to insufficient natural light, unless an adequate and approved artificial lighting system is provided and operated.

19. PROTECTION OF CONCRETE:

The Contractor shall protect the new pavement from traffic damage at his expense. This includes erection and maintenance of barricades, warning lights or signs, and watchmen to direct traffic. Traffic shall be excluded from newly constructed pavement for not less than 7 days when the temperatures are generally 70°F. or higher and not less than 10 days when the temperatures are generally not lower than 60°F. traffic shall be kept off for any length of time the Engineer may require up to 21 days. Any part of the pavement damaged by traffic or otherwise damaged prior to its final acceptance shall be repaired or replaced by and at the expense of the Contractor to the satisfaction of the Engineer.

20. JOINTS:

a. GENERAL:

(1) **Longitudinal and transverse joints** shall be constructed as indicated on the plans and in accordance with these requirements. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. Joints shall not vary more than $\frac{1}{4}$ inch from a true line or from their designated position. The vertical surface of the pavement adjacent to all expansion joints shall be finished to a true plane and edged to a radius of $\frac{1}{4}$ inch, or as shown on the plans. The surface across the joints shall be tested with a 10-foot straightedge as the joints are finished, and any irregularities in excess of $\frac{1}{8}$ inch shall be corrected before the concrete has hardened. When required, keyways shall be accurately formed with template of metal or wood. The gauge or thickness of the material in the template shall be such that the full keyway, as specified, is formed and is in the correct location. Transverse joints shall be at right angles to the centerline of the pavement and shall extend the full width of the slab. The transverse joints in succeeding lanes shall be placed in line with similar joints in the first lane. In the case of widening existing pavements, transverse joints shall be placed in line with similar joints in the existing pavement. All joints shall be so prepared, finished, or cut to provide a groove of sufficient width and depth to receive and effectively retain joint-sealing material.

(2) **Tie bars installed principally in longitudinal joints** or as shown on the plans shall consist of deformed bars of $\frac{5}{8}$ -inch diameter and 30 inches long, or as designated on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals of 30 inches, unless otherwise specified. They shall be held in position parallel to the pavement surface and midway between the surfaces of the slab. When tie bars extend into an unpaved lane, they may be bent at right angles against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. These bars shall not be painted, greased, or enclosed in sleeves.

(3) **Dowel bars or other load-transfer units** of approved type shall be placed across transverse or other joints in the manner as specified on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A metal, or other type, dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on the plans. The portion of each dowel painted with rust preventative paint shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. An approved metal dowel cap or sleeve conforming to the requirements as shown on the standard detail sheet shall be furnished for each dowel bar used in expansion joints. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

b. INSTALLATION:

If the paving mixer is operated from an adjacent lane, any joint materials required shall be set immediately after the final testing of the grade. If the paving mixer is operated from the lane being poured, the materials shall be set immediately after the mixer moves forward to permit as much time as possible for proper installation. All joint materials required shall be put in place on the completed and accepted grade. The materials and joint position shall be either at right angles or parallel to the centerline of the pavement, except for fillets or irregular sections. The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be checked.

Such devices shall be set to the required position and line and shall be securely held in place by stakes or other means during the pouring and finishing of the concrete. The pre-molded joint material shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units. Dowel bars shall be checked for exact position and alignment as soon as the joint device is staked in place and the device shall be tested to determine whether it is firmly supported. Any joint installation not firmly and securely supported shall be reset.

When joints in concrete pavements are sawed, the joints shall be cut at the time and in the manner approved by the Engineer.

The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and at all times during concrete placement.

The circular cutter shall be capable of cutting a groove in a straight line; the circular cutter shall produce a slot at least 1/8 inch wide. When shown on the plans or required by the specifications, the top portion of the slot or groove shall be widened by means of a second shallower cut or by suitable and approved beveling to provide adequate space for joint sealers. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing. Sawing shall be carried on both during the day and night as required. The joints shall be sawed at the required spacing consecutively in sequence of the concrete placement, unless otherwise approved by the Engineer.

c. LONGITUDINAL JOINTS:

(1) Construction. Longitudinal construction joints necessary for lane construction shall be formed against suitable side forms (usually made of steel) with keyways, unless otherwise indicated in the plans. Wooden forms may be used under special conditions, when approved by the Engineer. In those instances where the keyed construction joint is not designated, a butt-type joint with dowels shall be installed. The dowels for this type joint shall be painted and greased. The edges of the joint shall be finished with a grooving tool or edging tool and a space or slot shall be formed along the joint of the dimensions, as indicated, to receive the joint sealing material. Provisions shall be made for the installation of tie bars as noted on the plans.

(2) **Contraction or weakened-plane type.** The longitudinal groove formed or sawed in the top of the slab shall be installed where indicated on the drawings. The groove shall be formed in the plastic concrete with suitable tools or material to obtain the width and depth specified, or it shall be sawed with approved equipment in the hardened concrete to the dimensions required. When the groove is formed in plastic concrete, it shall be true to line with not more than ¼ inch variation in 10 feet; it shall be uniform in width and depth; and the sides of the groove shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The sawed groove shall be straight and of uniform width and depth. In either case, the groove shall be clean cut so that spalling will be avoided at intersections with transverse joints. Tie bars shall be installed across these joints, unless otherwise shown on the plans.

d. **TRANSVERSE JOINTS:**

(1) **Expansion.** Transverse expansion joints shall be installed at the locations and spacing as shown on the plans. The joints shall be installed at right angles to the centerline and perpendicular to the surface of the pavement. The joints shall be so installed and finished to insure complete separation of the slabs.

Pre-molded joint filler for expansion joints shall conform to the requirements for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, AASHTO Designation: M 153, Types I, II, or III, or the Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction, AASHTO Designation: M 213, as per State D.O.T. Standard Specification Latest Designation. Also approved for expansion joint filler material is material conforming to A.S.T.M. D-1751 Specifications and/or U.S. Federal Specification HH-F-34le Type 1. The premolded joint filler shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

All concrete shall be cleaned from the top of the joint material. Before the pavement is opened to traffic this space shall be swept clean and filled with approved joint sealing material.

The filler shall be placed on the side of the installing plate nearest the mixer. The top edge of the filler shall be protected by a metal channel cap of at least 10-gauge material. The installing device may be designed with this cap self-contained.

All devices used for the installation of expansion joints shall be approved by the Engineer. They shall be easily removable without disturbing the concrete and held in proper transverse and vertical alignment. Immediately after forms are removed, any concrete bridging the joint space at the ends shall be moved for the full width and depth of the joint.

Expansion joints shall be equipped with dowels of the dimensions and at the spacing and location indicated on the plans. The dowels shall be firmly supported in place and accurately aligned parallel to the subgrade and the centerline of the pavement by means of a dowel assembly, which will remain in the pavement and will insure that the dowels are not displaced during construction.

Other types of load-transfer devices may be used, when approved by the Engineer.

(2) **Contraction.** Transverse contraction joints, weakened-plane joints, or both, shall be installed at the locations and spacing as shown on the plans. These joints will be installed by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened in the same manner as specified. Dowel bar assembly shall be installed, when required, as shown on the plans. Reinforcing steel mesh or bars shall be continued through the weakened-plane joints as shown for reinforced concrete pavement.

(3) **Construction.** Transverse construction joints shall be installed, when it is necessary to suspend work for more than 30 minutes, in accordance with details on the plan. The standard transverse construction joint shall be used when such suspension of work can be planned in advance so that the joints is located at the normal location for contraction or expansion joint. Should the discontinuance of paving operations fall short of normal location of contraction or expansion joint, it will be required that a tied construction joint be installed, as shown on the standard detail. If the pouring of concrete has been stopped falling within the 8-foot limitations, the fresh concrete shall be removed back to the previous normal transverse construction joint.

e. **SEALING JOINTS:**

Unless otherwise provided in the contract, all contraction and expansion joints in concrete pavement, which are required to be sealed, shall be sealed with Hot-Poured Elastic Type Joint Sealer equal to Sealtight Hi-Spec. Polymeric Compound and meeting Fed. Specs. SS-S-1401B and ASTM Specs. D3405. The sealer shall be installed in accordance with the manufacturer's recommendations, which includes "tooling" the surface of the sealant with a blunt instrument so that the surface is slightly concave and approximately one-quarter inch below the pavement surface. Tooling should be done before skin forms on the sealant, usually within ten minutes of application.

Each lot of the sealer shall be delivered in containers plainly marked with the manufacturer's name or the trademark and the date of manufacture.

A certificate of compliance (manufacturer's certification) to the effect that the material furnished complies with the specified requirements for the item shall be submitted to the Engineer in triplicate and acceptance of the material shall be obtained before installation in the work will be permitted.

Joints shall not be sealed until they have been inspected and approved by the Engineer.

Should any spalling of the sawed edges occur that would in the opinion of the Engineer detrimentally affect the joint sealing ability, it shall be patched with an approved epoxy and allowed to harden prior to installation of the joint seal. Each patch shall be true to the intended neat lines of the finished cut joint.

The operation of sealing shall be performed as soon as practical upon elapse of the curing period, and in any event; prior to the time traffic of any kind uses the pavement. All joint sealing shall meet requirements of the Department of Transportation of Wisconsin, Standard Specifications for Highway and Structure Construction, current edition, Except for material to be used as specified above.

21. **HIGH-EARLY-STRENGTH CONCRETE PAVEMENT:**

- a. **General:** High-Early-Strength Concrete Pavement shall be constructed when and where required by the plans or special provisions. All other requirements hereinbefore specified for "Concrete Pavement" shall be applicable, subject to modifications set forth.
- b. **Curing:** High-Early-Strength Concrete Pavement shall be cured for the period specified for concrete pavement, provided that the curing period shall end if and when the pavement is opened to traffic prior to the expiration of specified curing period.
- c. **Opening to traffic.** Traffic shall be excluded from the newly constructed pavement for such periods as are hereinafter designated:

For not less than 3 days when the atmospheric temperatures are generally 70°F. or higher during the period.

For not less than 4 days when the atmospheric temperatures are generally not lower than 60°F. during the period.

For not less than such a length of time up to 7 days as the Engineer may require, taking into consideration the temperatures and protective measures, if any, when the atmospheric temperatures are generally lower than 60°F.

- d. **Protection during cold weather.** High-Early-Strength Concrete Pavement shall be protected in cold weather in accordance with the previous pertinent requirements.

22. **SAWING EXISTING CONCRETE FOR REMOVAL:**

This work shall consist of full-depth sawing of existing concrete pavement, curb and gutter, driveways, sidewalks or other concrete work that is to remain in place as directed by the Engineer.

Full depth sawcuts of concrete shall be made with diamond blades. The full depth saw cut shall be straight as marked by the Engineer and performed so that the surface to remain is generally vertical for its full depth.

The sludge from sawing shall be removed from the pavement upon completion of each saw cut by methods, which minimize the amount of sludge flowing onto or being deposited on the pavement of any live traffic lane.

All traffic control devices shall be cleaned of any sludge deposits by darkness of the day in which the deposition occurs.

Sludge from sawing may only be disposed of on areas of the roadway or roadside approved by the Engineer.