Chapter amendments approved:	OMPC	Owensboro	Daviess Co.	Whitesville
Re-adoption of Public Improvement Specifications	24-Mar-77	01-Apr-77	20-Apr-77	?
Revised Public Improvement Specifications	18-Apr-81	22-May-81	26-May-81	06-Jul-81
Street geometrics revised	08-Dec-83	06-Mar-84	22-Feb-84	?
2002 Revised Public Improvement Specifications	08-Aug-02	No action required by legislative bodies		
Revised Public Improvement Specifications	11-Mar-10	No action required by legislative bodies		
Revised Public Improvement Specifications	11-May-17	No action required by legislative bodies		

3.0 PURPOSE. The purpose of this chapter is to give the standards to which all streets should be designed and built. This chapter covers the requirements and specifications for street construction including excavation and compaction for embankments and roadbeds, subgrade stabilization, DGA base course, bituminous concrete pavement, Portland cement concrete paving, field testing, inspections and pollution control.

3.1 STREET GEOMETRICS. Local streets shall conform to the applicable geometric, cross-sections, and intersection standards as specified hereinafter and shown by Exhibits 3-1 through 3-6. All other classes of streets shall be designed by an Engineer licensed in Kentucky, and designed to the standards in the most current edition of AASHTO "A Policy on Geometric Design of Highways and Streets". Streets shall be related to topography and shall generally provide for the continuation of existing streets in adjoining or nearby tracts.

3.2 CLASS OF STREET. Streets shall be classified as freeways, arterials, collectors or locals.

3.2.1 Freeways hold the first rank in the classification of streets, and are used only for movement of vehicles, providing for no vehicular or pedestrian access to adjoining properties; interchange of traffic between a freeway and any other streets is accomplished by grade separated interchanges with merging deceleration and acceleration lanes, and no at-grade intersections are permitted. Freeways generally carry higher volumes, require greater right-of-way width, and permit higher speed limits than any other class of street. Arterials are the only class of street that generally should be connected with expressways at interchange points.

3.2.2 Arterials hold the second rank in the classification, and should be used only for the movement of vehicles, and preferably should not provide for vehicular access to adjacent properties. Interruption of traffic flow should be permitted only at street intersections that should contain medians, deceleration lanes, and left turn storage lanes. Arterials are the link between freeways and collectors, and rank next to freeways in traffic volumes, speed limit, and right-of-way width.

3.2.3 Collectors hold the third rank in the classification of streets, and are used more for movement of vehicles than for providing access to adjacent properties. Access to adjoining properties should be planned and controlled so that minimum disturbance is made to the traffic moving efficiency of the collector street. Intersections should contain medians, deceleration lanes, and left turn storage lanes. Collectors are the link between arterials and local streets, and generally rank next to arterials in traffic volumes, speed limit, and right-of-way width.

3.2.4 Locals hold the fourth rank in the classification of streets, and are used primarily for providing access to adjacent properties. Vehicles moving on these streets should have an origin or destination in the immediate vicinity, and all types of through traffic should be eliminated thru initial design of its connections with other streets. Local streets are the primary link between trip generation points (homes, offices, stores, work) and collector streets. Locals have the least right-of-way, the lowest speed limit, and the least amount of vehicular traffic. Local streets can be subdivided further into five sub-classes, all but one (dead-end streets) of which are permitted in these regulations:

a. **Continuing Streets** are local streets having two open ends; each end generally connects with different streets; one or more other streets may intersect it between its two open ends; and property fronts on both sides of the streets.

b. **Marginal Access Streets** are local streets generally having two or more open ends which are sometimes referred to as access points, but herein are considered to be full part of the marginal access street; the ends generally connect with the same street, other streets may intersect between the ends, and property fronts on only one side of the street (the other street side is parallel,

and adjacent, to a higher classification street such as a collector or arterial).

c. **Loop Streets** are local streets having two open ends; each end generally connects with the same street; no other streets generally intersect between its two ends, and property fronts on both sides of the street.

d. **Cul-de-sac Streets** are local streets having only one open end providing access to another street; the closed end provides a turnaround circle for vehicles, no other street generally intersects between the two ends, and property fronts on both sides of the street.

e. **Dead-end Streets** are similar to cul-de-sacs except that they provide no turnaround circle at their closed end, and are not permitted as streets in any proposed subdivision. Stub streets, planned for future continuation, are not considered to be dead-end streets.

f. **Alleys** generally have two open ends, each end connects with different streets; and property generally backs onto both sides of the alley. Special permission from the Planning Commission is required whenever alleys are proposed.

3.3 POLLUTION CONTROL

3.3.1 General. The Contractor shall perform construction activities in such manner so as to prevent air pollution from occurring as the result of drilling, blasting, grading, hauling, or other construction activities of any kind.

3.3.2 Open Burning. Open burning will not be permitted on the construction site except for trees removed from site. No burning of any kind within the City of Owensboro per Section 10-7 of the Owensboro Municipal Code. Any open burning outside of the City of Owensboro shall be subject to any and all applicable ordinances.

3.3.3 Dust/Mud Control. Water or approved chemical additives shall be applied on roadways, stockpiles, graded areas, etc. to prevent and abate fugitive dust resulting from the Contractor's operations. Paved streets and roads shall be kept clean of all earth materials deposited by the Contractor's operations. Control techniques may include but shall not be limited to the following: rock runouts (#3 rock or stone), water truck, power brooms, etc.

3.3.4 Equipment. The Contractor's equipment shall be maintained to prevent excessive fumes, gases, vapors, noise, or fluids from escaping and creating a nuisance to the public. The contractor shall be responsible for cleaning spills from public rights-of-way.

3.4 EARTHWORK. All embankments, excavations, grading, stripping, topsoiling, etc. shall be done in accordance with the following specifications.

3.4.1 Work Conditions. Only materials acceptable to the Engineer shall be used in embankment construction. No frozen material, stumps, logs, roots or other perishable materials shall be placed in any embankment. No stone or masonry fragment greater than four (4) inches in any dimension shall be placed within 12 inches of the finished subgrade elevation.

All excavation, embankment construction, grading, stump removal, and topsoil removal shall be accomplished at such places as are indicated on the plans and to the lines, grades and elevations shown on the plans, in the specifications or as directed by the Engineer.

3.4.2 Embankment Construction Methods. Before Embankment placement is begun; all vegetation and rubbish shall be removed from the area within the limits of the embankment. This material shall be disposed of in a method approved by the Engineer.

Embankments shall not be constructed upon frozen areas. All snow and ice shall be removed from the area to be covered prior to placement of embankment material. Earth embankment shall be formed by distributing the material in successive uniform horizontal layers not exceeding 12 inches in thickness, loose depth, to the full width of the cross section. Each layer of the embankment shall be thoroughly compacted as hereinafter specified. The embankment shall be properly drained at all times.

a. **Clearing and Grubbing.** The Contractor shall accomplish all clearing and/or clearing and grubbing within the limits designated on the plans or as directed by the Engineer, or as required for the construction of the work involved, and shall satisfactorily dispose of all materials so removed.

The work under this paragraph shall consist of the cutting and removing of all trees, stumps, brush, logs, removal of fences, or other loose or projecting material within the designated areas. Unless otherwise specified, it shall also include the grubbing of stumps, roots and other natural obstructions that, in the opinion of the Engineer, must be removed to prosecute properly the construction work and operate properly the facility upon completion of construction. Disposal shall be by methods satisfactory to the Engineer. Disposal methods shall be in compliance with all local, state, and federal regulations. Trees and other features that are designated to remain shall be properly protected.

b. Excavation shall consist of the removal and satisfactory disposal of all materials taken from between the original ground line and the excavation limits approved by the Engineer as shown on the final cross-sections.

All waste material encountered, of whatever nature, within the project limits shall be removed and disposed of properly. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. Temporary drains and/or drainage ditches shall be installed to intercept or divert surface water that may affect the prosecution or condition of the work. If at any time it is not possible to place excavated material in its proper section of the permanent construction, it shall be stockpiled properly for later use.

Where rock, shale, clay or other unsatisfactory subgrade material is encountered, it shall be excavated to a depth of at least 12 inches below subgrade, or to such greater depth below subgrade as the Engineer may direct. The portion so excavated shall be refilled with suitable material and compacted as set out hereinbefore in the section on "Embankments" or as specified by the Engineer.

(1) Earth Excavation. Earth excavation shall consist of all excavation of any or all materials of whatever name or character not defined as solid rock excavation.

(2) Solid Rock Excavation. Solid rock excavation shall include all solid rock in bedded deposits, in unstratified masses; also conglomerate deposits so firmly cemented as to present characteristics of solid rock and which cannot be removed without drilling and blasting. All boulders of one (1) cubic yard or greater shall be classified as solid rock excavation.

(3) Unclassified Excavation. Unclassified excavation shall include the excavation of both "Earth Excavation" and "Rock Excavation" combined and as above classified and/or not separately measured.

(4) Borrow Excavation. If sufficient material for the embankment around buildings and structures cannot be obtained from the excavation, then the Contractor shall obtain suitable material from acceptable borrow pits. Borrow pits shall be excavated to regular lines as staked, so as to permit accurate measurement.

c. Embankment Compaction. Shall be required to bring the soil layers to a uniform density and such density shall not be less than 95 percent of maximum density as determined by the ASTM 698 (Standard Proctor Test). Testing should be at the optimum moisture content. The moisture content shall not vary from the optimum, as determined by KM 64-511 (Standard Proctor) by more than plus two (2) percent and minus four (4) percent. The moisture content shall have equal weight with the density requirement when determining the acceptability of embankment. The final in-place density shall be determined by field density tests as specified in 3.5.1. However as a minimum, all embankments shall receive the compactive effort of three passes of a sheep's foot or vibratory roller operating over the entire subgrade. Should the subgrade lose its density for any reason prior to construction of a base, it shall be recompacted. Any area in the subgrade that has yielding or unsuitable material shall be excavated and backfilled with approved material properly compacted as directed by the Engineer.

3.4.3 Blasting Operations. Shall be conducted in accordance with all applicable municipal ordinances, state laws, and federal laws. All explosives shall be stored in conformity with said ordinances, laws and safety regulations. No blasting shall be done within five feet of any water mains, except with light charges of explosives. Any damage done by blasting is the

responsibility of the Contractor and shall be promptly and satisfactorily repaired by him.

To implement these requirements, and unless otherwise required by ordinance or law, each excavation crew shall be provided with two metal boxes with suitable locks. One of these boxes shall be for storing explosives and one for caps. The boxes shall always be locked except when in actual use. They shall be painted a bright color and stenciled with appropriate warning signs. At night explosives and caps shall be stored in separate magazines. All shots shall be covered with heavy timber or steel blasting mats to prevent flying material. Unless otherwise specified or directed, delay caps shall be used to reduce earth vibrations and noise. In sparsely populated areas, the Engineer may permit the Contractor to use regular type caps and/or Primacord.

In specific cases authorized by the Engineer, the Contractor may elect to drill through overburden into rock to place explosives. The Contractor shall also comply with the following:

a. Blasting operations shall be covered by public liability insurance, or if said public liability insurance does not cover blasting, then the Contractor shall have separate public liability insurance to cover his blasting operations.

b. All blasting shall be supervised and performed by a licensed blaster.

3.4.4 Grading consists of the preparation, shaping, and compaction of that portion of the roadbed upon which base or pavement is to be placed, including base and paving for shoulders.

A tolerance of plus or minus 1/2 inch from the established grade will be permitted in the graded compacted subgrade. No base or pavement construction shall begin on subgrade that has not been inspected and approved by the Engineer.

3.4.5 Subgrade Preparation. Shall be accomplished by shaping to the lines, grades and typical sections shown on the plans. Where the Engineer directs that areas of the subgrade be stabilized, methods that may be used are:

a. Subgrade Compaction. The Contractor shall dry or add moisture to the subgrade to achieve a uniformly compacted and acceptable subgrade or remove undesirable soil and replace with suitable soil to achieve compaction of 95 percent of standard proctor density (ASTM D 698). Testing should be at the optimum moisture content. The moisture content shall not vary from the optimum, as determined by KM 64-511 (Standard Proctor) by more than plus two (2) percent and minus four (4) percent. The moisture content shall have equal weight with the density requirement when determining the acceptability of embankment. Proof rolling or density testing shall be performed as directed by the Engineer.

b. Stabilizer Stone. The Contractor may undercut the subgrade to a suitable depth for placement of # 3 stone. After placing the # 3 stone, #11 stone or other material approved by the Engineer shall be spread on top and worked in with a grader to fill the voids.

c. Portland Cement Stabilization. The process is achieved by mixing cement with roadbed materials and compacting. The modification shall comply with the KTC specifications.

d. Lime Stabilized Roadbeds. All lime stabilization material shall be furnished and placed in accordance with the KTC specifications.

e. Time, Weather, and Traffic. When approved by the Engineer, dense graded aggregate may be placed on unstable subgrade, provided that no bituminous concrete base course is placed until time, weather and traffic stabilizes the subgrade and the dense graded aggregate base course.

3.5 BASE COURSE FOR BITUMINOUS CONCRETE AND CEMENT CONCRETE SURFACES A pavement design shall be performed by an engineer licensed to practice in the State of Kentucky if soil conditions warrant thicker cross sections, or if the anticipated traffic (ESALs) exceeds those stated in Section 3.6. In lieu of a design, the thicknesses shall be as follows:

For all streets designated as local streets, the cross section thickness shall be a minimum of six (6) inches thick after compaction for bituminous concrete pavements and two (2) inches thick after compaction for cement pavements.

For all streets designated as collectors, arterials, or freeways, the cross section shall be designed by an engineer licensed to practice in the State of Kentucky and the design shall be submitted to the Engineer for review.

The Developer may also choose to present to the Engineer an alternative method of Construction, including but not limited to those methods described in 3.4.5. If approved,

the Engineer may allow this alternative method to be utilized. All repairs to each layer must be completed prior to the placement of the subsequent layers.
The DGA shall be placed on the prepared subgrade, shaped and compacted to the lines, grades, and cross sections shown on the plans or approved by the Engineer. It shall have no more than 1/2-inch deviation from the typical section after compaction. The base material may be placed by tailgating from trucks and spread with a motor grader, providing such operation produces a uniform grade and section satisfactory to the Engineer. The base shall be placed in no single layer greater than 6 inches.

The DGA base shall be compacted to a density of not less than 98% of the target density. In no case shall each layer receive less than the compactive effort of a ten (10) ton tandem roller.

3.5.1 Field Density Tests. Field tests on compacted backfill, embankment materials and roadbed subgrade shall be performed at the request of the Engineer. The acceptable method of performing field density tests is per KYTC Standard Specifications Section 302.

3.6 BITUMINOUS CONCRETE BASE AND SURFACE COURSE. All bituminous concrete shall be hot-mixed and hot-laid on a prepared subgrade, old surface or underlying course. If poor soil conditions beneath the subgrade is suspected to exist, (i.e. the CBR value is less than 6), then subgrade stabilization should be considered at the discretion of the Engineer. Soils may be stabilized by using lime, lime-fly-ash, Portland Cements, cutback asphalts, emulsified asphalts, a geogrid membrane, or a well-graded mixture of #3 aggregates and chips, as long as the undercut portion of the subgrade has positive drainage. All materials shall be in accordance with the KYTC Specifications.

Producer firms shall be qualified with the KYTC as an approved Asphalt Mix Producing Firm.

These specifications are established for low volume applications such as residential developments, office parks, school parking lots and commercial/retail developments. The binder selection for all applications where the Equivalent Single Axle Loads (ESAL) is expected to exceed 300,000, or for all heavy truck facilities shall be designed by the Developer.

3.6.1 Spreading and Finishing. All bituminous concrete shall be laid using self-propelled pavers which are capable of spreading and finishing all courses to the indicated widths and depths, true to line, grade and cross-section as shown on the plans or directed by the Engineer, with a smooth finish, uniform in density and texture. The paver shall be equipped with the following equipment:

a. A screed or strikeoff assembly that easily adjusts to the required crown and will place the asphalt mixture in variable widths;

b. An auger and vibrator that operates along the full width of the screed;

c. A level that is placed on the screed and is in full view of the operator;

d. Automatic screed controls, with sensors for both sides of the paver, capable of sensing grade from an outside reference, sensing the transverse slope of the screed, and providing automatic signals that operate the screed to maintain the desired grade and transverse slope;
e. A transverse slope controller that is capable of maintaining the screed at the desired slope within +/- 0.1%; and,

f. Automatic feeder controls that properly adjust to maintain a uniform depth of material ahead of the screed.

A string line shall be placed by the Contractor for the first lane of each layer of mixture placed to provide alignment control for the paver, except that a string line will not be required when the first layer is placed adjacent to a curb section.

Pavers shall be equipped with quick and efficient steering mechanism and shall operate at variable speeds consistent with proper laying of material, but shall not exceed a speed of 50 feet per minute. When placing adjacent lanes of the same course, pavers shall be equipped with a joint matching device which will automatically provide control of the depth of the mixture being placed so that, when compacted, it will match the depth of the existing lane. All paving machines shall be maintained in good mechanical condition.

Prior to mixing, all aggregates and binder shall have temperatures that conform to KYTC Specification 401.03.01, current edition. The asphalt mixture at the project site shall have a minimum temperature of 230°F and a maximum of 330°F for PG 64-22, and a minimum of 300 °F and a maximum of 350°F for PG 76 -22 .

Machine pavers shall spread the mixture as described hereinbefore. After striking off and before rolling, the surface of each course shall be checked for irregularities and corrected as necessary. Over areas where machine paving is impractical, hand spreading may be done. The material shall be uniformly distributed, without segregation, to the depth necessary to provide the required compacted depth. Rakes may be used, but the final leveling and surface adjustment shall be done with mechanical or manually operated screeds or lutes.

3.6.2 Compaction. Compaction shall be done by rolling each course as soon as the mixture has cooled sufficiently to bear the weight of the roller without undue displacement. Each paving spread operation shall have as a minimum the following rollers:

One ten (10) ton tandem roller shall be used for initial or breakdown rolling on bituminous base course only.
One tandem roller weighing not less than eight (8) tons shall be used for final rolling on bituminous base and surface courses.

These rollers shall be in good condition, capable of reversing without backlash. The steel-wheel rollers shall be equipped with wetting devices to prevent the mixture from sticking to the roller wheels.

The initial or breakdown rolling shall consist of one complete coverage of the course with a ten (10) ton tandem roller. The final rolling shall be performed with a tandem roller (8 tons) and shall operate continuously until all roller marks are eliminated and satisfactory density has been obtained.

Rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one-half roller width, progressing to the high point of the road. On super-elevated curves rolling shall begin at the low side and progress to the high side with trips overlapping as provided above.

In areas inaccessible to equipment, the mixture shall be thoroughly compacted by the use of hand tampers or hand operated mechanical tampers.

3.6.3 Finished Surface Tolerance. Shall show no deviation greater than 1/4 inch from a ten (10) foot straight edge placed parallel to the centerline nor more than 1/4 inch from the typical cross section.

3.6.4 Minimum Construction Length. Minimum construction length of street that will be approved to receive bituminous base paving shall be 250 feet, and the minimum length of street that will be approved to receive bituminous surface shall be 500 feet unless otherwise approved by the Engineer.

Except for streets stubbed out to adjacent property, the subgrade shall be prepared to elevations as shown on the plans for a minimum of twenty five (25) feet beyond the end of the base aggregate. The bituminous base shall be placed no closer than ten (10) feet from the end of aggregate base and the bituminous surface no closer than five (5) feet from the bituminous base.

3.6.5 Transversal Joints. When the laying of the mixture is to be suspended long enough to permit the mixture to become chilled, transverse joints shall be constructed. At the end of the day's operation, the Contractor shall construct a sloped wedge ahead of the end of the full depth pavement to provide for proper compaction and protection of the full depth pavement. When directed by the Engineer, the Contractor shall place a paper-parting strip beneath this wedge to facilitate joint construction.

Before paving operations are resumed, the Contractor shall remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth. Such joints shall be vertical and in a straight line perpendicular to the course. A tack coat shall be applied to the vertical edge of the joint prior to the placement of the adjacent asphalt. When multi-lane multi--layer construction is required, the width of paving spreads shall be adjusted so as to provide for offsetting of longitudinal joints in the base and surface courses.

3.6.6 Weather and Seasonal Limitations. No bituminous concrete shall be laid when the air temperature is below the temperatures listed in this section, or when the underlying course is wet, or when other weather conditions are unsuitable. No hot-mix bituminous concrete shall be laid between November 15 and April 1 unless approved by the Engineer. Minimum ambient air temperature and minimum temperature of the existing surface for placing asphalt mixtures are as follows:

Asphalt Mixture, Surface (one inch thick or less): 45^{o} F
Asphalt Mixture, Surface (thicker than one inch): 40^{o} F
Asphalt Mixture, Base and Binder: 35^{o}F

3.6.7 Material Specifications

3.6.7.1 Aggregate. All coarse aggregates shall be sound, angular crushed stone, or crushed gravel, complying with KYTC Standard Specifications Section 805. The fine aggregates shall be natural sand or sand prepared from stone, gravel, properly cured blast furnace slag, or combinations thereof complying with KYTC Standard Specifications Section 804. Recycled Asphalt Pavement (RAP) shall be milled or removed asphalt pavement utilized in accordance with KYTC Standard Specifications Section 409.

Type "A" polish resistance aggregate shall be used in all streets with an anticipated ADT of greater than 15,000.

Type "B" polish resistance aggregate shall be used in all streets with an anticipated ADT between 5,000 and 15,000.

Type "D" polish resistance aggregate shall be used in all streets with an anticipated ADT of less than 5,000.

3.6.7.2 Asphalt Material. All binder shall conform to KYTC Standard Specifications Section 406. The asphalt binder shall be AASHTO MP 1, Performance Graded Binder PG 64-22 for general applications. Asphalt binder PG 76-22 shall be utilized when specified by the Engineer. All tack coat shall comply with the provisions in the KYTC Standard Specifications Section 406.

3.6.7.3 Base Course Mixes. All hot-mix hot-laid plant mixes shall meet the requirements of the KTC Standard Specifications. The base course shall be a KYTC mixture designation as follows:

a. Class 2 for an ESAL of less than 3,000,000.

b. Class 3 for ESAL between 3,000,000 and 30,000,000.

c. Class 4 for an ESAL of greater than 30,000,000.

3.6.7.4 Surface Course Mixes. All hot-mix hot-laid plant mixes shall meet the requirements of the KYTC Standard Specifications. The Surface Course shall be a KYTC mixture designation as follows:

a. Class 2 for an ESAL of less than 3,000,000.

b. Class 3 for ESAL between 3,000,000 and 30,000,000.

c. Class 4 for an ESAL of greater than 30,000,000.

3.6.8 Lift Thickness.

A pavement design shall be performed by an engineer licensed to practice in the State of Kentucky if soil conditions warrant thicker cross sections, or if the anticipated traffic (ESALs) exceeds those stated in Section 3.6. In lieu of a design, the pavement on new construction shall consist of not less than the following:

For all streets designated as local streets, the cross section thickness shall be a minimum of two (2) inches of base asphalt course after compaction and 1 ¼" of surface asphalt course after compaction.

For all streets designated as collectors, arterials, or freeways, the cross section shall be designed by an engineer licensed to practice in the State of Kentucky and the design shall be submitted to the Engineer for review.

The Developer may also choose to present to the Engineer an alternative method of Construction. If approved, the Engineer may allow this alternative method to be utilized. All repairs to each layer must be completed prior to the placement of the subsequent layers.

3.7 CEMENT CONCRETE PAVEMENT shall consist of a single course, having a minimum depth of at least six (6) inches and shall be constructed on a prepared base in close conformity with the lines, grades or cross-sections shown on the plans or as established by the Design Engineer. The base shall consist of a minimum of two (2) inches of dense graded aggregate placed on the compacted (95% of the Standard Proctor Density ASTM D 698) subgrade and may require greater thickness in areas of poor subgrade.

The concrete pavement shall consist of type "P" 4,000 psi 28 day in accordance with the KTC specifications.

3.7.1 Preparation and Control of Concrete Mixes.

a. Batching may be performed at a batch plant, central mix plant, or in truck mixers as approved by the Engineer.

b. Proportioning. Concrete mixes shall be proportioned in accordance with KTC Specifications. Any changes in mix design shall be approved by the Engineer.

c. Consistency of Concrete. The mixture shall contain no more water than is necessary to produce a workable plastic concrete. The consistency of the concrete shall be continuously uniform and shall be measured in accordance with the "'Slump Test" ASTM C-143. The slump shall not be less than 3 inches nor more than 5 inches for concrete to be placed without vibration. The slump shall not be more than 2 1/2, inches when the concrete is to be vibrated during placement.

d. Air Entrainment. Unless otherwise specified, the required air content of the concrete shall fall in the range of six (6) to seven (7) percent by volume. The entrainment of air may be accomplished by introducing at the mixer an approved air-entraining admixture, by blending normal Portland cement with natural cement having an air entraining agent interground, or by using an air entraining Portland cement having an air entraining agent interground.

e. Strength of Concrete. The minimum strength of concrete at 28 days shall be 4,000 pounds per square inch compressive strength when tested in accordance with method ASTM C-39. The Contractor shall remove and replace all sections of the pavement from which the concrete specimens consistently tested at low strength.

f. Hauling Equipment. The concrete shall be transported in truck mixers or agitator trucks.

3.7.2 Dense Grade Aggregate Base Preparation beneath Portland cement concrete pavement shall be performed in accordance with previous sections of these specifications, except that the Contractor shall use an approved automatically controlled fine grading machine to produce final base surfaces, meeting the lines, grades and cross sections required by the plans. When in the judgment of the Engineer, the pavement design makes the use of such equipment impractical, this requirement will be waived. The surface of the base shall be damp at the time the concrete is placed. The Contractor shall sprinkle the base when necessary to provide a damp surface. The Contractor shall satisfactorily correct all soft areas in the subgrade or base prior to placing concrete. Hauling over the base course will not be allowed unless written approval is obtained form the Engineer.

3.7.3 Forming. Forms shall be of such section and design that they will adequately support the concrete and the construction equipment.

Forms shall have a depth not less than the edge thickness of the pavement to be constructed and not more than 1 inch greater than the edge thickness of the pavement to be constructed. The top face of the form shall not vary from a true plane more than 1/4 inch in 10 feet. All forms shall be thoroughly cleaned before being set and a form release agent shall be applied before any concrete is placed. Forms shall be set a sufficient distance in advance of the point where the concrete is being placed to provide for a continuous operation in placing the concrete and for proper inspection of line and grade.

3.7.4 Concrete Placement. Shall be accomplished only in the presence of an authorized representative of the Engineer unless otherwise directed by the Engineer.

Concrete shall be handled in such a manner as to prevent segregation and kept free from mud, soil, or any other foreign matter. Paving operations shall not be undertaken or shall be discontinued when any of the following conditions exist:

a. When a descending air temperature in the shade and away from artificial heat reaches 40ºF, unless the Engineer approves other means and methods to accommodate cold weather placement.

b. When the subgrade or base course is frozen.

c. When aggregates to be used in the mix contain frozen particles.

The mixer and hauling equipment shall not be operated on any new pavement until at least 10 curing days have elapsed. When the mixer is operated on new pavement, the Contractor shall operate the paver on wood matting or other approved material that will prevent the marking of the pavement and will distribute the load uniformly over the mat area.

3.7.5 Placement of Reinforcing Steel. Where required, the minimum length of longitudinal bars shall be 15 feet except where shorter bars are required for starting or ending a specified staggered lap pattern.

The reinforcement shall be supported on a system of chairs approved by the Engineer. The Contractor shall present his proposed support system including sample chairs for approval prior to beginning the work. Where the support system does not maintain the reinforcement in the required position, the Contractor shall increase the number or chairs or make other changes to the support system to assure proper final position of the reinforcement. Other methods of placement for reinforcement shall be used only with the written approval of the Engineer.

Longitudinal bars and transverse bars shall be lapped not less than 40 times the nominal diameter of the reinforcement being spliced, and tied with wire ties or clipped together. Welding shall not be permitted. Welded wire mesh meeting the requirements of ASTM A-165 may be used for reinforcement. It shall be in mats of the size, design, and weight specified on the plans. The concrete shall be placed in two operations, unless methods approved by the Engineer are employed that will insure the proper positioning of the mesh in the completed pavement. The initial placement shall be struck off by means of an approved template or spreader to the proper depth below the proposed finished surface and the reinforcement placed thereon. Adjacent sheets or mats shall be lapped as provided on the plans and shall be fastened in at least two places in each pavement lane either by the tie wires or by bending the extending longitudinal wires back over two adjacent transverse wires of each sheet.

The reinforcement shall be free from flaky rust, oil, mud or other coatings that will reduce bond and shall be handled prior to installation in such a manner as to avoid bent bars. The reinforcement shall be placed and tied sufficiently in advance of the paving operation to allow adequate time for inspection by the Engineer.

Refer to Chapter 13 “Concrete Specifications Materials and Methods” for additional specifications.

3.7.6 Spreading and Vibrating Concrete. The concrete shall be spread over the entire area between the forms without segregation. Spreading shall be done with a mechanical vibrating screed. Where hand methods are necessary vibrating may not be used.

3.7.7 Concrete Finishing shall be accomplished with a combination of properly designed equipment to provide the required grade and finish. Hand finishing will be permitted when the use of mechanical finishing equipment is impractical. The concrete shall be screeded and float finished to the required cross section and shall then be checked by the use of hand-held, 10-foot straightedges for longitudinal surface uniformity. Hand correction work shall be held to a minimum and, where directed by the Engineer, mechanical finishing equipment shall be adjusted or replaced to eliminate handwork. The final finishing of the pavement shall be accomplished by brooming, or other acceptable methods that will produce a similar surface texture acceptable to the Engineer.

3.7.8 Joints shall be constructed according to the plans or as required by the Engineer.

a. Transverse Contraction Joints shall be provided by sawing with an approved concrete saw. Sawing shall be done as soon as the concrete has hardened sufficiently to be sawed without spalling and raveling, usually six (6) to 24 hours after placing and before shrinkage cracking occurs. The minimum depth of a contraction joint shall be ¼ the thickness of the slab. Transverse contraction joints shall be constructed at 16-foot intervals unless otherwise shown on the plans. Where the pavement is constructed adjacent to an existing concrete pavement, the joint shall be spaced to match the existing joints.

b. Longitudinal Contraction Joints – shall be spaced no further apart than 30 times the pavement thickness in accordance with the details and dimensions shown on the plans, and shall be formed by an approved joint insert or by an approved concrete saw. When a joint insert is used, the alignment of the finished joint shall be parallel with the centerline of the pavement and shall be free from local irregularities in alignment. Where longitudinal contraction joints are sawed, sawing shall be done as soon as the concrete has hardened sufficiently to be sawed without spalling and raveling, usually six (6) to 24 hours after the concrete is placed or as specified by the Engineer. The minimum depth of a contraction joint shall be ¼ the thickness of the slab.

c. Transverse Construction Joints shall be constructed at the end of each day's operation (planned joint) or whenever the placing of concrete is suspended for more than 30 minutes (emergency joint). The joints shall be formed by placing an approved header shaped to fit the pavement typical section, which forms a vertical face on the end of the pavement. The header shall be designed to permit the placement of dowel or tie bars and shall hold such bars

in their correct locations. Planned transverse construction joints shall be located at the same spacing required for contraction joints. Smooth dowel bars of the size and spacing shown on the plans shall be used. Emergency transverse construction joints shall be used when placing of concrete is suspended for more than 30 minutes. Deformed tie bars of the size and spacing shown on the plans shall be used. The spacing of contraction joints shall not be changed due to emergency construction joints and the emergency construction joint shall not be located less than three (3) feet from any contraction joint.

d. Longitudinal Construction Joints. Where necessary, may be constructed either by the use of tie bars or hook bolts in accordance with the details shown on the plans.

e. Transverse Expansion Joints shall be constructed in accordance with the details shown on the plans utilizing an approved joint assembly. The ends of the dowel bars shall be coated with heavy grease or approved bond-preventing material when the assembly is installed.

f. Sealing of Expansion Joints. Concrete shall be at least three (3) days old before the expansion joint is sealed. Joints shall be sealed as soon after this three (3) day period as possible, and before any traffic is allowed on the pavement. The joint shall be thoroughly cleaned and dry before sealing. When the joints have dried, they shall be filled to within approximately 1/8 inch of the surface of the pavement with joint sealer. Care shall be taken in handling the nozzle of the application equipment so that the joint will be filled from the bottom up. Any sealer spilled on the surface of the concrete shall be removed immediately. A premolded insert shall be used to seal joints where required by the plans.

3.7.9 Curing Concrete. Immediately after finishing operations have been completed and surface water has disappeared, all exposed surfaces of the pavement shall be cured with Liquid Membrane Curing Compounds. These compounds shall be applied in conformance with the manufacturer's recommendations.

3.7.10 Protection from Cold Weather and Rain. Refer to Chapter 13 "Concrete Specifications Materials and Methods", Section 13.4.4.

3.7.11 Final Surface Testing. As soon as the concrete has set sufficiently to permit walking on it without marring toe surface, it shall be tested by the Contractor in the presence of the Engineer along the center point and the quarter points of the pavement with a rolling straightedge furnished by the Contractor. The rolling straightedge shall be 10 feet in length between the centers of the wheels. It shall be so designed, constructed and adjusted so that it will adequately indicate and mark all pavement areas, which deviate from a plane surface, by more than 1/4 inch in 10 feet. The rolling straightedge shall be of a design approved by the Engineer. All deviations more than 1/4 inch in 10 feet marked by the straightedge shall be corrected to within this tolerance by being rubbed or ground down and refinished.