APPENDIX A

Scope of Work

204 Removing or Abandoning Miscellaneous Structures

204.1 Description

(1) This section describes wholly or partially removing or abandoning existing miscellaneous structures, disposing of the resulting materials, or if required, salvaging and storing designated materials.

204.2 (Vacant)

204.3 Construction

204.3.1 General

204.3.1.1 General Requirements

(1) If retaining a portion of the existing structure, avoid damaging that portion during construction operations. Do not use any equipment or devices that might damage structures, facilities, or property to be preserved and retained. Complete operations necessary to remove or abandon an existing structure and that might endanger the new construction before constructing new work.

204.3.1.2 Backfilling

(1) Backfill trenches, holes, and pits resulting from breaking down, removing, or abandoning miscellaneous structures as specified for backfilling trenches in 203.3.6.

(2) Unless the contract specifies otherwise, backfill to the elevation of the natural ground, the proposed finished earth subgrade, or finished slopes, as necessary due to the location of the removed structure.

204.3.1.3 Salvaging or Disposing of Materials

(1) Carefully remove materials designated for salvage to avoid damage. Place salvaged materials in neat piles outside construction limits but within the right-of-way, at locations the engineer approves. Stockpile materials designated for salvage at locations the engineer approves, without contaminating the material with dirt or foreign matter.

(2) Dispose of concrete, stone, brick, and other material not designated for salvage as specified for disposing of materials under 203.3.4.

204.3.2 Breaking Down and Removing

204.3.2.1 General

(1) Unless specified otherwise, remove structures that the contract designates for removal or that interfere with the new construction as follows:

- From within the roadway.
- From within the removal limits the plans show.
- From within the limits designated under the Obliterating Old Road bid item, whether specified or subsequently found necessary and required.
- If the contract specifies, also wholly or partially remove structural elements occurring outside the limits of construction and beyond the limits of Obliterating Old Road.

(2) Unless the plans show otherwise, remove entirely or break down walls, piers, surface drains, foundations, and similar masonry structures as follows:

1. Within the roadbed, to a depth at least 2 feet below the subgrade.
2. Outside the roadbed, to a depth at least 2 feet below the finished grade.
3. At any location, to the extent required to avoid interfering with the work.

(3) If removing pavement, curb, gutter, sidewalk, crosswalk, and similar structures and portions of the existing structure are to remain in the surface of the finished work, remove the structure to an existing joint, or saw and chip the structure to a true line with a face perpendicular to the surface of the existing structure. Remove enough of the structure to provide proper grades and connection to the new work. Maintain drainage as specified for drainage during construction in 205.3.3.

(4) The contractor becomes the owner of the removed asphaltic pavement or surfacing and is responsible for its disposal as specified for disposing of materials under 204.3.1.3.

204.3.2.2 Removing Items

204.3.2.2.1 General

Revise 204.3.2.2(13) to clarify information regarding removing storm sewer. Add paragraph (14) for new bid item "Removing Cable Barrier".

(1) Under the Removing Concrete Pavement bid item, remove concrete pavements, concrete alleys, concrete driveways, or rigid base including surfaces or other pavements superimposed on them.

(2) Under the Removing Concrete Pavement Butt Joints bid item, remove concrete pavements to allow the construction of butt joints. Remove existing pavement to the depth the plans show sawing, milling, or other engineer-approved methods.

(3) Under the Removing Asphaltic Surface bid item, remove all types of asphaltic pavement or surfacing not supported on rigid bases or not underlain by proposed excavation. Also, remove asphaltic overlays of existing concrete pavements, bases, or bridge decks designated to remain in place.

(4) Under the Removing Asphaltic Surface Butt Joints bid item, remove asphaltic pavement or surfacing to allow the construction of butt joints. Remove existing asphaltic pavements or surfacing to the depth the plans show by sawing, milling, or other engineer-approved methods.

(5) Under the Removing Concrete Sidewalk bid item, remove concrete sidewalk, crosswalk, and steps.

(6) Under the Removing Lip Curb bid item, remove lip curb to the plane of the pavement surface, +/- one inch.

(7) Under the Removing Concrete Slope Paving bid item, restore the slope in front of the abutment to a smooth, plane surface after removing the slope paving.

(8) Under the Removing Delineators and Markers bid item, remove delineators and markers.

(9) Under the Removing Railroad Track bid item, remove rails, paving, ties, track encasement, and other appurtenances. Remove concrete foundation and leave the ballast aggregate in place.

(10) Under the Removing Manholes, Removing Catch Basins, and Removing Inlets bid items, rebuild, and properly reconnect live sewers connected with them. Maintain satisfactory bypass service during these operations. Plug unused sewers as specified for abandoning pipes and structures under 204.3.3.1.

(11) Under the Removing Septic Tanks bid item, first completely remove the contents of the tank. Conform to the WDNR requirements for removal and disposal of these contents. Break down and remove the tank, to an elevation not less than 2 feet below the proposed ground surface, or 2 feet below the finished slopes or natural ground surface, as required due to the location of the tank. Before backfilling, break a hole in the bottom of any remaining portion of the tank to allow drainage. Backfill as specified for trenches, holes, and pits in 204.3.1.2. If the septic tank disposal system includes a dry well, remove the dry well to not less than 2 feet below ground surface, and backfill it in the manner specified above for the septic tank.

(12) Under the Site Clearance bid items, remove building foundations and concrete slabs, backfill exposed openings, and clear the site within the right-of-way at the locations the plans show. Materials removed from building sites under this bid item become the contractor's property. The contractor may incorporate these materials in the roadway embankment if the engineer approves. Clear the entire premises of decomposable and combustible refuse, debris, and materials resulting from the removals and leave the premises in a neat condition.

(13) Under the Removing Storm Sewer bid items, remove existing storm sewer and precast endwalls. Backfill resulting trenches with granular backfill conforming to 209.2.

(14) Under the Removing Cable Barrier bid item, completely remove concrete line post footings. Remove cable barrier end terminal concrete footings to a depth at least 2 feet below the finish grade.

204.3.2.2.2 Removing Asphaltic Surface Milling

(1) Under the Removing Asphaltic Surface Milling bid item, remove existing asphaltic pavement or surfacing by milling at the location and to the depth the plans show. The contractor may incorporate suitable material into the work or dispose of it outside the project limits.

(2) If stockpiling material for subsequent incorporation into the work, store material at an engineer-approved location that will minimize the hauling required to place the material. Prepare the stockpile foundation to minimize contamination. Ensure that the stockpile foundation is free of clods, lumps, or stones larger than 2 inches in any dimension.

(3) Remove the existing asphaltic pavement or surfacing without incorporating or damaging underlying material that will remain in place. Provide a uniform milled surface that is reasonably plane, free of large scarification marks, and has the grade and transverse slope the plans show or the engineer directs.

(4) Use a self-propelled milling machine with depth, grade, and slope controls. Shroud the drum to prevent discharging loosened material into adjacent work areas or live traffic lanes. Provide an engineer-approved dust control system.

(5) Maintain one lane of traffic during working hours. Unless using a continuous removal and pick-up operation, do not windrow or store material on the roadway. Clear the roadway of materials and equipment during non-working hours. Grade shoulders adjacent to milled areas by the end of each

work day to provide positive drainage of the pavement. Do not allow abrupt longitudinal differences of 2 inches or more between lanes during non-working hours. The engineer may waive one or more of these requirements if the highway is closed to traffic or if a particular operation does not endanger traffic.

204.3.2.3 Removing Buildings

(1) Under the Removing Building and Removing Buildings bid items, remove buildings, dispose of material and debris resulting from removing buildings, and backfill resulting holes.

(2) Buildings removed and materials resulting from building removal become the contractor's property unless the contract specifies otherwise. Dispose of unclaimed and removed material as specified for disposing of materials in 203.3.4.

(3) The department assumes no responsibility for the condition of any building at any time. The department makes or implies no guarantee that any building will remain in the condition the bidder finds it in when the bidder prepares its proposal.

(4) Obtain permits necessary for removing buildings, including those necessary if the contractor's operations obstruct streets or alleys.

(5) Remove buildings and building materials safely and according to the requirements of the Wisconsin department of workforce development, applicable ordinances of the municipality where the building is located, and the WDNR. Pay close attention to the requirements regulating the handling and disposal of asbestos, lead paint, and other hazardous substances. If creating hazardous conditions incident to the contract operations, furnish, erect, and maintain suitable barricades to safeguard the public.

(6) Notify public utility companies serving the building in sufficient time, before removal operations, to allow them to disconnect and remove their facilities from the building.

(7) Shut off municipal water service lines at the curb boxes. Tightly plug or seal sewer connections. If municipal ordinances or permits specify the manner of sealing a sewer service connection, then perform the work accordingly.

(8) Unless the contract specifies otherwise, when removing a building also remove that portion of its foundation, including any masonry floors, to an elevation not less than 2 feet below the ground surface, the proposed finished earth subgrade, or finished slope grade, as necessary due to the location of the building.

(9) Remove heating units, plumbing fixtures, and similar appurtenances to the elevation of the basement floor.

(10) Before backfilling, remove debris not suitable for backfilling. Break holes comprising at least 10 percent of the floor area in basement floors to allow drainage.

204.3.2.4 Removing Ancillary Structures

(1) Remove individual ancillary structures, designated with structure ID numbers beginning with "S" or "L", and their concrete foundations. Unless the contract specifies otherwise, dispose of structure components off-site.

(2) Under the Removing Ancillary Structure with Restoration bid items, also restore areas disturbed by construction activities to the final grade lines with topsoil, mulch, seed, and seed water that meet the requirements of 625, 627, and 630.

204.3.3 Abandoning Pipes and Structures

204.3.3.1 General

(1) If the contract calls for abandoning manholes, catch basins, or inlets, clean them thoroughly. Plug the existing pipe connections with brick or concrete block masonry, or with any grade of concrete specified under 501.3.1, or any engineer-approved commercial grade of concrete. Unless the plans show otherwise, remove the walls of the structures as follows:

1. Within the roadbed, to a depth at least 2 feet below the subgrade.
2. Outside the roadbed, to a depth at least 2 feet below the finished grade.
3. At any location, to the extent required to avoid interfering with the work.

204.3.3.2 Abandoning, Closing, and Sealing Items

(1) Under the Abandoning Culvert Pipes bid item, plug both ends of the abandoned pipe as specified in 204.3.3.1.

(2) Under the Closing Culvert Pipes bid item, close both ends of the abandoned pipe as specified for closing culverts in 203.3.3.

(3) Under the Sealing Pipes bid item, thoroughly clean the ends of the abandoned pipe, and seal them with brick, concrete block, or any grade of concrete specified under 501.3.1.

204.3.3.3 Abandoning Wells

(1) Under the Abandon Wells bid item, fill and seal wells conforming to the Wisconsin administrative code as follows:

For monitoring wells.....NR 141

For community wells or high capacity wells .....NR 811

For private water supply wells .....NR 812

204.4 Measurement

Revise 204.4(7) to add information relating to new bid item Removing Cable Barrier. Revise paragraph (19) to clarify information for Removing Storm Sewer bid item.

(1) Unless specified otherwise, the department will measure this work in the original position of the removed structures. If the contract does not include bid items for removing the listed miscellaneous structures from within the roadway, the department will measure the excavation for those removals as common excavation. The department will determine the volume of excavation for removing concrete structures as the area of the structure times the depth removed.

(2) The department will measure Removing Concrete Pavement, Removing Concrete Pavement Butt Joints, Removing Asphaltic Surface, and Removing Asphaltic Surface Butt Joints by the square yard acceptably complete regardless of the depth or number of courses encountered. The department will measure Removing Asphaltic Surface Milling by the square yard, or by the ton acceptably completed.

(3) If removing curb, gutter, or curb & gutter is required in conjunction with removing pavement, the department will measure removing these structures by the square yard acceptably completed, under the Removing Concrete Pavement bid item. If removing a rigid base with an asphaltic surface extending beyond the lateral limits of the rigid base, as in a widened pavement, the department will measure only the area occupied by the rigid base under the Removing Concrete Pavement bid item. The department will measure the portion of the asphaltic surfacing beyond the rigid base removed under the Excavation bid items or the Obliterating Old Road bid item. The department will make no deductions for any opening in the removed pavement having an area of 3 square yards or less.

(4) The department will make no deductions from the volume measured under the Excavation bid items for pavement removed under the Removing Concrete Pavement bid item.

(5) If removing curb, gutter, or curb & gutter that is separate from and not removable in conjunction with removing pavement, the department will measure Removing Curb, Removing Gutter, and Removing Curb & Gutter by the foot acceptably completed, measured along the flow line of gutter for gutter, or curb & gutter, and along face of curb for curb.

(6) The department will measure Removing Concrete Sidewalk by the square yard acceptably completed. The department will include steps based on the area of the horizontal projection of the steps.

(7) The department will measure Removing Concrete Barrier, Removing Lip Curb, Removing Guardrail including end sections or anchorages, Removing Cable Barrier by linear foot acceptably completed, measured from end terminal to end terminal, and Removing Fence by the linear foot acceptably completed.

(8) The department will measure Removing Concrete Slope Paving by the square yard acceptably completed, measured in the plane of the removal surface.

(9) The department will measure Removing Delineators and Markers as each individual delineator or marker acceptably completed.

(10) The department will measure Removing Masonry by the cubic yard acceptably completed.

(11) The department will measure Removing Surface Drains as each individual surface drain acceptably completed.

(12) The department will measure Removing Concrete Bases as each individual concrete base acceptably completed.

(13) The department will measure Removing Railroad Track by the linear foot acceptably completed, measured along single track lines, tracks with 2 rails.

(14) The department will measure Removing Utility Poles as each individual pole, or pole stub acceptably completed, including attached parts and connections.

(15) The department will measure Removing Manholes, Removing Catch Basins, and Removing Inlets as each individual manhole, catch basin, or inlet acceptably completed, including attached parts and connections.

(16) The department will measure Removing Septic Tanks as each individual septic tank acceptably completed, including any dry wells in the tank's disposal system.

(17) The department will measure the Removing Building (station) bid items as each individual building acceptably removed. The department will measure the Removing Building (parcel) bid items as each individual parcel with all buildings acceptably removed.

(18) The department will measure the Site Clearance (parcel) bid items as each individual parcel acceptably cleared.

(19) The department will measure the Removing Storm Sewer bid items by the linear foot acceptably completed, including precast endwalls, measured along the centerline of the pipe.

(20) The department will measure the Removing Ancillary Structure and the Removing Ancillary Structure with Restoration bid items by each individual structure, including its associated concrete foundation, acceptably completed.

(21) The department will measure the Abandoning Manholes, Abandoning Catch Basins, Abandoning Inlets, and Abandoning Wells bid items as each individual unit acceptably completed.

(22) The department will measure Abandoning Culvert Pipes, Closing Culvert Pipes, and Sealing Pipes as each individual pipe acceptably completed, having both ends plugged.

204.5 Payment

204.5.1 General

Add bid item to 204.5 for removing cable barrier.

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
204.0100	Removing Concrete Pavement	SY
204.0105	Removing Concrete Pavement Butt Joints	SY
204.0110	Removing Asphaltic Surface	SY
204.0115	Removing Asphaltic Surface Butt Joints	SY
204.0120	Removing Asphaltic Surface Milling	SY
204.0125	Removing Asphaltic Surface Milling	TON
204.0130	Removing Curb	LF
204.0140	Removing Gutter	LF
204.0150	Removing Curb & Gutter	LF
204.0155	Removing Concrete Sidewalk	SY
204.0157	Removing Concrete Barrier	LF
204.0160	Removing Lip Curb	LF
204.0165	Removing Guardrail	LF
204.0167	Removing Cable Barrier	LF
204.0170	Removing Fence	LF
204.0175	Removing Concrete Slope Paving	SY
204.0180	Removing Delineators and Markers	EACH
204.0185	Removing Masonry	CY
204.0190	Removing Surface Drains	EACH
204.0195	Removing Concrete Bases	EACH
204.0200	Removing Railroad Track	LF
204.0205	Removing Utility Poles	EACH
204.0210	Removing Manholes	EACH
204.0215	Removing Catch Basins	EACH
204.0220	Removing Inlets	EACH
204.0225	Removing Septic Tanks	EACH
204.0231	Removing Building (station)	EACH
204.0236	Removing Building (parcel)	EACH
204.0241	Site Clearance (parcel)	EACH
204.0245	Removing Storm Sewer (size)	LF
204.0246	Removing Ancillary Structure (structure)	EACH

204.0247	Removing Ancillary Structure with Restoration (structure)	EACH
204.0250	Abandoning Manholes	EACH
204.0255	Abandoning Catch Basins	EACH
204.0260	Abandoning Inlets	EACH
204.0265	Abandoning Wells	EACH
204.0270	Abandoning Culvert Pipes	EACH
204.0275	Closing Culvert Pipes	EACH
204.0280	Sealing Pipes	EACH

(2) Payment for removing or abandoning miscellaneous structures is full compensation for breaking down, removing, closing, plugging, or sealing; for removing headwalls; for obtaining any required work permits; for providing any required bentonite, soil, brick, concrete block, or concrete; for restoring the roadway cross-section; and, unless the contract specifies granular backfill, for backfilling.

(3) Payment for the Removing Ancillary Structures and the Removing Ancillary Structure with Restoration bid items also includes removing associated concrete foundations and, for the Removing Ancillary Structure with Restoration bid items, the required topsoil, mulch, and seed.

(4) If the contract specifies or the engineer directs backfilling with granular backfill, the department will pay separately for that backfilling under the Backfill Granular bid items as specified in 209.5.

(5) Except for storm sewer, if the contract does not include:

1. Bid items for removing the listed miscellaneous structures from within the roadway, the department will pay for excavating these removals under the Excavation Common bid item. The department will pay for excavation for removing concrete structures exceeding one cubic yard, that were not specified for removal in the contract, at 5 times the unit price bid for Excavation Common under the Removing Miscellaneous Concrete Structures administrative item. Other work involved in removing or abandoning miscellaneous structures within the roadway is incidental to the work.
2. A separate bid item for removing miscellaneous structures listed above from within the limits of Obliterating Old Road, work involved in the removal thereof, whether specified or subsequently found necessary and required, is incidental to Obliterating Old Road.
3. A separate bid item for removing miscellaneous structures listed above from beyond the roadway and outside the limits of Obliterating Old Road, work involved in the removal, if the removal is specified in the contract, is incidental to other bid items of work. If this removal is not specified but later found necessary and required, the department will pay for work involved in this removal as extra work.

204.5.2 Storm Sewer

(1) If the contract or the engineer requires storm sewer removal and the contract does not include the Removing Storm Sewer bid item, the department will pay for that removal as extra work.

305 Dense-Graded Base

305.1 Description

(1) This section describes constructing a dense-graded base using one or more of the following aggregates at the contractor's option:

Crushed stone	Reclaimed asphalt
Crushed gravel	Reprocessed material
Crushed concrete	Blended material

305.2 Materials

305.2.1 General

(1) Provide aggregate conforming to 301.2 for crushed stone, crushed gravel, crushed concrete, reclaimed asphalt, reprocessed material, or blended material. Provide QMP for dense-graded base as specified in 730.

(2) Where the contract specifies or allows 1 1/4-inch base, do not place reclaimed asphalt, reprocessed material, or blended materials below virgin aggregate materials unless the contract specifies or the engineer allows in writing. The department will allow virgin aggregate above reclaimed asphalt, reprocessed material, or blended materials in shoulder areas adjacent to concrete pavement.

305.2.2 Gradations

305.2.2.1 General

(1) Except for reclaimed asphalt, conform to the following gradation requirements:

	PERCENT PASSING BY WEIGHT		
SIEVE	3-INCH	1 1/4-INCH	3/4-INCH
3-inch	90 - 100	___	___
1 1/2-inch	60 - 85	___	___
1 1/4-inch	___	95 - 100	___
1-inch	___	___	100
3/4-inch	40 - 65	70 - 93	95 - 100
3/8-inch	___	42 - 80	50 - 90
No. 4	15 - 40	25 - 63	35 - 70
No. 10	10 - 30	16 - 48	15 - 55
No. 40	5 - 20	8 - 28	10 - 35
No. 200	2.0 - 12.0	2.0 - 12.0[1] [3]	5.0 - 15.0[2]

[1] Limited to a maximum of 8.0 percent for base placed between old and new pavement.

[2] 8.0 - 15.0 percent if base is >= 50 percent crushed gravel.

[3] 4.0 - 10.0 percent if base is >= 50 percent crushed gravel.

(2) Unless the plans or special provisions specify otherwise, do the following:

1. Use 1 1/4-inch in base course layers. Always use 1 1/4-inch in the top 4 inches of base. The contractor may substitute 3-inch for 1 1/4-inch in lower base zones including material underlying the shoulder.
2. Use 3/4-inch in shoulders. Always use 3/4-inch to match the thickness of the paved shoulder in the unpaved portion of the shoulder and on exposed shoulder foreslopes. The contractor may substitute 1 1/4-inch for 3/4-inch elsewhere in shoulders and shoulder foreslopes. If using 1 1/4-inch, limit the allowable reclaimed asphalt content to 50 percent or less.

305.2.2.2 Reclaimed Asphalt

(1) The contractor may use reclaimed asphalt with 100 percent passing a 1 1/4-inch sieve as 1 1/4-inch base. The engineer will assess gradation primarily by visual inspection but may test questionable material.

305.3 Construction

305.3.1 General

(1) Construct dense-graded base conforming to 301.3.

305.3.2 Compaction

305.3.2.1 General

(1) Compact each base layer, including shoulder foreslopes, with equipment specified in 301.3.1. Use standard compaction conforming to 301.3.4.2. Final shaping of shoulder foreslopes does not require compaction.

305.3.2.2 Compacting 1 1/4-Inch Base and 3/4-Inch Base

(1) If using a pneumatic roller, do not exceed a compacted thickness of 6 inches per layer. For the first layer placed over a loose sandy subgrade, the contractor may, with the engineer's approval, increase the compacted layer thickness to 8 inches.

(2) If using a vibratory roller, do not exceed a compacted thickness of 8 inches per layer.

305.3.2.3 Compacting 3-Inch Base

(1) Compact with a vibratory or pneumatic roller. Do not exceed a compacted thickness of 9 inches per layer.

305.3.3 Constructing Aggregate Shoulders

305.3.3.1 General

(1) Construct aggregate shoulders to the elevations and typical sections the plans show, except for minor modifications needed to conform to other work.

(2) Use equipment that does not damage or mar the pavement surface, curbs, or appurtenances.

(3) Place aggregate directly on the shoulder area between the pavement edge and the outer shoulder limits. Recover uncontaminated material deposited outside the limits and place within the limits.

(4) Do not deposit aggregate on the pavement during placement, unless the engineer specifically allows. Do not leave aggregate on the pavement overnight. After placing the shoulder aggregate, keep the pavement surface free of lose aggregate.

(5) Spread and compact the aggregate in compacted layers of 6 inches or less. Use standard compaction conforming to 301.3.4.2.

(6) After final compaction, shape the shoulders to remove longitudinal ridges to ensure proper drainage.

305.3.3.2 Shoulders Adjacent to Concrete Pavement or Base

(1) Construct shoulders along concrete pavement or concrete base so the completed shoulder is at the approximate grade and cross-section before opening the pavement to public traffic.

305.3.3.3 Shoulders Adjacent to Asphaltic Pavement or Surfacing

(1) If the roadway is closed to through traffic during construction, construct the aggregate shoulders before opening the road.

(2) If the roadway remains open to through traffic during construction and a greater than 2-inch drop-off occurs within 3 feet or less from the edge of the traveled way, eliminate the drop-off within 48 hours after completing that days paving. Unless the special provisions specify otherwise, provide aggregate shoulder material compacted to a temporary 3:1 or flatter cross slope from the surface of the pavement edge.

(3) Provide and maintain signing and other traffic protection and control devices, as specified in 643, until completing shoulder construction to the required cross-section and flush with the asphaltic pavement or surfacing.

305.3.4 Shaping Shoulders

(1) Under the Shaping Shoulders bid item, blade, shape, and compact the existing shoulder aggregate, before the end of the day's work, to ensure proper drainage while salvaging existing pavement and constructing new pavement. Do not contaminate the shoulder aggregate with deleterious material. Incorporate material obtained from shaping shoulders in the new shoulder, in widening the roadbed, or as the plans show.

305.3.5 Constructing Detours

(1) Under the Aggregate Detours bid item, provide aggregate on the designated detour at the locations the plans show or the engineer directs. Use 3/4-inch base unless the plans or special provisions specify otherwise.

305.4 Measurement

(1) The department will measure the Base Aggregate Dense and Aggregate Detours bid items under this section by the ton or cubic yard acceptably completed. The department may deduct for contaminated aggregate or unrecovered aggregate deposited outside the outer shoulder limits.

(2) If the department converts volume to weight as specified in 109.1, the conversion factor for the acceptably completed in-place Base Aggregate Dense bid items is 1.85 tons per cubic yard.

(3) The department will measure Shaping Shoulders by the station acceptably completed, measured along the centerline for each shoulder separately.

305.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
305.0110	Base Aggregate Dense 3/4-Inch	TON
305.0115	Base Aggregate Dense 3/4-Inch	CY
305.0120	Base Aggregate Dense 1 1/4-Inch	TON
305.0125	Base Aggregate Dense 1 1/4-Inch	CY
305.0130	Base Aggregate Dense 3-Inch	TON
305.0135	Base Aggregate Dense 3-Inch	CY
305.0410	Aggregate Detours	TON
305.0415	Aggregate Detours	CY
305.0500	Shaping Shoulders	STA

(2) Payment for the Base Aggregate Dense and the Aggregate Detours bid items is full compensation for preparing the foundation; and for placing, shaping, compacting, and maintaining the base.

(3) Payment for Shaping Shoulders is full compensation for blading, shaping, compacting, and maintaining the existing aggregate shoulders.

(4) If the contractor substitutes 3-inch in base course or 1 1/4-inch in shoulders as allowed under 305.2.2.1, the department will pay for the substitute material as follows:

- At the Base Aggregate Dense 1 1/4-Inch unit price if substituting 3-inch in base course.
- At the Base Aggregate Dense 3/4-Inch unit price if substituting 1 1/4-inch in shoulders.

415 Concrete Pavement

415.1 Description

(1) This section describes constructing concrete pavement as well as approach slabs, alleys, pavement gaps, and truck aprons.

415.2 Materials

415.2.1 Concrete

(1) Furnish grade A concrete conforming to 501 as modified for class I pavement concrete in 715. Provide QMP for class I pavement concrete as specified in 715.

(2) Furnish high early strength concrete under the HES bid items.

(3) Maintain a uniform consistency in consecutive batches of concrete. Use the following slumps for the technique used:

SLIP-FORMED	NOT SLIP-FORMED
2.5 inches or less	4 inches or less

415.2.2 Reinforcement

(1) Furnish steel reinforcement conforming to 505.2.4. Furnish dowel bars and tie bars as the plans show and conforming to 505.2.6.

415.2.3 Expansion Joint Filler

(1) Furnish expansion joint filler conforming to ASTM D8139. When constructing headers or providing slip form expansion, furnish expansion joint filler conforming to AASHTO M153, AASHTO M213, or ASTM D8139. Place material in lengths equal to the pavement lane width and of the thickness and height the plans show. Where dowel bars are required, use filler with factory-punched holes at the dowel bar locations and with a diameter not greater than 1/8 inch larger than the nominal dowel bar diameter.

415.2.4 Concrete Curing Compounds

(1) Furnish poly-alpha-methylstyrene (PAM) liquid curing compound conforming to ASTM C309, type 2, class B as modified here in 415.2.4.

(2) Furnish curing compound with a resin consisting of 100 percent poly-alpha-methylstyrene and with, by weight, 42 percent or more total solids. Modify ASTM C309 to ensure the following:

- Loss of water in 24 hours does not exceed 0.15 kg/m^2.
- Loss of water in 72 hours does not exceed 0.40 kg/m^2.
- Reflectance in 72 hours is greater than or equal to 65 percent.
- The volatile organic compound (VOC) content does not exceed 350 g/L.

415.2.5 Concrete Pavement Gaps

(1) Use concrete of the same mix design used for the contiguous pavement. If the engineer allows paving through the gap, use a concrete mix design that will develop 2500 psi opening strength in an engineer-approved maximum time.

415.2.6 Joint Filler

(1) Furnish a hot-poured elastic joint sealer according to ASTM D6690 type II.

415.3 Construction

415.3.1 General

(1) Use handling, weighing, batching, mixing, and hauling equipment and procedures conforming to 501. In addition, proportion aggregates and cement for concrete pavement in batching plants by weight using semi-automatic or automatic batching plants.

(2) If using ready-mixed concrete, ensure production and uniform delivery of at least 80 cubic yards per hour to support two-lane slip-form operations and at least 40 cubic yards per hour for single-lane slip-form or hand placement operations.

415.3.2 Concrete Placement and Finishing Equipment

415.3.2.1 Slip-Form Paver

(1) Use an engineer-approved, self-propelled slip-form paver capable of consolidating, screeding, and float-finishing freshly placed concrete in one complete pass of the machine for the required thickness. Use machines equipped to internally vibrate the concrete for the full width and depth placed in a single pass as required to produce a dense, homogeneous pavement. Equip the slip-form paver with devices that accurately space and position required tie bars and that allows for automatic or manual tie bar insertion.

(2) Ensure that paver vibration equipment is capable of producing the frequency and amplitude the paver manufacturer recommends for the placement at hand.

415.3.2.2 Hand Vibrators

(1) Use hand-operated single spud internal vibrators capable of consolidating concrete pavement adjacent to forms, joints, or fixtures. Ensure that vibrators produce a minimum of 7000 impulses per minute.

415.3.2.3 Screeds for Formed Pavement

(1) Use air-vibrated or mechanically-vibrated truss screeds designed for and capable of striking off fixed-form concrete pavement for the size of placement at hand.

415.3.2.4 Forms

(1) Use clean, straight, un-warped steel forms with a vertical face as high or higher than the pavement thickness minus 1 1/2 inches. Ensure that forms have side and base supports capable of supporting finishing equipment and are sufficiently strong to resist concrete pressure without bulging.

(2) The contractor may use wood or plastic forms for forming fillets, widened areas in intersections, curves less than 100-foot radius, truck aprons, and in other engineer-approved locations.

415.3.2.5 Hand Finishing Tools

(1) Use aluminum, magnesium, or wooden hand finishing tools. Do not use steel hand finishing tools.

415.3.2.6 Concrete Saws

(1) Use saws light enough to operate on and capable of sawing new concrete with minimal raveling, chipping, spalling, or otherwise damaging the pavement. Ensure that saws have diamond blades with functioning blade guards and are equipped with guides or other devices to control cut alignment and depth.

415.3.3 Preparing the Foundation

(1) Prepare the base course as specified in 211.3.4 before placing concrete. Repair and re-compact rutted or disturbed base resulting from hauling or paving operations. The engineer may suspend paving operations if the contractor fails to repair and maintain the base course in advance of the paving operation.

(2) Identify areas of yielding subgrade. The engineer may direct or allow EBS to correct subgrade problems as specified in 301.3.5.

415.3.4 Setting Forms

(1) Set forms to the required grade and alignment. Firmly support and anchor forms in a manner that prevents movement during concrete placement. Ensure that forms are sufficiently tight to prevent loss of concrete either under or through the forms.

(2) Immediately before placing concrete recheck the foundation as well as the grade and alignment of the forms. Ensure that the forms are not twisted. Make necessary corrections to the forms and foundation before placing concrete.

415.3.5 Reinforcement

(1) Reinforce the concrete if and as the plans specify. Keep reinforcement clean, free of rust and scale, and supported to prevent distortion. Store reinforcement steel, received on the job, in engineer-approved storage and distribute only as needed for placement.

(2) Protect epoxy coated steel from cumulative exposure to sunlight for more than 2 months by covering with an opaque engineer-approved material. Clear plastic shrink wrap for dowel bar bars and dowel baskets is sufficient protection for up to 4 months exposure.

415.3.6 Placing Concrete

415.3.6.1 General

(1) Unless the engineer allows otherwise, slip-form work that is 300 feet or more in length, a minimum of 10 feet in width or greater, and a constant width. Also use slip-formed placement wherever practicable for other work unless the engineer directs or allows otherwise. In irregular areas or areas inaccessible to self-propelled slip-form paving equipment, construct the pavement using fixed forms.

(2) Use machine methods to strike-off and consolidate the concrete. The contractor may, if the engineer allows, use hand methods for areas with variable slab width, for strips or lanes of pavement uniformly less than 10 feet wide, for transition sections on curves or at other points with variable pavement crown, and for other areas where it is impracticable to use machine methods.

(3) Deposit concrete on the base course continuously in a manner that minimizes segregation. Place to a depth sufficiently above grade so, after consolidating and finishing, the required slab thickness is obtained and the surface conforms to the specified grade and slope.

(4) Use two-lane placement for rural pavement unless staging dictates single-lane paving. Delay placement of adjoining lanes until completed lanes are sufficiently cured to preclude damage to work already placed. Do not operate paving equipment on pavement not meeting the opening to service criteria specified in 415.3.15.

(5) Shut down placement if paving train equipment breaks down, finishing and curing operations are delayed, or if the materials or work are nonconforming. Cover the concrete at the unfinished end of the placement to maintain moisture during temporary shutdowns. Provide construction joints if interruptions are long enough for the concrete to develop its initial set.

(6) Check the surface of the newly placed concrete with a long-handled 10-foot or longer straightedge. Overlap successive passes by about 1/2 the straightedge length. Cut down high areas. Fill depressions immediately with freshly mixed concrete and strike off, consolidate, and refinish the concrete. Do not add water to correct surface deficiencies except in emergency cases or with engineer authorization.

(7) Set castings and frames for manholes, catch basins, inlets, and other fixtures conforming to 611.3.3. Adjust to required alignment and grade while adjacent concrete is plastic. Hand vibrate concrete adjacent to fixtures to fill voids and openings between fixtures and support structures. Fill remaining voids beneath the base of these fixtures with an engineer-approved non-shrink grout before opening to traffic.

415.3.6.2 Slip-Formed Placement

(1) Coordinate the mixing, delivering, and spreading operations to provide uniform progress. Check and adjust string lines, sensors, and other paver guidance equipment during paving to assure uninterrupted placement to the plan alignment and grade.

(2) Advance the paving train at a slow uniform pace stopping and starting the paver as little as possible. If it is necessary to stop the forward movement of the paver, stop vibrating and tamping immediately, and restart when forward motion resumes.

(3) Ensure that concrete is uniformly consolidated throughout its width and depth, free from honeycombed areas, and has a consistent void-free closed surface.

(4) Keep hand finishing efforts on the surface to a minimum to avoid over finishing. Hand-float the surface only as needed to produce a uniform surface and sharp corners. Do not use excess mortar to build up slab edges or round the slab corners.

(5) Maintain an edge slump, exclusive of edge rounding, no greater than of 3/8 inch at free edges or 1/8 inch, where abutting other concrete. Correct excessive edge slump before concrete hardens and adjust operations to reduce edge slump to an acceptable level. Tool pavement edges to a 1/4-inch radius ensuring that edges are smooth and true to line.

415.3.6.3 Formed Placement

(1) Deposit concrete as near a possible to its final location to minimize segregation. Consolidate uniformly throughout the depth and systematically across the area of the placement to produce a dense, homogeneous pavement.

(2) Strike off with vibrating screeds unless the engineer directs or allows otherwise. Maintain a uniform quantity of concrete in front of the screed sufficient to fill voids or low areas. Do not allow excessive concrete accumulation in front of the screed, causing the concrete to surge under the screed, or produce ridges or waves in the surface. Do not make more than 2 passes of the vibratory screed on a given area of concrete. Coordinate forward movement of the screed with vibration frequency to optimize consolidation. Do not vibrate the concrete with the screed in a stationary position.

(3) Augment vibrating screeds with internal vibration in front of the screed for placements over 5 inches deep. Insert single spud hand vibrators vertically in a grid pattern just long enough to bring mortar to the surface. Ensure that areas visibly affected by successive vibrator insertions overlap by 2 - 3 inches. Do not drag spud vibrators through the concrete or move concrete laterally by vibration.

(4) Use single spud hand vibrators to consolidate the concrete adjacent to transverse construction joints and along the full length of dowel basket assemblies. Vibrate to a depth that consolidates the concrete above and below the dowel bars. Vibrate along the forms as required to achieve a void-free formed edge. Do not allow vibrators to contact reinforcement, forms, or the grade during vibration.

(5) Float the surface as needed to produce a uniform surface. Before the concrete's initial set, tool the pavement edges and along each side of transverse isolation joints, formed joints, transverse

construction joints, and fixed forms to produce a true-to-line 1/4-inch radius with a smooth, dense mortar finish.

(6) Remove forms after pavement has cured sufficiently to avoid damaging the concrete. The contractor may remove individual forms sooner to saw transverse joints. Fill surface voids as soon as practicable after form removal using a well-mixed grout composed of one part cement and 3 parts fine aggregate.

415.3.7 Jointing

415.3.7.1 General

(1) Construct joints as and where the plans show perpendicular to the pavement surface.

(2) For intersections, plan and locate points necessary to establish the horizontal position of transverse and longitudinal joints to prevent uncontrolled cracking. Submit a joint layout design to the engineer at least 7 calendar days before paving each intersection. Do not lay out joints until the engineer has reviewed the joint layout design. Mark the location of concrete joints in the field. Follow the concrete pavement jointing plan details making adjustments as required to fit field conditions. For unique project circumstances not covered in the plan details, review the joint layout plan with the engineer.

(3) Use construction joints as dictated by contractor operations to join together work at locations where the plans show no joints. Join new work to existing concrete pavement using tie bars epoxied into the existing pavement as specified in 416.3.3.2 or dowel bars epoxied into the existing pavement as specified in 416.3.4. The contractor may use cast-in-place tie bars or dowel bars in construction joints of pavement placed under the contract.

(4) Maintain the alignment of dowel bars, tie bars, and other reinforcing or embedments when placing joints. Augment machine vibration with hand vibrators if necessary to ensure complete consolidation at joints.

(5) Test joints with a straightedge before the concrete sets. Correct if one side of the joint is higher than the other or if higher or lower than adjacent slabs. Remove any concrete, mortar, or laitance resulting from paving operations before it hardens. Remove concrete fins extending across isolation joints, doweled joints, and expansion joints after the concrete hardens.

(6) Saw joints in a single cut to the width and depth the plans show. Begin sawing as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and finish before conditions induce uncontrolled cracking. Provide artificial light if sawing between sunset and sunrise.

(7) The contractor may saw the transverse joints by the skip method, wherein every third joint is sawed as soon as possible. Following this skip sawing, make the cuts of the remaining intermediate joints.

(8) The contractor may temporarily hand tool joints to reduce the potential for early cracking. Ensure that hand-tooled joints have a 1/4-inch radius and are smooth and true to line. Saw hand tooled joints to the plan depth as soon as practicable.

415.3.7.2 Longitudinal Joints

(1) If the plans do not show a specific location, construct parallel to the centerline along lane edges. On two-lane pavements, construct along the pavement centerline. On multilane pavements, construct along traffic and taper lane edges. Make joints perpendicular to the pavement surface. Do not deviate more than 1/2 inch in 10 feet from the required line.

415.3.7.3 Transverse Joints

(1) Extend transverse joints across the entire width of paving and through curb or median placed integrally with pavement. When the pavement abuts existing pavement, curb and gutter, or median, construct transverse joints in locations matching existing joints or cracks.

(2) Install dowel bars as follows:

- Within one inch of the planned transverse location and depth.
- Within 2 inches of the planned longitudinal location.
- Parallel to the pavement surface and centerline within a tolerance of 1/2 inch in 18 inches.

(3) Hold dowel bars in the correct position and alignment using an engineer-approved device during construction. Do not allow bonded longitudinal bars or reinforcement to extend across transverse expansion or contraction joints. The contractor need not cut dowel basket tie wires.

(4) If using a mechanical device to install dowel bars, conform to the following:

- Place and consolidate the pavement to full depth before inserting the dowel bars.
- Insert the dowel bars into the plastic concrete in front of the finishing beam or screed.
- Ensure that the installing device consolidates the concrete with no voids around the dowel bars.
- Do not interrupt the forward movement of the finishing beam or screed while inserting the dowel bars.

- Provide a positive method of marking the locations of the transverse joints.

(5) Remove concrete directly above expansion joint filler, if necessary, by sawing the full width of the filler to remove concrete bridging the joint.

(6) Form a construction joint at the end of each day's run or when an interruption long enough for the concrete to develop its initial set occurs by doing one of the following:

- Set a header board to support dowel bars. Use production quality concrete, hand vibrated behind the header board, and protect protruding steel from anything that might damage the bars or weaken the bond.
- Saw back the concrete full depth to expose solid concrete then drill and epoxy in dowel bars.

415.3.8 Surface Finishing

415.3.8.1 General

(1) Finish the pavement surface after straightedging, after excess moisture disappears, and while it is still possible to produce a uniform striated surface texture.

415.3.8.2 Design Speed Less Than 40 MPH

(1) Provide an artificial turf drag surface finish. Use a seamless strip of artificial turf approximately full pavement width and of sufficient length to provide approximately 2 feet of turf in contact with the pavement surface. Pull the drag with a device that allows control of the time and rate of texturing. Operate the drag in a longitudinal direction parallel with the centerline to produce a straight finish. Weight the drag as necessary to maintain contact with the pavement. Keep the drag clean and free of particles of hardened concrete.

(2) Where it is impracticable to apply a turf finish, apply a broom finish.

(3) Restore pavement texture damaged by rain by re-dragging the concrete while still plastic.

415.3.8.3 Design Speed - 40 MPH and Higher

415.3.8.3.1 General

(1) Texture and tine freshly placed pavement as soon as practicable after floating. Texture with an artificial turf drag as specified in 415.3.8.2.

(2) Longitudinally tine with a self-propelled tining machine. Where using a tining machine is impracticable, tine by hand. Produce uniformly deep grooves approximately 1/8 to 3/16 inch deep. Provide a finished surface free of tining defects. Complete before tining tears or unduly roughens the concrete.

(3) For hand work, use longitudinal tining unless the engineer directs or allows otherwise.

(4) When paving next to existing pavement and for repair work, match the existing tining direction whether using machine or hand methods. The contractor may apply transverse tining where the engineer directs or allows.

415.3.8.3.2 Longitudinal Tining

(1) Use a tining machine with an automated horizontal and vertical alignment control system to ensure that tining runs straight and parallel to the longitudinal axis of the pavement. Use a rake with individual 1/8-inch wide tines spaced uniformly 3/4 inches on center. Do not tine, but instead apply an artificial turf drag finish, within 2 inches of a longitudinal sawed joint.

415.3.8.3.3 Transverse Tining

(1) Use a rake with individual 1/8-inch wide tines spaced uniformly 5/8 inches on center. For machine work, use a 10-foot rake drawn transversely across the full pavement width without overlapping passes.

415.3.9 Stamping

(1) At the beginning of each day's run and at the end of the job, stamp the contractor's name and the year of pavement construction into the pavement. Use 2-inch numbers for the year of construction.

415.3.10 Surface Testing

415.3.10.1 Smoothness

(1) Test the pavement surface at engineer-selected locations with a 10-foot straightedge or other engineer-specified device. The engineer may direct the contractor to mark and grind down areas showing high spots greater than 1/8 inch but not exceeding 1/2 inch in 10 feet. Grind until there are no deviations greater than 1/8 inch when retested with the straightedge. The engineer may direct the contractor to remove and replace areas with deviations greater than 1/2 inch in 10 feet.

(2) Perform grinding as specified in 415.3.11.

(3) If the engineer directs removal, remove an area at least 6 feet long and extending across the full lane width. Also remove adjacent pavement less than 6 feet from a transverse joint.

415.3.10.2 Ride Quality

(1) Provide QMP for concrete pavement ride quality as specified in 740.

415.3.11 Pavement Grinding

(1) Perform grinding with an engineer-approved device specifically designed for pavement grinding having diamond blades uniformly spaced with at least 50 blades per linear foot. Perform additional light grinding as necessary to provide a neat rectangular area of uniform appearance. Perform the grinding parallel with the centerline. Do not use a bush hammer or other impact device.

(2) Complete required grinding or replacement before determining the pavement thickness.

415.3.12 Curing Concrete

415.3.12.1 General

(1) Maintain adequate moisture throughout the concrete mass to support hydration until the concrete develops sufficient strength to open it to service. Except as allowed under 415.3.12.3, apply curing compound as specified in 415.3.12.2. Use PAM except, use curing compound conforming to 501.2.8 on pavement that will get an overlay under the contract.

(2) If the contractor does not cure concrete as specified in this subsection, the engineer may suspend concrete placement.

415.3.12.2 Impervious Coating Method

(1) After finishing operations, and as soon as the free water disappears, spray the concrete surface with a uniform coating of curing compound. Seal moisture in the concrete by applying a continuous water-impermeable film on exposed concrete surfaces.

(2) Provide sufficient agitation while spraying to ensure uniform consistency and dispersion of pigment within the curing compound during application.

(3) Apply the curing compound with an engineer-approved self-propelled mechanical power sprayer whenever practicable. The contractor may use hand-operated spraying equipment for the following:

- Irregular, narrow, or variable width sections.
- Re-coating applications or after form removal.
- Special applications the engineer approves.

(4) For tined surfaces, apply the curing compound uniformly at or exceeding a minimum rate of one gallon per 150 square feet. For other surface finishes, apply the curing compound uniformly at or exceeding a minimum rate of one gallon per 200 square feet.

(5) If the curing compound coating is damaged within 72 hours after application, immediately recoat the affected area. If removing forms within 72 hours after placing the concrete, coat newly exposed surfaces within 30 minutes after form removal.

415.3.12.3 Alternate Curing Methods

(1) If the contractor requests, the engineer may approve the use of alternate materials or curing methods. If the engineer requests, supply technical specifications, test results, or performance records to support the proposed alternative method.

(2) The engineer will approve delayed application of curing compound if the contractor uses the impervious sheeting method as specified in 502.3.8.1.2 to protect freshly placed concrete from rain damage, protect adjacent property from overspray damage, or to otherwise accommodate specific job conditions. Apply PAM curing compound immediately after removing the impervious sheeting.

415.3.13 Cold Weather Concreting

415.3.13.1 General

(1) The contractor is responsible for the quality of the concrete placed in cold weather. Take precautions necessary to prevent freezing of the concrete until it has developed sufficient strength to open it to service. Remove and replace frozen or frost damaged concrete.

(2) Unless the engineer gives written permission to continue, suspend concreting operations if a descending air temperature in the shade and away from artificial heat falls below 35 F. Do not resume concreting until an ascending air temperature in the shade and away from artificial heat reaches 30 F. The engineer may require the contractor to measure the concrete temperature, at the point of placement, if the ambient air temperature falls below 40 F. Maintain the temperature of the concrete at or above 50 F at the point of placement.

(3) If necessary to maintain placement temperature, the contractor may heat the water, aggregates, or both. Uniformly heat, with steam or by other means, aggregates frozen or containing frost. Accurately control the temperature of the mixing water as it is heated. Do not allow the temperature of either the

mixing water or the aggregates to exceed 100 F when placed together with the cement in the mixer. Control the temperature of the water and the aggregates so that the temperature of the concrete discharged from the mixer is between 50 and 80 F inclusive.

(4) Do not heat the cement, add salt or chemical admixtures to the concrete mix to prevent freezing, or place concrete on a frozen base or subgrade.

415.3.13.2 Protective Covering

(1) Arrange to have available a sufficient quantity of material to provide thermal protection for concrete that has yet to conform to the opening criteria specified in 415.3.15. The contractor may provide clear, black, or white polyethylene sheeting conforming to 501.2.8, except for color and reflectance. The engineer may allow other curing materials with suitable water resistance, strength, and insulating properties.

(2) If the national weather service forecast for the construction area predicts temperatures of less than 17 F within the next 24 hours, arrange to have available a sufficient quantity of straw or hay to protect concrete that has yet to conform to the opening criteria specified in 415.3.15. If the engineer approves, the contractor may use other materials placed to the thickness necessary to provide the same insulating protection as the required thickness of loose, dry straw or hay.

(3) At any time of the year, if the national weather service forecast for the construction area predicts freezing temperatures within the next 24 hours, or when freezing temperatures actually occur, provide the minimum level of thermal protection specified below for concrete that has yet to conform to the opening criteria specified in 415.3.15.

PREDICTED OR ACTUAL AIR TEMPERATURE	MINIMUM EQUIVALENT LEVEL OF PROTECTION
22 to <28 F	single layer of polyethylene
17 to <22 F	double layer of polyethylene
<17 F	6" of loose, dry straw or hay between 2 layers of polyethylene

(4) Place protective material as soon as the concrete is finished and sets sufficiently to prevent excessive surface marring. Maintain protective material in place until the concrete conforms to opening criteria specified in 415.3.15. If removing coverings to saw joints or perform other required work, and if the engineer approves, the contractor may remove the covering for the minimum time required to complete that work.

415.3.14 Protecting Concrete

(1) Erect and maintain suitable barricades and, if necessary, provide personnel to keep traffic off the newly constructed pavement until it is opened for service as specified in 415.3.15. Conform to 104.6 for methods of handling and facilitating traffic.

(2) Protect the pavement against both public traffic and construction activities. Repair or replace, as the engineer directs, pavement damaged by traffic or otherwise damaged before acceptance.

(3) Arrange to have available materials for protecting the unhardened concrete against rain damage. If rain is imminent, cover unhardened concrete immediately with plastic or other engineer-approved material secured along pavement edges. Provide drainage as required to protect the work.

415.3.15 Opening to Service

415.3.15.1 General

(1) Maintain moisture, temperature, and physical protection for concrete until it develops sufficient strength to open it to service. The engineer will use the same criteria to allow opening of non-pavement concrete to service as are used to allow opening of pavement to traffic.

(2) The engineer will allow the contractor to open pavement to construction and public traffic when the concrete attains a verified compressive strength of 3000 psi. Absent compressive strength information, the engineer may allow the contractor to open pavement after the following minimum times, as adjusted for changes in the ambient air temperature on the project:

APPLICATION	EQUIVALENT CURING DAYS
High early strength concrete	3
Grade A general purpose concrete Without blended cements or field-added supplementary cementitious materials	4
Grade A general purpose concrete With blended cements or field-added supplementary cementitious materials	7

(3) The equivalent curing day is based on a daily average ambient temperature of 60 F. The daily average ambient temperature is the average of the high and low engineer-recorded temperatures on the project site for each day. If this daily average ambient temperature falls below 60 F, accumulate equivalent curing days at a reduced rate. For a daily average ambient temperature of:

1. 60 F or more; accumulate one equivalent curing day per calendar day.
2. 40 to less than 60 F; accumulate 0.6 equivalent curing day per calendar day.
3. Less than 40 F; accumulate 0.3 equivalent curing day per calendar day.

(4) The contractor may operate concrete saws and lightweight profilers on concrete that does not conform to these opening criteria. If the engineer approves, the contractor may operate other necessary light equipment on concrete that does not conform to these opening criteria. The engineer may suspend or delay operations that injure the surface or otherwise damage the concrete. Clean the surface before allowing traffic of any kind on the pavement.

415.3.15.2 Opening Strength

415.3.15.2.1 General

(1) Determine opening strength and provide the engineer with the information required to verify that strength by one or a combination of the following methods:

1. Compressive strength testing of cylinders.
2. Maturity method.
3. Compressive strength testing of cores.

(2) The resulting opening strength, after engineer verification, will apply to concrete on the same project conforming to the following criteria:

- Of the same mix design as the test location.
- Cured under similar or more desirable conditions.
- Placed on or before the test location.

(3) If direct compressive strength test results and maturity data are not available, the engineer may estimate compressive strength based on test results of concrete of the same mix design placed contiguously under similar conditions on the same project.

415.3.15.2.2 Compressive Strength Testing of Cylinders

(1) Submit the compressive strength test results to the engineer for verification. Compute the opening strength as the average of compressive strength test results for 2 cylinders. If the strength of a cylinder is less than 90 percent of the required strength, the engineer will reject the resulting average. Field cure cylinders under conditions similar to those prevailing for the pavement they represent. Fabricate cylinders according to WTM R100 and test the cylinders according to WTM T22.

415.3.15.2.3 Compressive Strength Testing of Cores

(1) Submit core test results to the engineer for verification. Determine opening strength from the compressive strength of cores obtained and tested according to WTM T24.

415.3.15.2.4 Maturity Method

(1) Conform to the concrete maturity method requirements of 502.3.10.1.3.3.

415.3.16 Tolerance in Pavement Thickness

415.3.16.1 General

(1) Construct the plan thickness or thicker. The department will accept pavement thickness based on the results of department-performed acceptance testing conforming to:

Magnetic Pulse Induction ..... WTM E3209
Probing ..... WTP C-002
Preplacement Measurement ..... WTP C-003

415.3.16.2 Pavement Units

415.3.16.2.1 Basic Units

(1) Basic unit is defined as a slip formed, single lane, with a minimum lane width of 10 feet. Width is measured from the pavement edge to the adjacent longitudinal joint; from one longitudinal joint to the next; or between pavement edges if there is no longitudinal joint.

415.3.16.2.2 Special Units

(1) Establish special units for areas of fillets, intersections, gaps, gores, shoulders, ramps, truck aprons, pavement lanes less than 10 feet wide and other areas not included in basic units.

415.3.16.3 Test Plate Locations

(1) Place department-furnished test plates. Within 5 business days after paving, enter the sequential number and associated position data into MRS available at:

http://www.atwoodsystems.com/

(2) Maintain plate location markings for 10 business days after paving.

415.3.16.4 Acceptance Testing

415.3.16.4.1 Basic Units

415.3.16.4.1.2 Magnetic Pulse Induction

(1) The department will measure thickness within 10 business days of paving. Upon completion of the project thickness testing, the department will provide the test results to the contractor within 5 business days.

(2) The department will establish a project reference plate at the start of each paving stage. The department will notify the contractor of project reference plate locations before testing. The department will measure the project reference plate before each day of testing.

(3) If the random plate test result falls within 80 to 50 percent pay range specified in 415.5.2, the department will measure the second plate in that unit. The department will notify the contractor immediately if the average of the 6 readings fall within the 80 to 50 percent pay range.

(4) If an individual random plate test result is more than 1 inch thinner than contract plan thickness, the department will measure the second plate in that unit. If both plates are required to be measured, then all six thickness measurements will be averaged for that unit. If the average of the six measurements is more than 1 inch thinner than contract plan thickness, the pavement is unacceptable.

415.3.16.4.2 Special Units

415.3.16.4.2.1 Magnetic Pulse Induction

(1) The department will measure thickness within 10 business days of paving. Upon completion of the project thickness testing, the department will provide the test results to the contractor within 5 business days.

(2) Department will establish a project reference plate at the start of each paving stage. Project reference plate will be measured before each day of testing. Department will notify the contractor of project reference plate locations before testing.

(3) If the random plate test result falls within 80 to 50 percent pay range specified in 415.5.2, the department will measure the second plate in that unit. The department will notify the contractor immediately if the average of the 6 readings fall within the 80 to 50 percent pay range.

(4) If an individual random plate test result is more than 1 inch thinner than contract plan thickness, the department will measure the second plate in that unit. If both plates are required to be measured, then all six thickness measurements will be averaged for that unit. If the average of the six measurements is more than 1 inch thinner than contract plan thickness, the pavement is unacceptable.

415.3.16.4.2.2 Probing

(1) The department will measure slip form special units during concrete placement. Upon completion of the project thickness testing, the department will provide the test results to the contractor within 5 business days.

(2) The department will probe 2 random locations within the special unit. The average of the two readings is the reported thickness measurement for the special unit.

415.3.16.4.2.3 Preplacement Measurement

(1) The department will measure non-slip form special units before concrete placement.

(2) Correct the thickness until conforming by reshaping the base aggregate before the placing pavement.

415.3.17 Concrete Crack Repair

(1) The engineer will inspect concrete pavement for transverse cracking, twice, as follows:

1. After attaining opening strength as specified in 415.3.15 but before opening to construction or public service.
2. Before opening to public service or before partial acceptance as defined in 105.11.1, whichever comes first.

(2) The engineer will determine if a transverse crack needs repair and the type of repair needed. Repair the cracked concrete as the engineer directs.

415.3.18 Pavement Gaps

(1) Construct gaps using either doweled or tied construction joints. Locate construction joints and joints within the gap ensuring that the resulting slab lengths are greater than or equal to 6 and less than or equal to 15 feet long. Alternatively, if the engineer approves, the contractor may pave continuously through the gap using concrete conforming to 415.2.5.

415.3.19 Approach Slabs

(1) Unless the engineer directs otherwise, the contractor may construct the approach slab before, at the time of, or after constructing the roadway pavement.

(2) The contractor may use built-up forms instead of full depth metal side forms. Place reinforcing steel as the plans show. Employ engineer-approved methods to support bar steel and dowel bars in their plan position during concrete placing and finishing.

415.3.20 Filling Joints

(1) Fill joints in concrete pavement, not requiring tining under 415.3.8, and in the adjacent curb and gutter with filler conforming to 415.2.6 as soon as practicable after the engineer inspects them.

(2) Clean joints of laitance, curing compound, and other contaminants before filling. Saw construction joints at least 3/4 inches deep before filling. Sawing is not required for tooled joints in curb and gutter. Sandblast or waterblast exposed joint faces using multiple passes as required to clean joints surfaces of material that might prevent bonding. Blow clean and dry with oil-free compressed air immediately before filling.

(3) Heat filler to the manufacturer's recommended pouring temperature in an engineer-approved double boiler with the space between the inner and outer shells filled with oil or other engineer-approved heat transfer medium. Ensure that the heating kettle is equipped with a mechanical agitator, positive temperature control, and an engineer-approved thermometer. Do not operate the heating kettle on concrete without insulation or a heat shield to protect the concrete surface. If applying only a small amount of filler, the engineer may allow alternate heating equipment.

(4) Do not heat above the maximum safe temperature the filler manufacturer recommends. Discard over-heated material.

(5) Maintain a uniform filler temperature within the manufacturer's recommended working range throughout the filling operation. Cease filling if the temperature in the applicator falls more than I0 F below the manufacturer's recommended pouring temperature.

(6) Completely fill joints without overflowing so that the finished filler is approximately flush with the adjoining surfaces after shrinking. If one pass gives unsatisfactory filling, use 2 passes making sure that at least half of the required filler is poured on the first pass. Make the second pass as soon as practicable after the first pour attains maximum shrinkage but not later than an hour after the first pour.

415.4 Measurement

(1) The department will measure the Concrete Pavement and Concrete Alley bid items by the square yard acceptably completed, measured using the centerline length and the width from outside to outside of completed pavement, but limited to the width the plans show or the engineer directs. The department will include fillets for widened sections, or at drain basins and similar locations, placed monolithic with the pavement. The department will not deduct for fixtures with an area of one square yard or less as measured in the plane of the pavement surface.

(2) The department will measure the Concrete Pavement Approach Slab and Concrete Truck Apron bid items by the square yard acceptably completed, based on the pay limits the plans show.

(3) The department will measure Concrete Pavement Gaps as each individual gap acceptably completed including eliminated gaps the engineer allows the contractor to pave through, measured separately for each roadway. The department will measure multiple gaps at one roadway location as required to conform to contract staging provisions, but not solely to accommodate the contractor's means and methods.

(4) The department will measure Concrete Pavement Joint Filling by the square yard acceptably completed, measured as the concrete pavement area plus the length times nominal width of adjacent curb and gutter.

415.5 Payment

415.5.1 General

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
415.0060 - 0199	Concrete Pavement (inch)	SY
415.0210	Concrete Pavement Gaps	EACH
415.0310	Concrete Alley	SY
415.0410	Concrete Pavement Approach Slab	SY
415.1080 - 1199	Concrete Pavement HES (inch)	SY
415.1310	Concrete Alley HES	SY
415.1410	Concrete Pavement Approach Slab HES	SY
415.2000 - 2050	Concrete Truck Apron (inch)	SY
415.4100	Concrete Pavement Joint Filling	SY

(2) Payment for the Concrete Pavement and Concrete Truck Apron bid items is full compensation for providing pavement; for preparing the foundation, unless provided otherwise; for placing thickness plates; and for thickness coring and filling core holes as required under 415.3.16.4. Payment also includes providing tie bars and dowel bars within concrete placed under the contract. The department will pay separately for tie bars and dowel bars used to connect the work to concrete not placed under the contract under the Drilled Tie Bars and Drilled Dowel Bars bid items as specified in 416.5. The department will not pay for removal and replacement of pavement not meeting the surface smoothness tolerances specified in 415.3.10. The depatment will pay seperately for coloring concrete as required for roundabout truck aprons.

(3) Payment for Concrete Pavement Gaps is full compensation for providing pavement gaps. If the engineer allows paving through a gap, the department will pay the full contract price for each gap eliminated. Payment for furnishing and placing concrete material is included under Concrete Pavement.

(4) Payment for the Concrete Pavement Approach Slab bid items is full compensation for providing the approach slab; and for bar steel reinforcement, dowel and tie bars, and jointing materials.

(5) The department will pay for engineer-approved EBS to correct subgrade problems beyond the contractor's control as specified in 301.5.

(6) Payment for Concrete Pavement Joint Filling is full compensation for filling concrete pavement joints; for filling adjacent curb and gutter joints; and for sawing.

415.5.2 Adjusting Pay for Thickness

(1) The department will adjust pay for pavement thickness under the Nonconforming Thickness Concrete Pavement administrative item as follows:

FOR PAVEMENT THINNER THAN PLAN THICKNESS BY:	PERCENT OF THE CONTRACT UNIT PRICE
> 1/4 inch but <= 1/2 inch	80
> 1/2 inch but <= 3/4 inch	60
> 3/4 inch but <= 1 inch	50

(2) If the department determines areas of pavement have unacceptable final thickness, as specified in 415.3.16.4, the department will direct the contractor to either:

1. Remove and replace unacceptable concrete pavement to the nearest joint with new concrete pavement of conforming thickness. The department will pay once for the area at the full contract price.
2. If the unacceptable pavement is less than 100 LF, the department may allow the concrete to remain in place without payment for the unacceptable area.

415.5.3 Adjusting Pay for Pavement Crack Repairs

(1) The engineer will allocate responsibility and costs for crack repairs, mobilization for traffic control, and traffic control devices, according to CMM 424. The department will adjust pay under the Crack Repair Concrete Pavement administrative item.

(2) Pay adjustment for crack repair costs, based on the total repair area in a single panel, includes mobilization for the repair work; sawing; removing pavement; furnishing and placing materials including dowel bars; drilling in tie and dowel bars; and incidentals. The department will adjust pay for contiguous repair areas in adjacent panels separately. The engineer will compute the pay adjustment for repair costs as follows:

Total Reimbursement = (unit price x repair area + $1700)

Shared Reimbursement = 1/2 of the total reimbursement amount

(3) The department will adjust pay for traffic control devices and mobilization for traffic control separately.

416 Concrete Pavement – Repair and Replacement

416.1 Description

(1) This section describes constructing concrete repair and replacement; and drilling in tie bars to tie existing concrete to new concrete and drilling in dowel bars to transfer load between existing concrete and new concrete.

416.2 Materials

416.2.1 General

(1) Furnish concrete conforming to 501 as modified for class II concrete in 716. Provide QMP for class II ancillary concrete as specified in 716.

(2) The contractor may use HES concrete even where the contract does not require it.

(3) Furnish calcium chloride for concrete placed under SHES bid items as follows:

1. Conform to AASHTO M144, type S as grade N1 or grade N2, class A.
2. Conform to AASHTO M144, type L, in a concentration of approximately 30 percent for premixed solutions.
3. Do not exceed the manufacturer's recommended maximum dosage.
4. If the engineer requests, provide a written copy of the manufacturer's dosage recommendations.

416.2.2 Tie bars and Dowel bars

416.2.2.1 General

(1) Furnish steel reinforcement conforming to 505.2.4. Furnish tie bars and dowel bars as the plans show and conforming to 505.2.6.

416.2.2.2 Epoxy for Anchoring Dowel Bars and Tie Bars

(1) Furnish epoxy consisting of a 2-component epoxy material of contrasting colors and conforming to AASHTO M235, grade 3 - non-sagging consistency, type IV epoxy, except as modified below:

1. Use class B material for mid-depth slab temperatures between 40 and 60 F.
2. Use class C material for mid-depth slab temperatures between 60 F and the highest temperature allowed by the manufacturer of the product.

(2) Bond strength, tensile strength, and elongation testing is not required.

(3) Achieve a minimum compressive yield strength of 5000 psi at 8 hours for special high early strength concrete, or at 3 days for grades A, C, and E concrete. Test according to AASHTO M235 and ASTM D695, with the following restrictions:

1. Mold and cure compressive test specimens in cylinders with a one-inch nominal diameter.
2. Machine specimen ends square to produce a final specimen length of 2 inches.

(4) Before using the epoxy submit a manufacturer's certificate of compliance, and a certified report of test or analysis, from a qualified independent laboratory to the engineer certifying that the epoxy conforms to these specifications. Identify the temperature classes and compressive strength cure times for which the product is certified.

(5) The contractor may furnish an engineer-approved acrylic adhesive that meets the same physical requirements specified for epoxy.

416.2.3 Concrete Pavement Repair and Replacement

(1) Use grade A or C concrete as specified in 501.

(2) The engineer will allow the contractor to open to construction and public traffic when the concrete reaches 2000 psi.

416.2.4 Special High Early Strength Concrete Pavement Repair and Replacement

416.2.4.1 Composition and Proportioning of Concrete

(1) The engineer will allow the contractor to open to construction and public traffic when the concrete reaches 2000 psi. During the contract closure window, the contractor is required to complete all construction operations for the work and provide a concrete mixture that meets the required opening strength and air content to be able to open to service. The contractor may use one or more admixtures or other ingredients to the concrete mixture to obtain the required performance. Do not retemper the concrete mixture.

(2) If adding calcium chloride in solution, use an engineer-approved procedure to the batch ingredients while placing them in the mixer. Provide sufficient water in job-mixed solutions to dissolve the calcium chloride completely and ensure that the solution is of a uniform and known concentration. Reduce the quantity of mixing water by the quantity of solution used. Introduce the correct quantity of calcium

chloride into the mixer using a method by which the quantity added cannot vary appreciably from the target value.

(3) Discharge concrete within 45 minutes after adding mixing water to the cement, or the cement to the aggregates, or within 30 minutes after adding an accelerating admixture, whichever comes sooner.

416.2.4.2 Evaluating Strength

(1) At least 3 business days before starting construction, provide the engineer with adequate evidence that the required strength is obtainable in the field with the materials used and at the various temperatures encountered. Conduct a continued strength evaluation, if the engineer requires, during the course of the work to ensure continued compliance with the strength requirements.

(2) Notify the engineer before making test cylinders and, if the engineer chooses, make arrangements for the engineer to observe cylinder production. Use a department qualified laboratory and an HTCP-certified technician to conduct preliminary and continued strength evaluations. Base each reported value on a minimum of 2 cylinders. After submitting data showing obtainment of the required strength, do not change the mix without first submitting a complete new set of test data showing compliance with the requirements.

416.3 Construction

416.3.1 General

(1) Remove existing pavement at the locations the plans show or where the engineer directs. Conform to pavement repair and replacement plan details for placement of new concrete. Conform to concrete pavement repair plan details for individual areas at least one lane wide that are 15 feet or less in length. Confrom to concrete pavement replacement plan details for individual repair areas at least one lane wide and greater than 15 feet to less than 300 feet long.

(2) Place concrete to the thickness of the contiguous pavement.

(3) Construct conforming to the following:

- Remove concrete pavement, remove asphaltic patch, and prepare the base as specified under 416.3.6.1.
- Place concrete in repair and replacement areas as specified under 416.3.6.
- Place concrete in special high early strength concrete repair and replacement areas conforming to 416.3.6 and 416.3.6.3.

(4) The engineer will inspect concrete repair and replacement, as defined in 601.5.2 and built under 416, for transverse cracking as specified in 415.3.17. Repair cracked concrete as the engineer directs.

416.3.2 Removing Existing Pavement

(1) Remove deteriorated slabs without damaging adjacent pavement. If removing only a portion of an existing slab, make a straight full lane-width full depth saw cut to facilitate removal without damaging the remaining pavement. Ensure that repair areas in adjacent lanes match longitudinally.

(2) Remove existing asphaltic patches. Saw the existing pavement full depth, to an area of sound concrete, as the plans show.

(3) If the contractor damages pavement remaining in place, repair as the concrete pavement repair and replacement details show. Ensure that the length of the damage pavement and the adjacent planned repair or replacement area are the same and both are a full lane wide. If damage is done to pavement not adjacent to a planned removal and replacement area, conform to the minimum removal length the repair and replacement details show and remove and replace the full lane width.

(4) Remove concrete with minimal disturbance to the aggregate base. At the close of each day's work, ensure that slabs have been removed from the project limits and stored away from the roadway. Incorporate or dispose of removed pavement as specified in 203.3.5.

(5) Replace areas of the asphaltic shoulder removed during these pavement removal operations to the elevation of the adjacent shoulder using a commercially produced asphaltic patching material. Before patching, clean, dry, and provide a uniform edge for the repair area.

416.3.3 Base Course

(1) Place the concrete on existing base course shaped to the required cross-section. Remove concrete rubble and foreign material with minimal disturbance of the base. Fill low areas or depressions in the base following removal operations with either compacted aggregate base or additional concrete.

416.3.4 Placing Tie Bars in Hardened Concrete

416.3.4.1 Force Driven

(1) Drill a suitably sized hole into the edge of the hardened concrete. Force drive the tie bar to a depth of 6 inches into the prepared hole as the plans show.

416.3.4.2 Epoxied

(1) Drill holes into the edge of the hardened concrete to the dimensions the plans show. Anchor the tie bars into the hardened concrete with an epoxy conforming to 416.2.3.2 and install conforming to 416.3.4 except no bond breaker is required.

416.3.5 Placing Dowel Bars in Hardened Concrete

(1) Drill holes into the edge of the hardened concrete to the dimensions the plans show. Anchor the dowel bars into the hardened concrete with an epoxy conforming to 416.2.3.2.

(2) Clean drilling dust, debris, and excess moisture from holes before inserting the epoxy and dowel bar.

(3) Inject the epoxy into the back of the drill hole. Use an epoxy with a workable viscosity, pumpable, yet thick enough to remain in the hole. Insert a sufficient volume of epoxy into the hole to provide a small quantity of excess material at the face of the concrete after fully inserting the dowel.

(4) Insert dowel bars in the drill holes and rotate 1/2 turn. Do not force drive dowel bars into the drill holes.

(5) Completely fill the annular space between the dowel bar and the concrete with epoxy. Insert a retaining ring over the bar and push the ring flush against the concrete surface to retain the epoxy.

(6) Coat the protruding portion of each dowel bar with a thin uniform layer of bond breaking lubricant.

(7) Use a positive fixed displacement dispensing system, equipped with a nozzle of sufficient length to deposit the epoxy at the back of the drilled hole. Use a system equipped with a means of checking the mix ratio of the epoxy components. Use the manufacturer's recommended mix ratio and check the ratio at least once a day.

(8) For minor quantities of dowel bars, the contractor may use hand-powered mixing and injecting equipment capable of thoroughly mixing and depositing the epoxy at the back of the drill hole.

416.3.6 Placing Concrete

416.3.6.1 General

(1) Place each repair in one continuous, full depth operation. Consolidate the concrete in place using an immersion type vibrator. Finish the surface by screeding twice, floating, and texturing. Orient the length of the screed parallel to the pavement centerline unless the repair is over 12 feet in length.

(2) Make transverse edges of the finished repair flush with the edges of the existing concrete pavement. Make the longitudinal surface form a straight line from edge to edge with a tolerance of +/- 1/8 inch.

(3) Finish the final surface of full depth concrete repairs to match the edge of existing HMA or concrete pavement and, if the abutting pavement is concrete, match the existing pavement texture.

(4) Place each repair or replacement area in conforming to 415.3.6 through 415.3.15; follow opening strength requirements in 416.2.3.

(5) Date each replacement slab with the month and year of construction.

416.3.7 Special High Early Strength Concrete Pavement Repair and Replacement

(1) Place, cure, and open special high early strength concrete to traffic on the same day removing the old pavement. Follow opening strength requirements in 416.2.4.

416.4 Measurement

(1) The department will measure the Drilled Tie Bars and Drilled Dowel Bars bid items as each individual bar acceptably completed.

(2) The department will measure the Concrete Pavement Repair and Concrete Pavement Replacement bid items by the square yard acceptably completed.

416.5 Payment

416.5.1 General

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
416.0610	Drilled Tie Bars	EACH
416.0620	Drilled Dowel Bars	EACH
416.1710	Concrete Pavement Repair	SY
416.1715	Concrete Pavement Repair SHES	SY
416.1720	Concrete Pavement Replacement	SY
416.1725	Concrete Pavement Replacement SHES	SY

(2) The department will adjust pay for concrete pavement repair and replacement crack repairs as specified in 415.5.3.

(3) Payment for Drilled Tie Bars is full compensation for providing tie bars, including coating; for drilling holes in hardened concrete not placed under the contract; and for epoxying or driving. Drilled Tie Bars into hardened concrete placed under the contract will be paid for when the following is met:

- Adjacent concrete is to be removed in a subsequent stage and concrete placed must abut the existing concrete.
- Bent tie bars are not able to be inserted into concrete placed under the contract due to traffic staging operations.

(4) Payment for Drilled Dowel Bars is full compensation for providing dowel bars, including coating; for drilling holes in hardened concrete not placed under the contract; and for epoxying.

(5) Payment for the Concrete Pavement Repair and the Concrete Pavement Replacement bid items is full compensation for furnishing, hauling, preparing, placing, curing, and protecting materials; for replacing damaged pavement designated to remain in place; for removing existing pavements and excavated materials; for repairing asphaltic shoulders; for sawing joints; for preparing the foundation; for backfilling; and for testing concrete cylinders. The department will pay for individual repairs at least one lane wide and greater than 15 feet to less than 300 feet long as Concrete Pavement Replacement. Payment includes jointing and providing tie bars and dowel bars in unhardened concrete. The department will pay separately for associated work as follows:

- For tie bars and dowel bars in concrete not placed under the contract, exclusive of those necessary to repair contractor-caused damage, under the Drilled Tie Bars and Drilled Dowel Bars bid items.
- For sawing existing concrete for removal, under the Sawing Concrete bid item as specified in 690.5.
- For repairs 300 feet long or longer, under the Removing Concrete Pavement bid item as specified in 204.5 and the Concrete Pavement bid items as specified in 415.5.

501 Concrete

501.1 Description

(1) This section describes concrete requirements including component materials, proportioning, mixing, placing, and protecting concrete mixtures.

501.2 Materials

501.2.1 (Vacant)

501.2.2 Definitions

(1) Use the definitions in 301.2, and interpret these terms used in 501 as follows:

Ancillary concrete	A general term used throughout the standard specs in reference to all concrete items that are not class I concrete.
Coarse aggregates	Aggregate predominantly retained on the No. 4 sieve
Concrete class	The department categorizes concrete as class I, II, or III defined by the sampling, testing, and reporting requirements specified in 715 and 716.
Concrete grade	The department categorizes concrete as grade A, B, C, or E defined by cementitious material content.
Fine aggregates	Aggregate that entirely passes the 3/8-inch sieve, almost entirely passes the No. 4 sieve, and is predominantly retained on the No. 200 sieve.

501.2.3 Sampling and Testing

(1) Sample and test aggregates for concrete according to the following:

Aggregate Sampling	WTM R90
Lightweight pieces	WTM T113
Material finer than No. 200 sieve	WTM T11
Aggregate unit weight	AASHTO T19
Organic impurities for Concrete	AASHTO T21
Aggregate Gradation	WTM T27
Effect of organic impurities in fine aggregate	AASHTO T71
LA Wear	WTM T96
Alkali silica reactivity (ASR) - aggregates	ASTM C1260
ASR - combinations of cementitious materials and aggregates	ASTM C1567
Freeze-thaw	WTM T103
Sodium soundness	WTM T104
Fine aggregate specific gravity	WTM T84
Coarse aggregate specific gravity	WTM T85
Flat and elongated	WTM D4791

(2) Test cementitious materials and admixtures in a department-recognized laboratory, defined as any state department of transportation or other cement and concrete laboratory regularly inspected by the Cement and Concrete Reference Laboratory.

(3) Test for soft or non-durable particles conforming to department laboratory methods. The department will field evaluate or laboratory test to determine aggregate acceptability relative to excessive clay lump quantities.

501.2.4 Cementitious Material

501.2.4.1 Portland Cement

(1) Use cement conforming to ASTM specifications as follows:

- Type I portland cement; ASTM C150.
- Type II portland cement; ASTM C150.
- Type III portland cement; ASTM C150, for high early strength.
- Type IP portland-pozzolan cement; ASTM C595, except maximum loss on ignition of pozzolan component is 2.0 percent and maximum pozzolan content is 30 percent.
- Type IS portland blast-furnace slag cement; ASTM C595, except maximum slag content is 30 percent.
- Type IL portland-limestone cement; ASTM C595.
- Type IT ternary blended cement; ASTM C595, except maximum supplementary cementitious material content is 30 percent.

(2) Obtain portland cement from manufacturers on the APL. The engineer may accept cement not on the APL under the department's cement acceptance program in CMM 870.

(3) For blended cements, provide a manufacturer's written certification stating the source, quantity, and composition of essential constituents and the composition of the final cement provided under the contract. Ensure constituents conform to requirements specified in 501.2.4.2 and 501.2.4.3.

(4) Store cement of different types, brands, and sources separately. Keep batches of concrete made from different types, brands, and sources from becoming intermixed in the work, unless the engineer approves otherwise.

(5) The engineer will reject cement that is partially set or that contains lumps.

(6) The engineer may reject cement if, the temperature at the time of delivery to the mixer exceeds 165 F. To avoid this, store it until it cools to at least 165 F before incorporating into the batch.

501.2.4.2 Supplementary Cementitious Material (SCM)

501.2.4.2.1 General

(1) When the contract requires or allows, use fly ash, slag, silica fume, or alternate SCMs as a direct replacement by weight for cement in concrete mixes. The department will sample and test SCMs during concrete production to verify material conformance.

501.2.4.2.2 Fly Ash

501.2.4.2.2.1 General

(1) Test the fly ash using the test methods prescribed in ASTM C311, starting at least 30 calendar days before its proposed use and continuing at ASTM-required frequencies as the work progresses.

(2) Obtain, from the fly ash manufacturer, a copy of the certified report of test or analysis made by a qualified independent laboratory, showing compliance with ASTM C618 for the appropriate fly ash class, except limit the loss on ignition to 2 percent. Submit the report to the engineer with the mix design, at least 7 business days before use.

(3) Retain test records for at least 5 years after completing the work and provide these records upon request.

(4) For contracts with 100 tons or more of fly ash, obtain under the engineer's observation, one 4-pound sample for every 2000 tons of fly ash used, or fraction thereof. The engineer will take possession of the sample and submit to the BTS laboratory for department verification testing.

501.2.4.2.2.2 Class C Ash

(1) Conform to ASTM C618 class C.

501.2.4.2.2.3 Class F Ash

(1) Furnish a class F fly ash from a source listed on the APL and conforming to ASTM C618 class F.

(2) For class F sources not on the APL, limit the content to a maximum 15 percent.

501.2.4.2.3 Slag

(1) At least 7 business days before use, submit a certified report of test or analysis showing the ground granulated blast furnace slag conforms to ASTM C989, grade 100 or 120.

(2) For contracts with 100 tons or more of slag, obtain, under the engineer's observation, one 4-pound sample for every 2000 tons of slag used, or fraction thereof. The engineer will take possession of the sample and submit to the BTS laboratory for department verification testing.

501.2.4.2.4 Silica Fume

(1) Furnish silica fume conforming to ASTM C1240.

(2) Use a high range water reducer, superplasticizer, conforming to 501.2.5.3.3 in mixtures containing 3 percent or more silica fume.

(3) Submit a mix design, including material sources and quantities, to the department at least 14 calendar days before use. The engineer will coordinate with the BTS laboratory for review and approval analysis.

501.2.4.2.5 Blended SCMs

(1) Furnish blended SCMs conforming to ASTM C1697.

(2) Submit a mix design, including material sources and quantities, to the department at least 14 calendar days before use. The engineer will coordinate with the BTS laboratory for review and approval analysis.

(3) Conform to sampling/testing requirements specified by the engineer.

501.2.4.3 Alternative Supplementary Cementitious Material (ASCM)

(1) Test ASCMs according to ASTM C1709. Submit a mix design, including material sources and quantities, to the department at least 14 calendar days before use. Include a certified report of test or analysis showing the chemical composition, physical properties, and performance test results of the ASCM. The engineer will coordinate with the BTS laboratory for review and approval analysis.

(2) Conform to sampling/testing requirements specified by the engineer.

501.2.5 Chemical Admixtures

501.2.5.1 General

(1) Conform to the manufacturer's recommendations for use of admixtures. The contractor is responsible for ensuring that admixtures used in the same batches of concrete are compatible and produce the required properties in concrete.

501.2.5.2 Air-Entraining Admixtures

(1) Furnish an air-entraining admixture on the APL, or provide a certified report of test or analysis showing the air-entrainer conforms to AASHTO M154 for 7-day and 28-day compressive and flexural strengths and resistance to freezing and thawing. The engineer will not require tests for bleeding and setting time.

(2) If the contractor offers to use an admixture that is essentially the same as one on the APL, with only minor differences in concentration, the department will require certification stating it is essentially the same as the department-approved admixture, and that it contains no other admixture or chemical agent.

501.2.5.3 Retarding, Water-Reducing, and Non-Chloride Accelerating Admixtures

501.2.5.3.1 Water-Reducing Admixtures

(1) Furnish a water-reducer on the APL or submit a certified report of test or analysis showing conformance to AASHTO M194, type A, except if it is also a set retarder, then conform to type D.

501.2.5.3.2 Retarding Admixtures

(1) If furnishing an admixture to retard concrete setting, submit a certified report of test or analysis showing conformance to AASHTO M194 type B, except if it is also a water-reducer, furnish one from the APL, conforming to type D.

501.2.5.3.3 High Range Water-Reducing Admixtures

(1) If furnishing a high-range water-reducing admixture, superplasticizer submit a certified report of test or analysis showing conformance to AASHTO M194, type F, except if it is also a set retarder, then conform to type G.

(2) Submit a mix design, including material source and quantity, to the engineer 14 calendar days before use. BTS approval is required before use.

501.2.5.3.4 Non-Chloride Accelerating Admixture

(1) If furnishing a non-chloride accelerating admixture, provide a certified report of test or analysis showing conformance to AASHTO M194, type C, except if it is also a water-reducer, then conform to or type E.

501.2.5.3.5 Hydration Controlling Admixtures

(1) When furnishing hydration stabilizers conform to AASHTO M194, type B or type D.

(2) Submit a mix design, including material source and quantity, to the engineer 14 calendar days before use. BTS approval is required before use.

(3) Conduct preliminary trials on-site to determine the required dosage rate.

501.2.6 Mixing Water

501.2.6.1 General

(1) Furnish water for use with cement in concrete, mortar, neat cement paste, and in other cement mixing operations.

501.2.6.2 Requirements

(1) The contractor may furnish drinking water from municipal water supplies for concrete; the engineer may test this water for compliance with the requirements specified below.

(2) Water from other sources must comply with the following:

Acidity, maximum of 0.1N NaOH to neutralize 200 mL of water; WTP C-001 ..... 2 mL

Alkalinity, maximum of 0.1N HCL to neutralize 200 mL of water; WTP C-001 ..... 15 mL

Maximum sulphate (S04); WTP C-001 ..... 0.05 percent

Maximum chloride; WTP C-001 ..... 0.10 percent

Maximum total solids; WTP C-001

Organic ..... 0.04 percent

Inorganic ..... 0.15 percent

(3) Furnish water that is not brackish and is clean and free of injurious quantities of sugar, oil, or other deleterious substances.

(4) Furnish water that causes no indication of unsoundness, no significant change in the set time, and does not affect the compressive strength of standard 1:3 mortar briquettes by more than 10 percent compared to strengths from mixtures containing distilled water and the same cement and sand.

(5) Do not use water from shallow, muddy, or marshy sources. The contractor shall not use water from suspected sources until the engineer tests and approves it. If supply sources are relatively shallow, enclose the suction pipe intake to keep out silt, mud, grass, and other foreign materials. Position the suction pipe to provide at least 2 feet of water beneath the pipe intake.

501.2.6.3 Sampling and Testing

(1) Under the engineer's observation, obtain at least 2 quarts of water in clean plastic or glass containers, from each source to be tested. Carefully pack and label the samples. The engineer will take possession of the samples for department testing conforming to CMM 870.

501.2.7 Aggregates

501.2.7.1 General

(1) Furnish material conforming to the individual component requirements of 501.2.7.2 for fine aggregates, 501.2.7.3 for coarse aggregates, and 501.2.7.4 for size requirements.

(2) The engineer may prohibit using, or may require additional testing of, aggregates from any source, plant, pit, quarry, or deposit if the character of the material is questionable or the method of operation makes it unlikely that the aggregates produced will conform to specified requirements; or from deposits or formations known to produce unsound materials.

(3) Furnish samples of materials from previously untested sources and from previously tested sources if the engineer requires; obtain department approval before use.

(4) If procuring aggregates from pits or quarries, conform to 104.9 for final cleanup.

501.2.7.2 Fine Aggregates

501.2.7.2.1 General

(1) Fine aggregate consists of a combination of sand with fine gravel, crushed gravel, or crushed stone.

(2) Furnish hard, strong, and durable fine aggregate from an approved source. Use an approved source listed on the APL or follow the source approval process specified in 106.3.4.2.

501.2.7.2.2 Deleterious Substances

(1) Provide fine aggregate free of frozen material and foreign matter. Do not exceed the following deleterious substance limits:

TABLE 501-1 DELETERIOUS SUBSTANCE LIMITS

SUBSTANCE	PERCENT BY WEIGHT[1]
Material passing No. 200 sieve	3.5[2]
Coal	1.0
Clay lumps	1.0
Shale	1.0
Other local deleterious substances	1.0

[1] The total amount of coal, clay lumps, shale, and other deleterious substances must not exceed 3.0 percent by weight.

[2] Reduce to 2.3 percent if used in grade E concrete.

501.2.7.2.3 Organic Impurities

(1) Fine aggregate must not contain harmful quantities of organic impurities. The engineer will reject aggregates that produce a color darker than the standard color, organic plate no. 3, when subjected to the AASHTO T21 colorimetric test for organic impurities, unless they pass the AASHTO T71 mortar strength test by producing a relative strength at 7 days of not less than 95 percent.

501.2.7.3 Coarse Aggregates

501.2.7.3.1 General

(1) Provide coarse aggregates from a department-approved source. Use an approved source listed on the APL or follow the source approval process specified in 106.3.4.2.

(2) Use clean, hard, durable gravel, crushed gravel, crushed stone, or crushed concrete; do not use crushed concrete as coarse aggregates in concrete for bridges, culverts, or retaining walls.

501.2.7.3.2 Physical Properties

(1) Furnish coarse aggregates approved for use in concrete and conforming to table 501-2.

TABLE 501-2 PHYSICAL PROPERTIES

AGGREGATE QUALITY TEST	MAXIMUM PERCENT (by weight)
LA wear	50
Sodium soundness	12
Freeze-thaw	18

(2) The department may prohibit using crushed stone from limestone/dolomite deposits having thinly bedded strata, or strata of a shale nature.

(3) If all coarse aggregates used are produced from the same deposit or source, ensure that testing for wear, sodium sulfate soundness, and soundness by freezing and thawing uses a composite sample. This sample will contain equal percentages of each component coarse aggregate used. If the component coarse aggregates are produced from more than one deposit or source, ensure that testing for wear, sodium sulfate soundness, and soundness by freezing and thawing uses one sample from each deposit or source.

501.2.7.3.3 Deleterious Substances

(1) Ensure aggregates are free of excess flat & elongated particles, lightweight pieces, frozen lumps, vegetation, deleterious substances, or adherent coatings considered injurious. Do not exceed the maximum limits of deleterious substances specified in table 501-3.

TABLE 501-3 DELETERIOUS SUBSTANCES

SUBSTANCE	PERCENT (by weight)
Flat and elongated	15
Lightweight pieces[2] in concrete not for prestressed concrete members	5.0[3]
Lightweight pieces[2] in concrete for prestressed concrete members	2.0
Shale	1.0
Coal	1.0
Clay lumps	0.3
Soft fragments	5.0
Any combination of shale, coal, clay lumps, and soft fragments	5.0
Material passing No. 200 sieve	1.5

[1] As modified in CMM 860.

[2] Material having a saturated surface-dry bulk specific gravity of less than 2.45, tested according to WTM T113. Determine the percentage of lightweight pieces by dividing the weight of lightweight pieces in the sample retained on a 3/8-inch sieve by the weight of the total sample.

[3] The engineer may accept aggregates exceeding this value if aggregates from the same deposit or from one of similar geological origin demonstrated a satisfactory service record, or tests the engineer select indicate no inferior behavior.

(2) If using 2 sizes of coarse aggregates, the engineer will determine the percentages of harmful substances based on a sample consisting of 50 percent of sizes No. 1 and No. 2 for source approval; or, based on a sample consisting of the actual mix design percentages of sizes No. 1 and No. 2 used in the work.

(3) The engineer will field evaluate or laboratory test to determine aggregate acceptability relative to excessive clay lump quantities.

501.2.7.3.4 Alkali Silica Reactivity Testing and Mitigation Requirements

(1) If using coarse aggregate from sources containing significant amounts of fine-grained granitic rocks including felsic-volcanics, felsic-metavolcanics, rhyolite, diorite, gneiss, or quartzite; test coarse aggregate according to ASTM C1260 for alkali silica reactivity. Gravel aggregates are exempt from this requirement.

(2) If ASTM C1260 tests indicate a 14-day expansion of 0.15 percent or greater, perform additional testing according to ASTM C1567. Test mortar bars made with coarse aggregate and the blend of cementitious materials proposed for concrete placed under the contract. The department will reject the aggregate if ASTM C1567 tests confirm mortar bar expansion of 0.15 percent or greater at 14 days.

501.2.7.4 Size Requirements

501.2.7.4.1 General

(1) Except as provided below, furnish aggregates in separate sizes and store each size separately to prevent mixture until proportioned into each batch. The engineer will allow the contractor to combine aggregate fractions to produce a gradation within the limits specified in table 501-4, provided they are proportioned separately by weight into the batch in proportions provided in the contractor's mix design.

(2) The contractor may provide coarse aggregate with 100 percent passing the 1-inch sieve in concrete mixes used for the following:

- Curb and gutter, sidewalk, and steps.
- Prestressed concrete members.
- Foundations for soldier pile walls and noise walls.
- Structure repairs or deck overlays.
- Ancillary structure foundations.
- Concrete masonary seals.
- Other engineer-approved applications.

501.2.7.4.2 Aggregate Gradations

(1) Use well graded fine and coarse aggregate conforming to the blended aggregate gradation limits specified in table 501-4.

(2) The department will accept aggregates based on the blended aggregate gradations as batched. Calculate blended values using the actual batch percentages for the component aggregates.

TABLE 501-4 AGGREGATE MASTER GRADATION LIMITS

SIEVE	COMBINED AGGREGATE GRADATION		OPTIMIZED AGGREGATE GRADATION (OAG)
	STANDARD	100 % PASSING 1-inch sieve	TARANTULA CURVE GRADATION BAND
	(% passing by weight)		(volumetric % retained)
2-inch	100	100	0
1 1/2-inch	96 - 100	100	<= 5
1-inch	70 - 99	100	<= 16
3/4-inch	55 - 96	95 - 100	<= 20
1/2-inch	48 - 86	75 - 91	4-20
3/8-inch	38 - 77	56 - 80	4-20
No. 4	30 - 60	42 - 60	4-20
No. 8	25 - 53	36 - 55	<= 12
No. 16	20 - 44	27 - 45	<= 12
No. 30	10 - 32	15 - 32	4-20
No. 50	2 - 14	3 - 14	4-20
No. 100	0 - 6	0 - 6	<= 10
No. 200	0 - 2.3	0 - 2.3	<= 5
ADDITIONAL REQUIREMENTS - OPTIMIZED AGGREGATE GRADATION			
Percent by weight passing the 200 sieve <= 2.3			

OAG sum of volumetric percentages retained on No. 8, No. 16, and No. 30	>= 15
OAG sum of volumetric percentages retained on No. 30, No. 50, No. 100, and No. 200	24-34[1]

[1] Increase to 40 percent if the concrete will be placed by a pump or by hand.

501.2.7.4.2.1 Optimized Aggregate Gradation

(1) Ensure the blended aggregate gradations conform to the volumetric percent retained limits of the tarantula curve for the individual sieves specified in table 501-4. Also conform to the required OAG sums of percentages retained for the sieves specified in table 501-4.

(2) For concrete pavements with a combined contract quantity over 50,000 square yards, the contractor must use optimized aggregate gradations. The contractor has the option to use optimized aggregate gradations for all other concrete items.

(3) When using optimized aggregate gradations, the contractor may use an optimized mix design as allowed in 501.3.2.3.

501.2.7.4.2.2 Combined Aggregate Gradation

(1) For standard mixes and mixes with 100 percent passing the 1-inch sieve, as allowed under 501.2.7.4.1(2), conform to the combined aggregate gradation limits specified in table 501-4.

501.2.8 Concrete Curing Materials

(1) Furnish liquid curing compound conforming to ASTM C309, type 2, class A from the APL. Curing compound not on the APL, including carry-over material from a previous year that is removed from the APL, must be tested by the BTS laboratory if the quantity exceeds 220 gallons.

- Submit a 1-quart sample for each 2000 gallons used, or fraction thereof. Obtain samples under the engineer's observation.
- Submit a certified report of test or analysis that includes the lot/batch number of the sampled material.
- Carry-over curing compound from the previous year must be re-tested and placed on the current year APL before use.

(2) Furnish sheeting conforming to ASTM C171 for white opaque polyethylene film, except that the contractor may use clear or black polyethylene for cold weather protection.

(3) Furnish burlap conforming to AASHTO M182, class 3 or 4. The contractor may use 2 layers of class 1 or class 2 instead of one layer of class 3 or class 4.

(4) Furnish polyethylene-coated burlap conforming to ASTM C171 for white burlap-polyethylene sheets.

501.3 Construction

501.3.1 Concrete Grades

(1) The department's standard concrete grades are defined in table 501-5.

501.3.2 Concrete Composition

501.3.2.1 General

(1) Unless the contract specifies otherwise, for all concrete grades:

- Provide air-entrainment.
- Use a water-reducing admixture.

501.3.2.2 Concrete Proportions

501.3.2.2.1 General

(1) Unless the contract specifies otherwise or if using an engineer-approved optimized mix design, conform to the cementitious material and the water-to-cement ratio master limits for grades of concrete as specified in table 501-5.

TABLE 501-5 CONCRETE GRADES

GRADE	MINIMUM CEMENTITIOUS CONTENT FOR A NOMINAL CUBIC YARD (lb/cy)	MAXIMUM W/CM
A	565	0.45
B	400	0.65
C	660	0.45
E	823	0.36

501.3.2.2.2 Supplementary Cementitious Materials

(1) Replace 15 to 30 percent by weight of the total cementitious material content with approved SCMs for class I concrete as specified in 715.

(2) Replace a maximum of 30 percent by weight of the total cementitious material content with approved SCMs for class II and class III concrete as specified in 716.

(3) Limit Class F fly ash sources not on the APL to maximum 15 percent.

(4) Minimum SCM content may be waived by the engineer.

501.3.2.2.3 Water

(1) Water-to-cementitious material ratio (w/cm) is the weight of total free water divided by the weight of total cementitious materials.

501.3.2.2.4 Aggregates

(1) Proportion fine aggregates and coarse aggregates to meet the blended aggregate gradation limits established in 501.2.7.4.2.1 or 501.2.7.4.2.2.

501.3.2.3 Optimized Concrete Mixtures

(1) The contractor may use an optimized concrete mixture with reduced cementitious material content for concrete items with optimized aggregate gradations as defined in 501.2.7.4.2.1.

(2) Develop an optimized mix design as specified in 710.

- Provide a minimum cementitious material content of 500 pounds per cubic yard of concrete, except for grades C and E conform to table 501-5.
- Provide a minimum Vpaste/Vvoids of 1.25. The paste/void ratio equals the volume of paste divided by the volume of voids.

501.3.2.4 Concrete Admixtures

501.3.2.4.1 General

(1) Dispense admixtures in liquid form only. Incorporate non-liquid admixtures in an aqueous solution according to the manufacturer's instructions before dispensing. Maintain admixtures at uniform concentration. The contractor is responsible for the uniform operation of the admixture and for its compatibility with other mix components and any other admixture used.

501.3.2.4.2 Air Entrainment

(1) Use an admixture conforming to 501.2.5.2 with non-air-entrained cement to produce air-entrained concrete. Ensure that concrete air content conforms to the following:

- Grade E concrete contains 6.0 percent air, +/- 1.0 percent.
- Slip-formed concrete contains 7.0 percent air, +/- 1.5 percent.
- Other concrete contains 6.0 percent air, +/- 1.5 percent.

(2) Test fresh concrete air content according to WTM T152 or WTM T395 at the contract-required frequency and as the engineer directs. Test concrete placed by pumping or belting at the point of discharge from the pump line or belt.

(3) The engineer may verify air content using a method that measures air volume directly. The contractor may request a check test performed according to WTM T152 to validate the engineer's method.

501.3.2.4.3 Set Retarder

501.3.2.4.3.1 General

(1) Use admixtures to retard concrete setting conforming to 501.2.5.3.

501.3.2.4.3.2 Bridge Superstructures

(1) If required, add a retarding admixture conforming to 501.2.5.3 to the concrete mix used for the superstructures of cast in place reinforced concrete slab, concrete floor slabs, sidewalks, and parapets of other types of structures, including the top slab of concrete for box girder bridges according to the following:

(2) Add the department-approved retarding admixture, to the concrete mix, as the engineer directs, if the air temperature when placing the concrete is 70 F or above; or if it is 50 F or above and it is expected to take 4 or more hours to place the concrete in any one span or pour. Add the retarding admixture in the proportions the manufacturer recommends for the anticipated temperature.

501.3.2.4.3.3 Extended Delivery Time

(1) If the contractor elects to use a retarder to extend delivery time for ready-mixed concrete, as specified for delivery in 501.3.5.2, add it to the concrete mix if the concrete temperature when placing the concrete is 60 F or above.

(2) Add the retarding admixture according to the manufacturer's instructions to obtain at least a one-hour delay in the initial set, as defined in AASHTO T197, at the temperature during placement.

501.3.2.4.4 Water Reducer

(1) Use a water-reducing admixture conforming to 501.2.5.3. Determine the specific type and dosage based on the atmospheric conditions, the desired properties of the finished concrete, and the manufacturer's recommended dosage. The actual dosage must at least equal the manufacturer's recommended dosage. Both the type and dosage used require engineer approval before use.

501.3.3 Handling Materials

501.3.3.1 Aggregates

(1) Keep materials required to manufacture concrete clean and free from contamination. The department will not accept aggregates mixed with foreign matter. Keep the fine aggregate and the coarse aggregates separate until measuring and placing in the batch. If mixing or storing aggregates from different supply sources in the same pile, the engineer will reject the entire pile. The engineer may approve use of aggregates from different sources alternately in the same class of construction or mix; this permission is contingent on amending the job mix and batch weights as necessary to protect the concrete quality produced.

(2) If using a composite material from 2 or more sources for any aggregate for a job mix, proportion material from the respective sources separately into the batch by weight in the proportions the engineer approves.

(3) Store aggregates in stockpiles. The aggregates must not go directly from the washing plant to the proportioning bins. After washing, drain fine aggregate in stockpiles for at least 12 hours before weighing for the batch, unless the engineer reduces this waiting period. After washing and before placing in the proportioning plant, allow coarse aggregates to drain for periods that ensure uniformity in the moisture content.

(4) Choose reasonably smooth, firm, and well-drained sites for aggregate stockpiles cleared of vegetable matter and foreign material that might contaminate the aggregates. If necessary, build adequate bulkheads or partitions for keeping the fine and the several sizes of coarse aggregates separated. If the aggregates become intermixed, then do not use them.

(5) Construct coarse aggregate stockpiles in a way that minimizes segregation of the coarse and fine fractions.

(6) Exercise care in removing aggregates near the bottom of stockpiles, to avoid incorporating foreign materials, and use of material removed from near the bottom of drainage stockpiles at production plants and batching plants is prohibited unless tests indicate the material is satisfactory.

501.3.3.2 Cement

(1) Handle bulk cement in a way that precludes contamination and avoids loss.

(2) If using packaged cement, deposit it directly from the containers, as shipped, into the mixer when placing the aggregates into the mixer, or dump it directly on the batch aggregates just before placing the batch aggregates into the mixer, except as required otherwise to conform to 415.3.13 and 502.3.9.2 for mixing concrete under cold weather conditions. Take care to place the container's full contents into the batch.

501.3.3.3 Fly Ash or Slag

(1) Use separate facilities equal to those used for cement for handling, storing, transporting, and conveying the fly ash or slag.

501.3.4 Proportioning

501.3.4.1 Aggregates

(1) Measure the specified quantities of each size of fine and coarse aggregates by weight into each batch, except as specified for volumetric plant and mixer in 501.3.6.4.

501.3.4.2 Cement

(1) Measure the specified quantity of cement accurately into each batch.

(2) The contractor may proportion cement in sacks by volume if the operations allow the engineer to accurately determine the quantity of cement proportioned into each batch. Do not use batches

requiring a fractional part of a sack of cement, unless the contractor elects to weigh the fractional part required for each batch.

(3) Proportion cement in bulk by weight, except as specified for volumetric plant and mixer in 501.3.6.4.

501.3.4.3 Water

(1) Measure water by volume or by weight. Use water-measuring equipment capable of accurately measuring to within one percent of the quantity required for each batch. Ensure that the measurement accuracy is uniform under all construction conditions and that variations in pressure in the water supply line do not affect it.

(2) Use water-measuring equipment with preset controls that enable the operator to automatically cut off the flow after discharging the required quantity of water. Use equipment that has an accurately calibrated and easily read indicator showing the quantity of water used in each batch. Arrange this measuring equipment to facilitate checking the calibration accuracy.

501.3.4.4 Admixtures

501.3.4.4.1 General

(1) The contractor may proportion admixtures by volume or by weight. Follow a department-approved procedure for adding the specified quantity of each admixture. Add admixtures during initial batching of the concrete except as specified in 501.3.4.4.2.

(2) If using more than one admixture, add each admixture in a way that prevents intermixing the admixtures before incorporating into the mixture. The contractor may introduce the admixture into the water line, directly into the mixer when adding the water, or uniformly dispense it into the fine aggregate just before incorporating into the mix.

501.3.4.4.2 Adding Air-Entraining Admixtures in the Field

(1) The department will allow re-tempering with air-entraining admixtures at the work site for concrete delivered in truck mixers.

(2) If additional air-entraining admixture is needed at the work site to raise the air content of the concrete above the lower spec limit, measure it in a calibrated container and then add to the mixer in a dilute solution with water. Mix the concrete at mixing speed for at least 30 revolutions before discharge.

501.3.4.5 Weighing Equipment for Aggregates

501.3.4.5.1 General

(1) The contractor may use manual, automatic, or semi-automatic batching plants for weighing fine and coarse aggregates.

(2) Ensure each plant has bins for holding each aggregate weighed, and batchers, and scales for weighing the aggregates, and conforms to the requirements specified below.

(3) The contractor may use batching plants that are a complete unit with bins, batchers, and scales mounted on a rigid framework for direct discharge of the aggregate from the bin to the batcher; or plants with the bins mounted separately from the batchers and provided with appropriate means for conveying the aggregate from the bin to the batcher. Ensure the framework supporting bins and batchers is rigidly constructed and mounted on firm foundations.

(4) After erection, test each batching plant before use. Fully load aggregate bins, batchers, and scales with aggregate for not less than 5 hours before testing, in order to allow for settlement and adjustment under working conditions.

(5) Provide each batching plant with at least 10 standard 50-pound weights accurate to within 0.1 percent.

(6) When the engineer is observing the testing, furnish any accessories and assistance required to test the weighing and metering equipment. If difficulties occur in calibrating and testing the weighing or metering equipment, or if discrepancies occur during use, the engineer may require an authorized testing firm or agency test the scales or meters. If testing weighing equipment, ensure the material bins are fully loaded at the time.

(7) The contractor may batch aggregates, both fine and coarse, in separate or accumulative weigh batchers.

501.3.4.5.2 Scales

(1) Use either the beam, digital, or springless dial-type scales suitable for supporting the batcher and of a simple rugged design with a minimum number of adjustments, consistent with the accuracy required. Use scales designed and constructed to prevent displacement of scale parts and that provide a means for readily checking the proper position and alignment of scale levers. Ensure pivots are constructed of

material that satisfactorily resists wear under repeated weighing and are set accurately in substantial mountings to ensure a permanent spacing of the knife edges under all loading and use conditions.

(2) If provided beam scales, they must have a separate beam, or separate beam and fractional beam for each aggregate weighed. Provide each beam with a sliding poise and locking device to firmly hold it in position. Provide a means to display to the scale operator that the required load weight is approaching, for example, a springless dial indicator or tare beam. If using a graduated dial, provide it with a separate movable pointer or marker for each aggregate weighed. Set these pointers or markers to indicate the load of each aggregate as required. Provide a moisture resistant dial face.

(3) If using digital scales, conform to NIST handbook 44.

(4) Design, build, and maintain the scales to an accuracy within 0.4 percent of the net load in the hopper. Arrange the scales or indicating devices so the operator can maintain full view of them.

(5) Use graduated dials, beams, or other indicators to allow readings or settings made to within 0.1 percent of the capacity of the scale.

(6) Ensure accessibility to the scale working parts for inspection and cleaning, and protect working parts against contamination. Provide full and complete instructions for setting up and adjusting the scale.

501.3.4.5.3 Manually Operated Batching Plants

(1) Bins must have: suitable size and shape, no leakage, compartments or separate bins for each size of aggregate, rigid framework that, if mounted on a suitable foundation, holds them in the correct position.

(2) Multiple compartment bins must have partitions that extend above the top of the bins to prevent intermixing of the separate sizes of aggregates if heaped above the top of the bins.

(3) Weigh batchers must: have suitable size and shape, not leak, rest entirely upon the scales, and hang free. Provide clearance between the batcher top and bin discharge gates, or charging facilities, to house a full batch without hand raking, and sufficient clearance to remove any overload of aggregate. Provide a means to tightly close the batcher discharge gate during the batching interval. Ensure the design, construction, and operation of the batcher and its appurtenances does not retain varying tare materials on any of its parts, and completely and quickly discharges without shaking or jarring the scales.

501.3.4.5.4 Automatic and Semi-Automatic Batching Plants

(1) Use automatic and semi-automatic plants with bins, batchers, and scales conforming to the requirements specified above for manually operated batchers.

(2) Provide a means to protect the device for setting the batch weights against tampering by unauthorized personnel.

(3) Provide an audible signal device activated by the discharge of any batch whose weight is outside the specified tolerance. Ensure a loud enough signal to hear throughout the plant area under normal operating conditions.

(4) Provide automatic and semi-automatic batching plants with a device to indicate any underweight or overweight material.

(5) Provide automatic batching equipment with batching devices that if activated by a single starting mechanism, automatically batches or measures any given material, and automatically stops the flow of material after attaining the desired quantity, within the allowable tolerance.

(6) Use an interlocking batcher charging mechanism on automatic plants that guards against opening until the batcher entirely discharges and the scale balances within +/- 0.3 percent of the scale capacity, and against opening if the batcher discharge gate is open. Also, it should interlock to ensure against opening if the batcher charging mechanism is open, and against opening if the batch is either over or underweight by more than 1.5 percent of the specified batch weight in individual batchers or 1.5 percent of the specified intermediate and final accumulative batch weight in accumulative batchers.

(7) Provide semi-automatic batching equipment with suitable batching devices that open or start separately, if actuated by individual starting mechanisms, to allow weighing or measuring the material, and close or stop automatically after attaining the desired quantity, within the allowable tolerance.

(8) Use an interlocking batcher discharge mechanism for semi-automatic plants to ensure against opening if the batch is either over or underweight by more than 1.5 percent of the specified batch weight in individual batchers, or 1.5 percent of the specified intermediate and final accumulative batch weights in accumulative batchers.

(9) Ensure that the batcher discharge mechanisms of automatic or semi-automatic plants interlock against opening until aggregate batchers and the cement batcher are charged with the correct weights.

(10) Equip the batching system with automatic controls to stop the cycle in the underweight check position and the overweight check position for each material to allow tolerance limit checking.

(11) The contractor may use a batching system consisting of a combination of automatic and semi-automatic batchers provided it furnishes the appropriate controls and interlocks.

(12) If the control system of automatic or semi-automatic batching plants breaks down, the contractor may manually operate plants for up to 72 hours while making repairs.

501.3.4.6 Weighing Equipment for Cement, Fly Ash, and Slag

(1) The contractor may use manual, automatic, or semi-automatic batchers for batching cement. If using a combination of bin, batcher, and scales to proportion cement in bulk, conform to 501.3.4.5 for batching plants, with the following additions and exceptions:

(2) Use a separate batcher and scales.

(3) If using a beam scale, provide a tare beam and a weigh beam or beams capable of being lifted out of weighing position to allow checking the batcher's tare weight to determine if it discharges all the cement into the batch, unless there are other positive means to determine if complete discharge took place.

(4) Mechanically operate the batcher discharge gate in a way that does not affect the scale balance.

(5) Ensure that the batcher charging mechanism of automatic batchers interlock against opening until the batcher entirely discharges and the scale balances within +/- 0.3 percent of scale capacity, and against opening if the batcher discharge gate is open. Also, it should interlock against opening if the batcher charging mechanism is open; and against opening if the batch is either over or underweight by more than one percent of the specified batch weight.

(6) If using semi-automatic batchers, ensure the batcher discharge mechanism interlocks against opening if the batch is either over or underweight by more than one percent of the specified batch weight.

(7) Ensure that the batcher discharge mechanisms of automatic or semi-automatic plants interlock against opening until charging the cement batcher and aggregate batchers with the correct weight.

(8) The contractor may weigh and batch fly ash or slag along with the cement, but if this occurs, weigh the cement into the batcher first, and then add the fly ash or slag to the top of the batch of cement to the appropriate accumulative weight.

(9) For separate scales, bins, and hoppers used to batch fly ash or slag conform to the requirements specified above for cement-weighing equipment.

501.3.4.7 Dispensing Equipment for Admixtures

(1) Use accurate, volumetric, mechanical measuring dispensers, capable of presetting to deliver a specified quantity of admixture, or engineer-approved scales. Furnish a separate volumetric dispenser or scale for each admixture. Use a dispensing system with a device that either detects and indicates the presence or absence of flow of the admixture, or provides a convenient way to visually observing the admixture during batching or discharging. Ensure that the dispenser piping is free from leaks and properly valved to prevent back flow or siphoning.

(2) Interlock admixture-dispensing systems used in conjunction with semi-automatic plants, automatic plants, or on-site mixers of 21 cubic feet or more with the batching operations. Ensure that the system is capable of dispensing the admixture within +/- 3.0 percent of the required volume or weight of admixture, or the minimum dosage rate per 100 pounds of cement, whichever is greater.

501.3.5 Ready-Mixed Concrete

501.3.5.1 General

(1) The contractor may use ready-mixed concrete instead of site-mixed concrete, except for grade E concrete. Do not use ready-mixed concrete to produce grade E concrete.

(2) Interpret ready-mixed concrete to include central-mixed, transit-mixed, and shrink-mixed concrete, defined as follows:

Central-mixed concrete	Concrete 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	Concrete completely mixed in a truck mixer.
Shrink-mixed concrete	Concrete mixed partially in a stationary mixer with the mixing completed in a truck mixer.

501.3.5.2 Delivery

(1) Deliver ready-mixed concrete at a rate that ensures reasonably continuous progress in the placing and finishing operations. If the time intervals between successive loads or batches causes a partial drying of previously placed concrete provide additional equipment of the kind necessary to preclude these delays. Failing in this, discontinue use of ready-mixed concrete and use site-mixed concrete.

(2) Provide sufficient facilities for the production and delivery of ready-mixed concrete for concrete pavement to ensure placement at a uniform rate of not less than 80 cubic yards per hour, unless performing single-lane construction.

(3) Deliver and completely discharge the concrete within the following limits, beginning when adding water to the cement, or when adding cement to the aggregates.

Delivered in Agitating Vehicles:

- 60 minutes if the concrete temperature is 60 F or higher at placement, and the contractor does not use a department-approved retarder.
- 90 minutes if the concrete temperature is less than 60 F at placement.
- 90 minutes if the concrete temperature is 60 F or higher at placement, and the contractor uses a department-approved retarder.

Delivered in Non-Agitating Vehicles:

- 30 minutes if the concrete temperature is 85 F or higher at placement, and the contractor does not use a department-approved retarder.
- 45 minutes if the concrete temperature is 60 to less than 85 F at placement, and the contractor does not use a department-approved retarder.
- 60 minutes if the concrete temperature is less than 60 F at placement.
- 60 minutes if the concrete temperature is 60 F or higher at placement, and the contractor uses a department-approved retarder.

(4) The engineer or inspector will consult with BTS if a hydration controlling admixture, as specified in 501.2.5.3.5, is added to the mixture.

(5) The engineer or inspector may reduce these times under conditions contributing to quick stiffening of the mix, or during cold weather when loss of heat occurs to the extent that the concrete temperature is not correct at placement.

(6) Except during the mixing revolutions, operate the drum or agitator of the vehicle at agitating speed until discharging the mix. Ensure the concrete's uniform composition, required consistency, and required air content at time of delivery.

(7) The contractor may deliver central-mixed concrete to the work site by equipment with non-agitating body types. These body types are smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactorily controlled rate. Do not use aluminum bodies. Provide watertight covers for protection against the weather if necessary. The concrete in these vehicles should show no appreciable water gain at the surface. The concrete should freely and readily discharge from the vehicle, be free of excessive segregation of the fine and coarse aggregates, and have an air content within the required range at the point of discharge. Slump tests made during discharge should not differ by more than 2 inches. Remove foreign material and accumulated concrete before batching concrete into those vehicles.

501.3.5.3 Mixers and Mixing

(1) The contractor may use stationary mixers, or truck mixers of the revolving drum type or, with the engineer's written approval, other types specifically designed for mixing. For agitators, use truck mixers or truck agitators. The manufacturer shall attach in a prominent place, to each stationary mixer, truck mixer, or truck agitator a metal plate plainly marked with the various uses of the equipment, the drum or container capacity in volume of mixed concrete, and the rotation speed of the mixing drum or blades.

(2) If using a stationary mixer to mix concrete, mix at least one minute, provided that plant operating procedures are reasonably stabilized and controlled, and that it achieves visible blending of materials during charging to the engineer's satisfaction. If this mix time does not achieve proper stabilization, control, and blending, the engineer may increase the mixing time to 75 seconds.

(3) Exceptions to the minimum mixing time for stationary mixers specified above are contained in an approved list, BTS maintains, of reduced minimum mixing times for specific makes and models of stationary mixers. If these department-approved reduced minimum mixing times do not produce satisfactory stabilization, control, and blending the engineer may increase the mixing time as needed.

(4) Blending implies a uniform volume of flow of all batch ingredients throughout the charging time interval, except for the brief introduction of water and coarse aggregate. Charge the batch into the mixer so that:

1. Some water enters shortly before the solid material, and all water is in the drum by the time mixing begins.
2. Introduce admixtures uniformly throughout the charging time interval.
3. Introduce some coarse aggregate before other solid materials.
4. For the remaining solid material charging time, introduce the large and small sizes of the coarse aggregate, sand, and cement in an acceptably uniform rate of flow, as determined by visual inspection.
5. Start mixing time after all solid materials are in the mixer.

(5) The maximum mixing time for stationary mixers must not exceed the minimum specified above, by more than 60 seconds.

(6) Consider transfer time in multiple drum mixers as part of the mixing time.

(7) For stationary mixers, compute the total mixed concrete volume based on the nominal cubic yard determined in DT2220 or DT2221.This volume must not exceed the manufacturer's rated maximum mixing capacity, for the type and volume of mixer used, in the concrete plant mixer standards of the Concrete Plant Manufacturer's Bureau.

(8) Equip stationary mixers with a timing device that automatically locks the discharge mechanism during the full mixing time and releases it at the end of the mixing period.

(9) If mixing concrete in a truck mixer, mix each batch for 70 or more revolutions at the manufacturer-designated mixing speed. Do not exceed 300 total revolutions per batch, the sum of the revolutions at mixing and agitating speeds. Begin mixer revolutions only after all materials, including mixing water are in the mixer.

(10) Add the mixing water at the batching plant, but if obtaining the specified slump requires more water, add it in the field with the engineer’s permission. Do not exceed the maximum specified water to cementitious materials ratio. Calculate the maximum water as the sum of free water added with the aggregates and all added mixing water. If adding more water at the work site, perform an additional 20 revolutions of the truck mixer at mixing speed before discharging any concrete. The process of adding more water and additional mixing must happen within 45 minutes of introducing the mixing water to the cement or the cement to the aggregates. The engineer may extend the time limit for adding water and additional mixing to 75 minutes for those grades of concrete mixed under the conditions described in 501.3.5.2 whose delivery time limit is 1 1/2 hours. If additional mixing revolutions are necessary because of added water at the site, the total revolutions at mixing and agitating speeds must not exceed 300.

(11) If using a truck mixer or agitator to transport concrete completely mixed in a stationary mixer, rotate the drum or agitator at the agitating speed during transportation and until discharge.

(12) Equip truck mixers with an engineer-approved revolution counter. Unless equipped to control and count revolutions at mixing speed, perform mixing at the batching plant or job site with the mixer operated at agitating speed while in transit.

(13) For truck mixers operating from plants erected to supply concrete to highway projects, if the delivery time is short enough that the truck cannot exceed the maximum number of revolutions at mixing speed in transit, then mixer may operate at mixing speed in transit.

(14) If using a stationary mixer for partial mixing of the concrete, the contractor may reduce the mixing time in the stationary mixer to the minimum required to blend the ingredients, about 30 seconds.

(15) If using a truck mixer to finish the partial mixing done in a stationary mixer, mix each batch for 50 or more revolutions at the manufacturer-recommended speed. Do not exceed 300 total revolutions at mixing and agitating speeds.

(16) For truck mixers, compute the total concrete volume mixed per batch based on the nominal cubic yard determined in DT2220 or DT2221 and do not exceed the manufacturer's rated capacity, or the following percentages of the drum’s gross volume:

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

(17) The engineer may obtain representative samples from approximately the 1/6 and 5/6 discharge points of the concrete load of any truck mixer or truck agitator. If the slump of the 2 samples differs by more than one inch, or the entrained air content in them differs by more than one percent, correct the condition before using the load.

(18) For central-mixed or shrink-mixed concrete, if using more than one batch to make up a load, properly proportion each batch using all the ingredients, including admixtures, fly ash, or slag.

(19) Do not incorporate water used to clean mixing equipment and accessories into the mix.

(20) Replace the pick-up and throw-over blades of truck mixers or agitators if any part or section is worn one inch or more below their original height. Provide a copy of the manufacturer's design, showing dimensions and blade arrangement, upon the engineer's request.

501.3.5.4 Inspection

(1) Notify the engineer at least 24 hours before the contractor requires delivery of ready-mixed concrete so the engineer can inspect the proposed ready-mix plant and facilities.

(2) With each load of ready-mixed concrete, provide a computer-printed batch ticket which includes load and truck identification, the actual batch weights of all materials in that load, the mixing time for central plant-mixed concrete or the start of the batch life as specified in 501.3.5.2(3) for transit-mixed concrete, and other pertinent data. Give batch tickets to the inspector upon arrival at the work site. The department will only accept loads that arrive in satisfactory condition and have a batch ticket. The engineer will only accept hand written batch tickets in remote locations where no computerized plant is available within deliverable distance of the work site.

(3) Instead of requiring a batch ticket for each load, the engineer may accept central-mixed concrete used in pavement and associated bid items based on daily production records from a computer-controlled plant erected specifically for work under the contract. Submit a complete load-by-load written record that ties the truck IDs to the batch quantities and batch times for each day's production to the engineer at the end of each day's production. During concrete production, operate under a plan acceptable to the engineer that ties the truck ID to the batch quantities and batch time for each load. In that plan describe how that information will be made available to the engineer immediately upon request. The engineer may also require batch tickets to address short-term operational difficulties.

(4) The engineer may accept minor quantities of ready-mixed concrete used in miscellaneous bid items without batch tickets.

501.3.6 Site-Mixed Concrete

501.3.6.1 General

(1) Site-mixed concrete is concrete manufactured in standard batch or volumetric type portable mixers at the work site. Use volumetric mixers only for work that specifically allows volumetric proportioning.

501.3.6.2 Batch Mixer

(1) Use a powered revolving drum type mixer conforming to the following requirements, unless the engineer allows another type.

(2) Maintain the mixer in good working order and operate it in a way that does not combine the mixed batch with the following dry batch, and so that the ingredients of only one batch are intermixed with each charge of the mixer. Keep charging devices, the throat, and drum interior free of accumulated materials. If charged with the batch, revolve the mixer drum at a speed that does not exceed the manufacturer's specified speed for the mixer, provided the drum makes between 14 and 20 revolutions per minute. Replace pick-up and throw-over blades showing a wear in excess of 3/4 inch from their original factory depth. Mixers must have a rated capacity of at least 5 cubic feet of mixed concrete per batch.

(3) Equip mixers with an engineer-approved automatic timing device, in proper working order, designed and constructed so that it starts when the charging skip is raised and dumped. The timing mechanism must have a device that transmits an audible or visible signal when mixing is complete.

(4) Equip mixers, with a rated capacity of 21 cubic feet or more of mixed concrete, with an engineer-approved discharge-locking device, in good working order, and automatically controlled by the timing device.

(5) Keep the box or compartment containing the timing device closed and locked at all times except for adjustment or repairs. Only the contractor or an authorized representative shall make adjustments under the direct supervision of the engineer or inspector.

(6) Compute the total volume of concrete mixed per batch based on the nominal cubic yard determined in DT2220 or DT2221 and do not exceed the mixer's rated capacity by more than 10 percent as established by the Mixer Manufacturer's Bureau of the Associated General Contractors of America. The capacities above are contingent on the mixer drum retaining the batch without segregating, spilling, or leaking during charging, mixing, and discharging; and upon adequate methods of handling, placing and finishing the resultant concrete.

(7) Stop using and repair or replace with a satisfactory mixer, any concrete mixer that is not adequate or suitable for the work, has insufficient power, inefficient mixing action, or has auxiliary units that do not function properly.

501.3.6.3 Batch Mixing Time

(1) Mix each batch for at least 50 seconds but not more than 90 seconds. During this time, the drum revolves at the rate specified above. Start the mixing time after all solid materials are in the drum.

(2) Introduce the mixing water to the drum ahead of the other materials and continue to discharge for a short time after all solid materials are in the drum.

501.3.6.4 Volumetric Plant and Mixer

(1) Use a truck-mounted mobile concrete plant and mixer, designed for automatic volume proportioning of concrete materials, and for mixing concrete for immediate use at the work site, for grade E concrete, and the engineer may allow its use for bid items from other grades. This machine must produce a thoroughly mixed and uniform concrete.

(2) Calibrate the plant on a weight-volume relationship according to the manufacturer's recommended procedures. Recalibrate the plant if changing aggregates and, as the engineer deems necessary.

(3) Volumetric proportioning equipment and procedures are subject to the engineer's approval. Equip the plant with either a water flowmeter or a recording water meter.

501.3.7 Concrete Consistency

(1) Concrete must have a uniform consistency, with all ingredients uniformly distributed throughout the weight, and so that the mortar clings to the coarse aggregate. Concrete must not have a consistency sufficiently wet so it flows and segregates, or a mealy, dry consistency.

(2) Use the minimum quantity of water that achieves the desired workability, as the engineer determines. Obtain the engineer's approval of any changes in this quantity.

501.3.7.1 Slump

(1) Use a 1-inch to 4-inch slump for concrete used in structures or placed in forms, except as follows:

- Do not exceed a slump of 2 inches for grade E concrete.
- Increase slump as specified in 502.3.5.3 for concrete placed underwater.
- The contractor may increase the slump to a maximum of 9 inches for a mixture that contains a high range water reducer conforming to 501.2.5.3.3. Do not exceed the maximum w/cm allowed for the grade of concrete being used when a high range water reducer is in use.

(2) Use the applicable slump specified in 415.2.1 for concrete pavements.

(3) Concrete pavement repair and replacement must conform to the following:

- Use the following slumps for the technique used:

SLIP-FORMED	NOT SLIP-FORMED
2.5 inches or less	4 inches or less

- The contractor may increase the slump to a maximum of 9 inches for a mixture that contains a high range water reducer conforming to 501.2.5.3.3. Do not exceed the maximum w/cm allowed for the grade of concrete being used when a high range water reducer is in use.

(4) Perform the slump tests for concrete according to WTM T119.

501.3.8 Placing

501.3.8.1 General

(1) Except as specified in 501.3.5.2 for ready-mixed concrete, place the concrete within 30 minutes of first adding water to the batch. Use placement techniques that minimize segregation. Batch, mix, place, and finish concrete within a monolithic unit as continuously as practicable.

501.3.8.2 Hot Weather Concreting

501.3.8.2.1 General

(1) The contractor is responsible for the quality of the concrete placed in hot weather. For concrete placed under the bid items enumerated in 501.3.8.2.1(2), submit a written temperature control plan at or before the pre-pour meeting. In that plan, outline the actions the contractor will take to control concrete temperature if the concrete temperature at the point of placement exceeds 80 F. Do not place concrete under these bid items without the engineer's written acceptance of that temperature control plan. Perform the work as outlined in the temperature control plan.

(2) If the concrete temperature at the point of placement exceeds 90 F, do not place concrete under the following structure and concrete barrier bid items:

Concrete Masonry Bridges	Concrete Masonry Retaining Walls
Concrete Masonry Bridges HES	Concrete Masonry Retaining Walls HES
Concrete Masonry Culverts	Concrete Masonry Endwalls
Concrete Masonry Culverts HES	Concrete Masonry Overlay Decks
Concrete Barrier Single-Faced 32-Inch	Concrete Barrier (type)
Concrete Barrier Double-Faced 32-Inch	Concrete Barrier Fixed Object Protection (type)
Concrete Barrier Transition Section 32-Inch	Concrete Barrier Transition (type)

(3) The department will pay $0.75 per pound for the quantity of ice required to reach a target concrete temperature of 80 F if the following conditions are met:

1. The un-iced concrete temperature exceeds 85 F.
2. The contractor has performed the actions outlined in the contractor's accepted temperature control plan.
3. The contractor elects to use ice.

(4) If the engineer directs the contractor to use ice when the un-iced concrete temperature is 85 F or less, the department will pay $0.75 per pound for that ice.

(5) Notify the engineer whenever conditions exist that might cause the temperature at the point of placement to exceed 80 F. If project information is not available, the contractor should obtain information from similar mixes placed for other nearby work.

501.3.8.2.2 Bridge Decks

(1) For concrete placed in bridge decks under the bid items enumerated in 501.3.8.2.2(2), submit a written evaporation control plan at or before the pre-pour meeting. In that plan, outline the actions the contractor will take to maintain concrete surface evaporation at or below 0.2 pounds per square foot per hour. Do not place concrete under these bid items without the engineer's written acceptance of that evaporation control plan. If the engineer accepts an evaporation control plan calling for ice, the department will pay $0.75 per pound for that ice. Perform the work as outlined in the evaporation control plan.

(2) If predicting a concrete surface moisture evaporation rate exceeding 0.2 pounds per square foot per hour, do not place bridge deck concrete under the following bid items:

Concrete Masonry Bridges	Concrete Masonry Overlay Decks
Concrete Masonry Bridges HES	

(3) Provide evaporation rate predictions to the engineer under one or more of the following conditions:

1. Conditions exist that might cause concrete surface evaporation to exceed 0.2 pounds per square foot per hour.
2. The concrete temperature at the point of placement exceeds 80 F.
3. The engineer requests that information.

(4) Compute the evaporation rate from the predicted ambient conditions at the time and place of the pour using the nomograph provided in CMM 525 Figure 1, or using a computerized equivalent. Use weather information from the nearest national weather service station. The engineer will use this information to determine if the pour will proceed as scheduled.

(5) On the day before the pour, the engineer will notify the contractor in writing whether or not to proceed with the pour as scheduled. If the actual computed evaporation rate during the pour exceeds 0.2 pounds per square foot per hour, the engineer may allow the contractor to complete the pour. If the engineer allows placement to continue, the department will pay $0.75 per pound for the quantity of ice required to maintain concrete surface evaporation at or below 0.2 pounds per square foot per hour. If ice is not available the department will pay for any actions, beyond those described in the contractor's evaporation plan, required to complete the pour as the engineer directs.

501.3.9 Mixing and Protecting During Cold Weather

(1) Mix, place, and protect concrete according to the method specified below, applicable to its use.

(2) Mix, place, and protect concrete for pavement, pavement repair and replacement, pavement widening, pavement gaps, driveways, alleys, headers, surface drains, pavement approach slabs, base, base widening or patching, curb, gutter, curb & gutter, ditch checks, sidewalks, steps not a part of a structure, loading zones, safety islands and other concrete of a similar nature as specified in 415.3.13.

(3) Mix, place, and protect concrete for bridges, culverts, retaining walls, end walls, or any other structure consisting, wholly or in part, of concrete, if placed during cold weather, as specified in 502.3.9.

501.4 (Vacant)

501.5 Payment

(1) The department will not pay directly for the concrete specified under this section. Concrete is incidental to the various bid items using it. Payment under those bid items includes providing materials, including aggregates and associated aggregate source testing, cement, fly ash, slag, and admixtures; and for preparing, transporting, storing, protecting and curing concrete.

(2) If required to remove and replace any concrete damaged by lack of proper protection. Perform this work at no expense to the department.

(3) The department will pay for ice used to cool concrete in hot weather as specified in 501.3.8.2 under the Ice Hot Weather Concreting administrative item.

690 Sawing

690.1 Description

(1) This section describes sawing of existing concrete or asphalt including pavement, curb & gutter, driveways, sidewalks, and similar work.

690.2 (Vacant)

690.3 Construction

690.3.1 Equipment

(1) Use diamond blades for sawing concrete where a full-depth cut is required. The contractor may use carbide cutting wheels to saw concrete that will be overlaid or for full-depth cuts where the cut face does not join the new concrete.

690.3.2 Sawing Asphalt

(1) Make straight saw cuts at least 2 inches deep. Saw so the surface remaining is generally vertical over its full depth. Saw to the depth the plan indicates or as the engineer directs or allows.

690.3.3 Sawing Concrete

(1) Do not extend saw cuts into newly placed concrete pavement or into existing pavements more than 12 inches beyond the limits the engineer designates. Saw full-depth unless the plans indicate otherwise or the engineer directs or allows otherwise.

(2) Remove sawing sludge after completing each saw cut. Minimize sludge on live traffic lanes. Remove sludge from traffic control devices each day before dark. Dispose of sludge at an acceptable material disposal site or on engineer-approved areas of the roadway or roadside.

690.4 Measurement

Revise 690.4(2) measurement language for sawing in conjuction with concrete pavement repair and replacement or concrete base patching.

(1) The department will measure Sawing Asphalt and Sawing Concrete by the linear foot acceptably completed. The department will not measure overcuts beyond the limits the plans show or the engineer directs.

(2) If performing sawing in conjunction with concrete pavement repair and replacement or concrete base patching, the department will measure the applicable total quantity of the following:

1. One full-depth longitudinal cut at each limit of the repair area that abuts to adjacent pavement. If the contractor is removing concrete pavement for double lane repairs, the department will also measure one full-depth longitudinal cut through the middle of the double lane repair area. If the contractor is breaking the concrete pavement prior to removal, no longitudinal cuts within the repair limits will be measured for payment.
2. Two full-depth transverse cuts, one at each limit of the repair area.
3. If the longitudinal length of a repair area is greater than 7 feet, the department will measure additional transverse cuts as necessary to reduce the removal slabs to a longitudinal length of 7 feet. If the contractor is breaking the concrete pavement prior to removal, no transverse cuts within the repair limits will be measured for payment.
4. Additional full-depth cuts the engineer directs to extend the repair limits, unless those cuts were required because of damage contractor operations caused.

(3) The department will measure and pay for composite cuts through both asphalt and concrete as concrete.

690.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
690.0150	Sawing Asphalt	LF
690.0250	Sawing Concrete	LF

(2) Payment is full compensation for sawing and sludge removal.

701 General QMP Requirements

701.1 Description

701.1.1 General

(1) This section describes contractor responsibilities common to QMPs under 700 including quality control plans; personnel and laboratory certification; quality control testing; data submission; and record keeping. This section also describes department responsibilities, common to all QMPs under 700, for verification and quality assurance testing. Exceptions and additional requirements under the QMP program are specified in individual QMP specifications.

701.1.2 Quality Control Program

701.1.2.1 General

(1) Provide and maintain a quality control program, defined as all contractor activities and documentation of the following:

1. Gradation and mix design.
2. Control and inspection of production and placement processes.
3. Material sampling, testing, and correction of in-place work.

(2) CMM 800 provides additional detailed guidance for QMP work and describes required sampling and testing procedures.

(3) Use MRS to report contract-required test results to the department electronically, estimate pay adjustments, and print reports. Qualified personnel may obtain MRS software at:

http://www.atwoodsystems.com/

701.1.2.2 Quality Control Plan

(1) Prepare a project-specific written quality control plan for each individual QMP specification and construct the project as that plan provides. Submit each individual quality control plan to the engineer no later than 10 business days before placing the respective material. Obtain engineer approval before making process or material changes that differ from those provided in approved QC plans. Update QC plans with changes as they become effective. Provide current plans to the engineer and post in each contractor laboratory before producing material and as changes are adopted.

(2) Ensure that quality control plans include the following elements:

1. Organizational chart including names, telephone numbers, current certifications with experation dates, and roles and responsibilities of quality control personnel.
2. Process for disseminating quality control and corrective action information to appropriate persons. Include a list of recipients, the communication means used, and action time frames.
3. Locations of qualified QC laboratories, including their effective expiration dates and tests qualified to perform.
4. Material sources; include unique identifier for each aggregate source.
5. Batch plants and processing locations.
6. Initial and routine equipment checks and documentation.
7. Frequency of contractor quality control testing.
8. Process control testing the contractor intends to perform, and associated control charts or other documentation the contractor will make available to the department.
9. Procedures for identifying and documenting the locations of yielding foundation before placing material.

701.1.2.3 Small Quantities

(1) For contracts with small quantities of material, as defined in individual QMP specifications, the contractor may submit an abbreviated quality control plan consisting of only items 1, 4, 5, and 7 of 701.1.2.2(2) or integrate that small-quantity work into another contract QC plan.

701.1.2.4 Personnel Certification

(1) Have personnel that are HTCP-certified at or above the minimum levels specified in table 701-1 perform sampling, testing, and documentation.

(2) A certified technician coordinates and is responsible for work an assistant certified technician (ACT) performs. The certified technician ensures that sampling and testing is performed correctly, analyzes test results, and posts resulting data. No more than one ACT can work under a single certified technician.

701.1.2.5 Laboratory Qualification

(1) Ensure that contractor portable and fixed laboratories, as well as commercial laboratories performing testing under the contract, are qualified to perform the work in question. Obtain information on the Wisconsin laboratory qualification program from the department's web site at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/appr-prod/qual-labs.aspx

701.1.2.6 Equipment

(1) Furnish the necessary equipment and supplies for performing quality control testing. The engineer may inspect the measuring and testing devices to confirm both calibration and condition. Calibrate testing equipment according to CMM 830 and maintain a calibration record at the laboratory.

701.1.2.7 Documentation

701.1.2.7.1 Control Charts

(1) When control charts are required under the contract, maintain standardized control charts at the laboratory. Record conractor test results on the charts the same day as testing. Plot the running average of the last four QC data points.

(2) Show upper and/or lower control and warning limits, when applicable. Plot test results from additional, non-random sampling as well as department test results as soon as the information becomes available; do not include them in the 4-point running average unless specified otherwise in the individual QMP provisions. Label the plotted information or include a legend.

(3) Monitor control charts and conduct corrective actions as specified in the QMP provisions. Document corrective actions as well as resulting effects in the materials report.

701.1.2.7.2 Quality Control Source Documents

(1) Document observations, material adjustments, process adjustments, and nonconforming material investigations daily in a permanent field record. Note additional process control information enumerated in the contractor's quality control plan.

(2) Use forms described in CMM 800. When electronic reporting is required, submit the data using MRS within 5 business days after results are available.

(3) Submit final testing records, control charts, source documents, and other documentation in a manner acceptable to the engineer within 10 business days after placement. For long-term test results, submit final records within 10 business days after contract-required information becomes available. The engineer may allow submission of scanned copies of hand-written documentation.

701.2 (Vacant)

701.3 Testing

701.3.1 General

(1) Perform contract required QC tests for samples randomly located according to CMM 830. Use the test methods specified in table 701-1.

TABLE 701-1 TESTING AND CERTIFICATION STANDARDS

TEST	TEST STANDARD	MINIMUM REQUIRED CERTIFICATION (any one of the certifications listed for each test)
Random Sampling	WTM D3665	Transportation Materials Sampling Technician (TMS) TMS Assistant Certified Technician (ACT-TMS) Aggregate Technician I (AGGTEC-I) AGGTEC-I Assistant Certified Technician (ACT-AGG) PCC Technician I (PCCTEC-I) PCCTEC-I Assistant Certified Technician (ACT-PCC) Grading Technician I (GRADINGTEC-I) Grading Assistant Certified Technician (ACT-GRADING)
Sampling Aggregates	WTM R90	TMS, ACT-TMS, AGGTEC-I, ACT-AGG
Percent passing the No. 200 sieve	WTM T11	AGGTEC-I, ACT-AGG
Fine & coarse aggregate gradation	WTM T27	
Aggregate moisture content	WTM T255	
Fractured faces	WTM D5821	
Liquid limit	WTM T89	Aggregate Testing for Transportation Systems (ATTS) GRADINGTEC-I, or ACT-GRADING
Plastic Limit and Plasticity index	AASHTO T90[1]	
Sampling freshly mixed concrete	WTM R60	PCCTEC-1 ACT-PCC
Air content of fresh concrete	WTM T152 WTM T395	
Air void system of fresh concrete	WTM T395	
Concrete slump	WTM T119	
Concrete temperature	AASHTO T309	
Making and curing concrete specimens	WTM R100	
Moist curing for concrete specimens	AASHTO M201	
Concrete compressive strength	WTM T22	Concrete Strength Tester (CST) CST Assistant Certified Technician (ACT-CST)
Concrete flexural strength	WTM T97	
Concrete surface resistivity	WTM T358	
Voids in aggregate	AASHTO T19	PCCTEC-II
Workability of Concrete	AASHTO T396	
Profiling	—	PROFILER

[1] A plasticity check, if required under individual QMP specifications, may be performed by an AGGTEC-I in addition to the certifications listed for liquid limit and plasticity index tests.

701.3.2 Contractor QC Testing

(1) Generate random numbers, determine sample and test locations according to WTM D3665, and provide to the engineer before placing material within the corresponding test increment. Perform contract required QC tests at the predetermined random location. Also, perform other tests as necessary to control production and construction processes, and additional testing enumerated in the contractor's quality control plan or that the engineer directs. Report test results to the engineer within timeframes specified in individual QMP specifications.

(2) Notify the engineer when an individual test exceeds a spec limit. Material from the first out-of-spec test up to, but not including, material from the first subsequent in-spec test is nonconforming. The department may reject or otherwise determine the final disposition of nonconforming material as specified in 106.5.

(3) The department may periodically observe contractor sampling and testing, and direct additional contractor sampling and testing for department evaluation.

701.3.3 Department Testing

701.3.3.1 General

(1) The department conducts verification testing to validate product quality and independent assurance testing to evaluate sampling and testing. The department will use the same sampling and testing

methods required for contractor testing under 701.3.1. The department will provide the contractor with a list of names and telephone numbers of project verification and independent assurance personnel upon approval of the QC plan.

(2) The department will provide test results to the contractor within timeframes specified in individual QMP specifications.

(3) Correct department-identified deficiencies. If the contractor fails to correct deficiencies or resolve discrepancies, the engineer may suspend production.

701.3.3.2 Quality Verification Testing

(1) The department will have an HTCP-certified technician, or ACT working under a certified technician, perform QV sampling and testing. Department QV testing personnel must meet the same certification requirements specified in 701.1.2.4.

(2) The department will sample and test randomly at locations independent of the contractor's QC tests and use separate equipment and laboratories. The department will notify the contractor before sampling so the contractor can observe QV sampling. The department will conduct a minimum of one verification test for each 5 contractor QC tests unless individual QMP specifications specify otherwise.

(3) If verification tests conform to specifications, no further action is required. If verification tests do not conform to specifications, the department will notify the contractor immediately and the two parties will jointly investigate. The investigation may include additional testing as well as review and observation of both department and contractor sampling and testing procedures, equipment, and other documented test results. Both parties will document investigative work.

701.3.3.3 Independent Assurance Testing

(1) The department performs independent assurance testing to evaluate department verification and contractor's QC sampling and testing including personnel qualifications, procedures, and equipment. The department will perform independent assurance reviews according to the department's independent assurance program, which may include one or more of the following:

1. Split sample testing.
2. Proficiency sample testing.
3. Witnessing sampling and testing.
4. Test equipment calibration checks.
5. Reviewing contract-required data and available contractor process control information.
6. Requesting that testing personnel perform additional sampling and testing.

701.3.4 Dispute Resolution

(1) The engineer and contractor will jointly investigate any testing discrepancies and potentially nonconforming materials. Attempt to seek a mutually agreeable solution. Abide to the dispute resolution procedures in 106.3.4.3.5.

701.3.5 Corrective Action

(1) Conform to corrective action specified in individual QMP specifications or as directed by the engineer.

701.4 (Vacant)

701.5 Payment

(1) Costs for sampling, testing, and documentation under 700 are incidental to the work. If the contractor fails to perform required QMP work, the department may reduce the contractor's pay. The department will administer pay reductions under the Non-performance of QMP administrative item.

710 General Concrete QMP

710.1 Description

(1) This section describes contractor QC testing requirements common to all concrete classes under 700. Exceptions and additional requirements for concrete testing are specified in:

- 715 for class I concrete used in structures and pavement.
- 716 for class II and class III concrete used in ancillary applications.

710.2 Small Quantities

(1) The department defines small quantities as follows:

- As specified in 715.1.1.2 for class I concrete.
- Less than 50 cubic yards of class II ancillary concrete placed under a single bid item.

(2) For contracts with only small quantities of material subject to testing, modify the requirements of 710 as follows:

1. The contractor may submit an abbreviated quality control plan as allowed in 701.1.2.3 that also includes concrete mix design documentation from 710.4.
2. Provide one of the following for aggregate process control:
    - Documented previous testing dated within 120 calendar days. Provide gradation test results to the engineer before placing material.
    - Non-random start-up gradation testing.

710.3 Certification Requirements

(1) Have a certified PCC technician I, or ACT-PCC working under a certified technician, on the project site, prepared and equipped to perform required sampling and testing whenever placing concrete.

710.4 Concrete Mixes

(1) The contractor is responsible for mix performance.

(2) At least 7 business days before producing concrete, document that materials conform to 501 unless the engineer allows or individual QMP specifications provide otherwise. Include the following:

1. For mixes: quantities per cubic yard expressed as SSD weights and net water, water to cementitious material ratio, air content, and SAM number.
2. For cementitious materials and admixtures: type, brand, and source.
3. For aggregates: absorption, SSD bulk specific gravity, wear, soundness, freeze thaw test results if required, and air correction factor. Also include aggregate production records dated within 2 years if using those results in the design. Submit component aggregate gradations, aggregate proportions, and target combined blended aggregate gradations using the following:
    - DT2220 for combined aggregate gradations.
    - DT2221 for optimized aggregate gradations.
4. For optimized concrete mixtures:
    - Complete the worksheets within DT2221 according to the directions.
    - Ensure the optimized aggregate gradations and the optimized mix design conform to WisDOT specifications and pass the built-in tests within DT2221.
    - Verify slip-form mixture workability and conformance to specifications through required trial batching.
    - Submit the completed DT2221 to the engineer electronically. Include the trial batch test results with the mix design submittal.

(3) Document mix adjustments daily during concrete production.

(4) Prepare and submit modifications to a concrete mix to the engineer for approval 3 business days before using that modified mix. Modifications requiring the engineer's approval include changes in:

1. Source of any material except for the following:
    - Water: Concrete plants with multiple water sources are not required to provide a mix change if all other components of the mix design are the same source and all water sources are approved per CMM 850.
    - Fly Ash: For class I pavement and cast-in-place barrier and class II concrete mixes a source change for fly ash of the same class does not constitute a mix design change.
2. Quantities of cementitious materials.
3. Addition or deletion of admixtures. Minor admixture dosage adjustments required to maintain air content or slump do not require engineer review or approval.

(5) When the department requires high early strength concrete, use one of the following:

- Add at least 95 pounds but no more than 280 pounds of cement per cubic yard to a previously accepted mix along with enough water to maintain workability without raising the w/cm.
- Use type III cement.

(6) When the department allows high early strength concrete for contract convenience, the contractor may increase the cement content up to 280 pounds of cement per cubic yard.

(7) Submit concrete mix designs into MRS as specified in 701.1.2.7.

710.5 Sampling and Testing

710.5.1 General

(1) Sample fresh concrete at the point of placement. Use the test methods specified in table 701-1.

710.5.2 Slump

(1) Provide material conforming to the slumps specified in 501.3.7.1. The contractor need not test slump for concrete placed by slip-form methods unless the engineer requests. For other placement methods, test slump whenever an air content test is performed, strength specimens are made, and as the engineer directs.

710.5.3 Air Content

(1) Provide material conforming to the air contents specified in 501.3.2.4.2. On each day of production, test each mix design at start-up and as frequently as practicable until concrete is conforming and concrete production is under control. Subsequently, test at the QC testing frequency specified in individual QMP specifications and as the engineer directs.

(2) If an individual air test is outside the spec limits, notify the engineer and test as often as practicable on subsequent loads until the air content is conforming.

710.5.4 Concrete Temperature

(1) Measure concrete temperature of the same sample used for air content testing and report the results along with the air content.

710.5.5 Strength

(1) Cast all 6" x 12" cylinders or all 6" x 6" x 21" beams in a set from the same sample. Do not cast more than one set of specimens from a single truckload of concrete. Mark each specimen to identify the lot and sublot or location on the project it represents.

(2) Provide facilities for initial curing. For up to 48 hours after casting, maintain the temperature adjacent to the specimens in the range of 60 to 80 F and prevent moisture loss. Between 24 and 48 hours after casting, transport the specimens to a department-qualified laboratory for standard curing until testing at 28 days.

(3) Determine the 28-day strength of specimens in psi. Test specimens to failure. Use a testing machine that automatically records the date, time, rate of loading, and maximum load of each specimen. Provide a printout of this information for each specimen tested.

710.5.6 Aggregate Testing During Concrete Production

710.5.6.1 General

(1) The department will accept gradation based on the results of department-performed acceptance testing.

(2) The department and contractor must obtain samples using the same method. When belt sampling, contractor personnel shall obtain samples for the department under the direct observation of department personnel. Define the sampling method in the contractor's quality control plan or in the contractor's abbreviated quality control plan.

710.5.6.2 Contractor Control Charts

710.5.6.2.1 General

(1) Test aggregate gradations during concrete production except as allowed for small quantities under 710.2. Perform required contractor testing using non-random samples.

(2) Sample aggregates from either the conveyor belt or from the working face of the stockpiles.

(3) Sample aggregates within 2 business days before placement for each mix design. Include this gradation on the control charts.

(4) Report gradation test results and provide control charts to the engineer within 1 business day of obtaining the sample. Submit results to the engineer and electronically into MRS as specified in 701.1.2.7.

(5) Conduct aggregate testing at the minimum frequency shown based on the anticipated daily cumulative plant production for each mix design. The contractor's concrete production tests can be used for the same mix design on multiple contracts.

TABLE 710-1 CONTRACTOR GRADATION TESTING FREQUENCY - CLASS I

DAILY PLANT PRODUCTION RATE FOR WisDOT WORK	MINIMUM FREQUENCY
Gradation Report Before Placement	
1000 cubic yards or less	one test per day
more than 1000 cubic yards	two tests per day

TABLE 710-2 CONTRACTOR GRADATION TESTING FREQUENCY - CLASS II

MINIMUM FREQUENCY
Gradation Report Before Placement
One test per calendar week of production

710.5.6.2.2 Optimized Aggregate Gradation Control Charts

(1) Determine the complete gradation using a washed analysis for both fine and coarse aggregates. Report results for the following:

- 1 1/2", 1", 3/4", 1/2", 3/8", #4, #8, #16, #30, #50, #100, and #200 sieves.
- Sum of volumetric percentages retained on #8, #16, and #30 sieves.
- Sum of volumetric percentages retained on #30, #50, #100, and #200 sieves.

(2) Calculate blended aggregate gradations using the mix design batch percentages for the component aggregates. Ensure the blended aggregate gradation conforms to the volumetric percent retained of the optimized aggregate gradation limits specified in table 501-4.

(3) Throughout the contract, construct a 4-point running average of the volumetric percent retained for each sieve to determine if the blended aggregate gradation is within the tarantula curve limits specified in table 501-4.

710.5.6.2.3 Combined Aggregate Gradation Control Charts

(1) Determine the complete gradation using a washed analysis for both fine and coarse aggregates. Report results for the 1 1/2", 1", 3/4", 1/2", 3/8", #4, #8, #16, #30, #50, #100, and #200 sieves.

(2) Calculate blended aggregate gradations using the mix design batch percentages for the component aggregates. Ensure the blended aggregate gradation conforms to the percent passing by weight requirements of the combined aggregate gradation limits specified in table 501-4.

(3) Throughout the contract, construct a 4-point running average of the percent passing by weight for each sieve to determine if the blended aggregate gradation is within the combined aggregate gradation limits specified in table 501-4.

710.5.6.3 Department Acceptance Testing

(1) Department testing frequency is based on the quantity of each mix design placed under each individual WisDOT contract.

(2) The department will split each sample, test for acceptance, and retain the remainder for a minimum of 10 calendar days.

(3) The department will obtain the sample and deliver to the regional testing lab in the same day. The department will report gradation test results to the contractor within 1 business day of being delivered to the lab. The department and contractor can agree to an alternative test result reporting timeframe. Document alternative timeframes in the contractor's quality control plan.

(4) Additional samples may be taken at the engineer's discretion due to a changed condition.

TABLE 710-3 DEPARTMENT GRADATION TESTING FREQUENCY

CONCRETE CLASSIFICATION	MINIMUM DEPARTMENT FREQUENCY
Small Quantity: Class I: Pavement Class I: Structures Class I: Cast-in-Place Barrier	1 test on first day of placement
Class I: Pavement	1 test per placement day for first 5 days of placement. If all samples are passing, reduced frequency is applied.
	Reduced frequency: 1 test per calendar week of placement
Class I: Structures	1 test per 250 CY placed - Minimum of 1 test per contract for substructure - Minimum of 1 test per contract for superstructure
Class I: Cast-in-Place Barrier	1 test per 500 CY placed
Class II	No minimum testing

710.5.7 Corrective Action

710.5.7.1 Optimized Aggregate Gradations

(1) If the contractor's 4-point running average or a department test result of the volumetric percent retained exceeds the tarantula curve limits by less than or equal to 1.0 percent on a single sieve size, notify the other party immediately and do the following:

Option A:

1. Perform corrective action documented in the QC plan or as the engineer approves.
2. Document and provide corrective action results to the engineer as soon as they are available.
3. Department will conduct two tests within the next business day after corrective action. Department will provide test results to contractor after each test is complete.
4. If blended aggregate gradations are within the tarantula curve limits by the second department test:
   - Continue with concrete production.
   - Include a break in the 4-point running average.
   - For Class I Pavements: The department will discontinue reduced frequency testing and will test at a frequency of 1 test per placement day. Once 5 consecutive samples are passing at the 1 test per placement day frequency, the reduced frequency testing will be reapplied.
5. If blended aggregate gradations are not within the tarantula curve limits by the second department test:
   - If the contract does not require optimized aggregate gradation under 501.2.7.4.2.1(2), stop concrete production and submit either a new optimized aggregate gradation mix design or a combined aggregate gradation mix design.
   - If the contract requires optimized aggregate gradations under 501.2.7.4.2.1(2), stop concrete production and submit a new optimized aggregate gradation mix design.

Option B:

1. Submit a new optimized aggregate gradation mix design.
2. Restart control charts for new mix design.

(2) If the contractor's 4-point running average or a department test result of the volumetric percent retained exceeds the tarantula curve limits by more than 1.0 percent on one or more sieves, stop concrete production and submit a new mix design.

(3) Both the department and contractor must sample and test aggregate of the new mix design at the frequency specified in 710.5.6.1.

710.5.7.2 Combined Aggregate Gradations

(1) If the contractor's 4-point running average or a department test result of the percent passing by weight exceeds the combined aggregate gradation limits by less than or equal to 1.0 percent on a single sieve size, do the following:

1. Notify the other party immediately.
2. Perform corrective action documented in the QC plan or as the engineer approves.
3. Document and provide corrective action results to the engineer as soon as they are available.
4. The department will conduct two tests within the next business day after corrective action is complete.

5. If blended aggregate gradations are within the combined aggregate gradation limits by the second department test:
    - Continue with concrete production.
    - Include a break in the 4-point running average.
    - For Class I Pavements: The department will discontinue reduced frequency testing and will test at a frequency of 1 test per placement day. Once 5 consecutive samples are passing at the 1 test per placement day frequency, the reduced frequency testing will be reapplied.
6. If blended aggregate gradations are not within the combined aggregate gradation limits by the second department test, stop concrete production and submit a new mix design.

(2) If the contractor's 4-point running average or a department test result of the percent passing by weight exceeds the combined aggregate gradation limits by more than 1.0 percent on one or more sieves, stop concrete production and submit a new mix design.

(3) Both the department and contractor must sample and test aggregate of the new mix design at the frequency specified in 710.5.6.1.

715 QMP Concrete Pavement, Cast-in-Place Barrier and Structures

715.1 Description

(1) This section describes contractor mix design, testing, and documentation requirements for class I concrete used in concrete structures, cast-in-place concrete barrier, and concrete pavement.

715.1.1 Quality Control Program

715.1.1.1 General

(1) Conform to general requirements under 701 and 710 as well as additional requirements for class I concrete specified here in section 715. The department defines class I concrete as cast-in-place concrete used in pavement, barrier, or structure applications where all of the following apply:

- Mix design requires review by the engineer.
- The contract defines spec limits for strength.
- The contractor may earn statistically based incentives for superior concrete strength.[1]

[1] HES and SHES concrete are not eligible for 28-day strength incentives.

715.1.1.2 Small Quantities

(1) The department defines small quantities of class I concrete, subject to the reduced requirements under 710.2, as follows:

- Less than 250 cubic yards of structure concrete placed under a single bid item.
- Less than 150 cubic yards of barrier concrete placed under the contract.
- Less than 2500 cubic yards of slip-formed pavement placed under the contract.
- Less than 1000 cubic yards of non-slip-formed pavement placed under the contract.

715.1.1.3 Pre-Pour Meetings for Structure Concrete

(1) Arrange at least two pre-pour meetings to discuss concrete placement. Discuss the placement schedule, personnel roles and responsibilities, testing and quality control, and how test results will be communicated. Schedule the first meeting before placing any concrete and the second before placing any bridge deck concrete. Ensure that representatives from all parties involved with concrete work, including contractor, sub-contractor, ready-mix supplier, testers, and the project manager, attend these meetings.

715.1.1.4 Quality Control Plan

(1) Submit a quality control plan 7 business days before producing concrete, conforming to 701.1.2.2 and include the following:

1. Concrete mix design documentation as required in 710.4.
2. Proposed methods for monitoring and recording batch weights.
3. Aggregate gradation acceptance method for class I concrete items.
4. Methods for monitoring and adjusting blended aggregate gradations before corrective action is required under 710.5.7; and methods for documenting corrective action.

715.1.1.5 Documentation

(1) Submit results electronically into MRS within 5 business days after those results become available for the following, if required under the contract:

- QC tests.
- Engineer-directed tests.
- Corrective-action tests.

(2) Submit aggregate gradation test results as specified in 710.5.6.1(2).

715.2 Materials

715.2.1 General

(1) Determine mixes for class I concrete used under the contract using one or more of the following methods:

- Have a HTCP-certified PCC technician II develop new concrete mixes qualified based on the results of mix development tests performed by a department-qualified laboratory.

(2) The contractor need not provide separate laboratory mix designs for high early strength concrete nor provide routine 28-day compressive strength tests during placement for high early strength concrete.

(3) In addition to the mix information required under 710.4, at least 3 business days before producing concrete, submit the following to the engineer:

- Strength data from trial batching.

- Test dates of each trial batch.
- Name and location of laboratory that performed the trial batching.

(4) The engineer will review the submitted mix design within 3 business days of receiving the mix design submittal and complete Project Staff Review section of mix design certification within DT2220 or DT2221.

715.2.2 Class I Concrete Mixes

715.2.2.1 Pavements and Cast-in-Place Barrier

(1) Use at least 3 pairs of cylinders from 3 separate trial batches to demonstrate the compressive strength of a mix design.

(2) For concrete pavement, also demonstrate the flexural strength of the mix design using at least 3 pairs of beams from 3 separate trial batches.

(3) Demonstrate that the strength or the 28-day flexural strength of the proposed mix will equal or exceed the following:

- For pavement: the 85 percent within limits criterion specified in 715.5.2.
- For barrier: the 90 percent within limits criterion specified in 715.5.3.

(4) Use a SCM as a partial replacement for cement as specified in 501.3.2.2.2.

(5) Ensure that the target ratio of net water to cementitious material for the submitted mix design does not exceed 0.42 by weight. Include free water on the aggregate surface but do not include water absorbed within aggregate particles. Control the w/cm ratio throughout production by adjusting batch weights for changes in the aggregate moisture as required under 715.3.3.

(6) Do not use chloride-based accelerators in mixes for new construction.

715.2.2.2 Structures

(1) Qualify compressive strength according to ACI 301 - Specifications for Structural Concrete - subsections 4.2.3.1 through 4.2.3.4. Demonstrate that the 28-day compressive strength of the proposed mix will equal or exceed the 90 percent within limits criterion specified in 715.5.3.

(2) Provide grade A concrete with SCM as a partial replacement for cement as specified in 501.3.2.2.2.

(3) Ensure that the target ratio of net water to cementitious material (w/cm) for the submitted mix design does not exceed 0.45 by weight. Include free water on the aggregate surface but do not include water absorbed within aggregate particles. Control the w/cm ratio throughout production by adjusting batch weights for changes in the aggregate moisture as required under 715.3.3.

(4) Do not use mixes containing accelerators, except the contractor may use mixes containing non-chloride accelerators in substructure elements.

715.3 Testing and Acceptance

715.3.1 Class I Concrete Testing

715.3.1.1 General

(1) Test slump, air content, concrete temperature and concrete strength as specified in 710.5. Conduct a battery of QC tests for each specified property, using a single sample randomly located within each sublot. If a sublot random test location falls within a mainline pavement gap, relocate the test to a different location within the sublot. Cast three specimens for strength evaluation.

715.3.1.1.1 Flexural Strength

(1) For contracts with 50,000 square yards or more of concrete pavement, cast a set of 3 beams instead of cylinders for flexural strength acceptance testing at 28 days.

715.3.1.1.2 Surface Resistivity

(1) Cast a set of 3 additional 6"x12" cylinders and test the concrete surface resistivity according to WTM T358. Submit the resistivity to the nearest tenth into MRS for information only. Perform this testing at least once per lot if total contract quantities are greater than or equal to the following:

- 20,000 square yards for pavements.
- 5,000 linear feet for barriers.
- 500 cubic yards for structure concrete.

Resistivity testing is not required for the following:

- Lot with less than 3 sublots.
- Concrete items classified as ancillary.
- Concrete placed under the following bid items:

- Concrete Pavement Approach Slab
- Concrete Masonry Culverts
- Concrete Masonry Retaining Walls

715.3.1.2 Lot and Sublot Definition

715.3.1.2.1 General

(1) Designate the location and size of all lots before placing concrete. Ensure that no lot contains concrete of more than one mix design or placement method defined as follows:

Mix design change A modification to the mix requiring the engineer's approval under 710.4(4).

For paving and barrier mixes, a source change under item 1 of 710.4(4) for fly ash of the same class that does not require a modification under items 2 or 3 of 710.4(4) does not constitute a mix design change.

Placement method Either slip-formed, not slip-formed, or placed under water.

(2) Lots and sublots include ancillary concrete placed integrally with the class I concrete.

715.3.1.2.2 Lots by Lane-Feet

(1) The contractor may designate slip-formed pavement lots and sublots conforming to the following:

- Lots and sublots are one paving pass wide and may include one or more travel lanes, integrally placed shoulders, integrally placed ancillary concrete, and pavement gaps regardless of mix design and placement method used in the gaps.
- Sublots are 1000 feet long for single-lane and 500 feet long for two-lane paving. Adjust terminal sublot lengths to match the project length or, for staged construction, the stage length. The contractor may include sublots less than or equal to 25 percent of the standard length in the previous sublot. For partial sublots exceeding 25 percent of the standard length, notify the engineer who will direct additional testing to represent that partial sublot.
- Ensure that sublot limits match for adjacent paving passes. Pavement gaps do not affect the location of sublot limits.
- Create lots by grouping 5 adjacent sublots matching lots created for adjacent paving passes.

(2) If a sublot random test location falls in a pavement gap, test at a different random location within that sublot.

715.3.1.2.3 Lots by Cubic Yard

(1) Define standard lots and sublots conforming to the following:

TABLE 715-1 CLASS I - LOT AND SUBLOT SIZES

CONCRETE CLASSIFICATION	LOT SIZE	SUBLOT SIZE	NUMBER OF SUBLOTS PER LOT
Class I: Pavement	1250 cubic yards	250 cubic yards	5
Class I: Structures	250 cubic yards	50 cubic yards	5
Class I: Cast-in-Place Barrier	500 cubic yards	100 cubic yards	5

(2) The contractor may include sublots less than or equal to 25 percent of the standard volume in the previous sublot. For partial sublots exceeding 25 percent of the standard volume, notify the engineer who will direct additional testing to represent that partial sublot.

(3) An undersized lot is eligible for incentive payment under 715.5 if the lot has 3 or more sublots for that lot.

715.3.1.3 Department Verification Testing

(1) The department will perform verification testing once for each 5 contractor QC tests with additional testing as required to obtain at least 1 verification test per lot for air content, slump, temperature, and concrete strength.

(2) The department will report QV test results to the contractor within 2 business days after the department obtains the sample, or in the case of long-term testing, within 2 business days after conducting the test.

715.3.2 Strength Evaluation

715.3.2.1 General

(1) The department will make pay adjustments for strength on a lot-by-lot basis using the compressive strength of contractor QC cylinders or the flexural strength of contractor QC beams.

(2) Randomly select 2 QC specimens to test at 28 days for percent within limits (PWL). Compare the strengths of the 2 randomly selected QC specimens and determine the 28-day sublot average strength as follows:

- If the lower strength divided by the higher strength is 0.9 or more, average the 2 QC specimens.
- If the lower strength divided by the higher strength is less than 0.9, break one additional specimen and average the 2 higher strength specimens.

(3)The department will evaluate the sublot for possible removal and replacement if the 28-day sublot average strength is:

- Pavement (Compressive): < 2500 psi
- Pavement (Flexural): < 500 psi
- Structure: < f'c - 500 psi [1]
- Cast-in-Place Barrier: < f'c - 500 psi [1]

[1] f'c is design strength found in plans or specials.

715.3.2.2 Removal and Replacement

715.3.2.2.1 Pavement

(1) The department will direct the contractor to core the affected sub lot to determine structural adequacy. Timeframe of coring operations and locations will be agreed upon between department and contractor.

(2) Obtain three cores from the sublot in question. Perform coring according to WTM T24.

(3) Have an independent consultant test cores according to WTM T24.

(4) The department will assess concrete for removal and replacement based on a sublot-by-sublot analysis of core strength. Perform coring and testing, fill specimen voids with an engineer-approved non-shrink grout or concrete, and provide traffic control during operations.

(5) The pavement sublot will remain in place if the compressive strength of all cores from the sublot are 2500 psi or greater. The pavement 28-day QC average sublot strength will be included in the respective compressive or flexural strength PWL equation of 715.5.2 or 715.5.3.

(6) If the compressive strength of any core from the sublot is less than 2500 psi, the dearptment will direct the contractor to either:

1. Remove and replace unacceptable concrete pavement sublot ot the nearest joint with new concrete pavement of conforming strength. There is no incentive for replaced pavement, but the department will adjust pay for PWL values of < 85 according to 715.5.2 or 715.5.3. The department will pay once for the area at the full contract price.
2. Permit concrete pavement to remain in place. The original 28-day QC average sublot strength will be included in the relevant strength PWL equation of 715.5.2 or 715.5.3.

715.3.2.2.2 Structures and Cast-in-Place Barrier

(1) The department will direct the contractor to core the affected sublot to determine the structural adequacy. Timeframe of coring operations and locations will be agreed upon between department and contractor. Determine core locations that do not interfere with structural steel.

(2) Perform coring according to WTM T24.

(3) Have an independent consultant test cores according to WTM T24. The department will assess concrete for removal and replacement based on a sublot-by-sublot analysis of core strength. Perform coring and testing, fill voids with an engineer-approved non-shrink grout or concrete, and provide traffic control during operations.

(4) The sublot will remain in place if the 3-core average is greater than or equal to 85 percent of f'c, and no individual core is less than 75 percent of f'c. The 28-day QC average sublot strength will be included in the compressive strength PWL equation of 715.5.2.

(5) If the compressive strength of the 3-core average is less than 85 percent of f'c or an individual core is less than 75 percent f'c, the department will direct the contractor to either:

1. Remove and replace unacceptable structure or cast-in-place barrier sublot with new concrete of conforming strength. There is no incentive for replaced concrete, but the department will adjust

pay for PWL values < 85 according to 715.5.2. The department will pay once for the area at the full contract price.

2. Permit concrete to remain in place. The original 28-day QC average sublot strength will be included in the compressive strength PWL equation of 715.5.2.

715.3.3 Aggregate

715.3.3.1 General

(1) Except as allowed for small quantities in 710.2, test aggregate conforming to 710.5.6.

715.3.3.2 Structures

(1) In addition to the aggregate testing required under 710.5.6, determine the fine and coarse aggregate moisture content for each sample.

(2) Calculate target batch weights for each mix when production of that mix begins. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, adjust the batch weights to maintain the design w/cm ratio.

715.4 Measurement

(1) The department will measure the Incentive bid items under this section by the dollar, calculated as specified in 715.5.

715.5 Payment

715.5.1 General

(1) The department will pay incentive for concrete strength under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
715.0502	Incentive Strength Concrete Structures	DOL
715.0603	Incentive Strength Concrete Barrier	DOL
715.0715	Incentive Flexural Strength Concrete Pavement	DOL
715.0720	Incentive Compressive Strength Concrete Pavement	DOL

(2) Incentive payment may be more or less than the amount the schedule of items shows.

(3) The department will administer disincentives for strength under the Disincentive Strength Concrete Structures, Disincentive Strength Concrete Barrier, Disincentive Flexural Strength Concrete Pavement, and Disincentive Compressive Strength Concrete Pavement,administrative items.

(4) The department will adjust pay for each lot using PWL of the 28-day sublot average strengths for that lot. The department will measure PWL relative to strength lower specification limits as follows:

- Compressive strength of 3700 psi for pavements.
- Flexural strength of 650 psi for pavements.
- Compressive strength of 4000 psi for structures and barrier.

(5) The department will not pay a strength incentive for concrete that is nonconforming in another specified property, for ancillary concrete accepted based on tests of class I concrete, or for high early strength concrete unless placed in pavement gaps as allowed under 715.3.1.2.2.

(6) Submit test results to the department electronically using MRS software. The department will verify contractor data before determining pay adjustments.

(7) All coring and testing costs under 715.3.2.2 including filling core holes and providing traffic control during coring are incidental to the contract.

715.5.2 Pavements

715.5.2.1 Compressive

(1) The department will adjust pay for each lot using equation “QMP 3.01” as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per square yard)
>= 95 to 100	(0.1 x PWL) – 9.5
>= 85 to < 95	0
>= 30 to < 85	(1.5/55 x PWL) – 127.5/55
< 30	-1.50

(2) The department will not pay incentive if the lot standard deviation is greater than 400 psi compressive.

(3) For lots with a full battery of QC tests at less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average strength below 3700 psi by $1.50 per square yard.

(4) For integral shoulder pavement and pavement gaps accepted using test from the adjacent travel lane, the department will adjust pay using strength results of the travel lane for integrally placed concrete shoulders and pavement gaps regardless of mix design and placement method, included in lane-foot lot.

715.5.2.2 Flexural

(1) The department will adjust pay for each lot using equation "QMP 6.02" as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per square yard)
>= 95 to 100	(0.2 x PWL) - 19
>= 85 to < 95	0
>= 50 to < 85	(2.0/35 x PWL) - 170/35
< 50	-2.00

(2) The department will not pay incentive if the lot standard deviation is greater than 60 psi flexural.

(3) For lots with a full battery of QC tests at less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average flexural strength below 650 psi by $2.00 per square yard.

(4) For integral shoulder pavement and pavement gaps accepted using test from the adjacent travel lane, the department will adjust pay using strength results of the travel lane for integrally placed concrete shoulders and pavement gaps regardless of mix design and placement method, included in lane-foot lot.

715.5.3 Structures and Cast-in-Place Barrier

(1) The department will adjust pay for each lot using equation "QMP 2.01" as follows:

Percent within Limits (PWL)	Pay Adjustment (dollars per cubic yard)
>= 99 to 100	10
>= 90 to < 99	0
>= 50 to < 90	(7/8 x PWL) – 78.75
< 50	-35

(2) The department will not pay incentive if the lot standard deviation is greater than 350 psi compressive.

(3) For lots with less than 4 sublots, there is no incentive, but the department will assess a disincentive based on the individual sublot average strengths. The department will reduce pay for sublots with an average compressive strength below 4000 psi by $35 per cubic yard.

716 QMP Ancillary Concrete

716.1 Description

(1) This section describes contractor mix design and testing requirements for class II and class III concrete.

716.1.1 Quality Control Program

716.1.1.1 General

(1) Conform to general requirements under 701 and 710 as modified here in 716 for class II and class III concrete defined as follows:

- Class II: ancillary concrete the department accepts based on field testing during placement.
- Class III: ancillary concrete the department accepts by certification.

716.1.1.2 Quality Control Plan

(1) The contractor need only submit an abbreviated quality control plan as defined in 701.1.2.3; include the following:

1. Identify concrete items to be designed and accepted with optimized aggregate gradations, as allowed in 501.2.7.4.2.1.
2. Methods for monitoring and adjusting blended aggregate gradations, and methods for documenting corrective action.
3. Concrete mix design conforming to one of the following:
   - Mix design for only class II concrete conforming to 710.4. Trial batching is not required.
   - Mix design for class II concrete also being used for class I conforming to 710.4 and 715.2.

716.2 Materials

716.2.1 Class II Concrete

(1) Ancillary concrete placed integrally with mainline pavement is accepted using tests of class I concrete but not eligible for incentive payment under 715.5. Document the locations and quantities of integral concrete and identify the class I sublot tests used for acceptance.

(2) Perform random QC testing at the following frequencies:

1. Test air content, temperature, and slump a minimum of once per 100 cubic yards for each mix design and placement method.
2. Cast one set of 2 cylinders per 200 cubic yards for each mix design and placement method. Cast a minimum of one set of 2 cylinders per contract for each mix design and placement method. Random 28-day compressive strength cylinders are not required for HES or SHES concrete.
3. For deck overlays, perform tests and cast cylinders once per 50 cubic yards of grade E concrete placed.
4. For concrete base, one set of tests and one set of cylinders per 250 cubic yards.

The department will allow concrete startup test results for quantities under 50 cubic yards. Cast one set of 2 cylinders if using startup testing for acceptance.

(3) The contractor will report QC test results to the engineer on the day sampled, except for long-term testing, report on the day tested.

(4) The department will perform verification testing at the frequency specified in 701.3.3.2.

(5) The department will report QV test results to the contractor within 2 business days after the department obtains the sample, or in the case of long-term testing, within 2 business days after conducting the test.

(6) Conform to the initial curing requirements under 710.5.5 except the contractor may extend initial curing for 72 hours before transporting the cylinders to a department-qualified laboratory.

(7) Except as allowed for small quantities in 710.2, test aggregate conforming to 710.5.6.

(8) Provide concrete with a 28-day compressive strength that equals or exceeds the following:

- If the contract specifies f'c, then f'c.
- If the contract does not specify f'c, then 3000 psi.

716.2.2 Class III Concrete

(1) Acceptance of class III concrete is based on a certificate of compliance. Submit the certificate of compliance at least 3 business days before producing concrete along with the initial concrete mix documentation as required under 710.4(2).

(2) Contractor testing for the mix and mix aggregates is not required for the items contained within the certificate of compliance. Conform to 716.2.1 for items not contained within the certificate of compliance.

(3) Department verification testing is optional for class III concrete. Correct any deficiencies found during the QV testing.

716.3 (Vacant)

716.4 (Vacant)

716.5 (Vacant)

730 QMP Base Aggregate

730.1 Description

730.1.1 General

(1) This section describes contractor QC and department QV testing and documentation for base aggregates. Apply to Base Aggregate Open Graded bid items and to Base Aggregate Dense bid items except reclaimed asphaltic pavement placed under the Base Aggregate Dense bid items.

(2) Do not apply to Aggregate Detours, Breaker Run, Select Crushed, Pit Run, Subbase, or Riprap bid items.

(3) Conform to the general QMP requirements under 701, to the base aggregate requirements under 301, 305, and 310, and to the additional requirements specified here in 730.

730.1.2 Quality Control Program

730.1.2.1 Quality Control Plan

(1) Submit a plan conforming to 701.1.2.2 and include additional information as follows:

1. Section and quarter descriptions for all aggregates that require QC testing.
2. Description of stockpiling and hauling methods.

730.1.2.2 Small Quantities

(1) The department defines a small quantity of base aggregate as a contract quantity of 6000 tons or less placed under a single bid item.

(2) For small quantity contracts:

- An abbreviated quality control plan is allowed under 701.1.2.3.
- Contractor QC placement testing is modified as specified in 730.3.4.1.

730.1.2.3 Documentation

(1) Submit gradation, fracture, liquid limit, and plasticity test results to the engineer within 1 business day of obtaining the sample and submit data electronically using MRS as specified in 701.1.2.7.

(2) Maintain standardized control charts according to CMM 830.

(3) Maintain separate gradation control charts for each sieve size specified in 305 or 310 for each base aggregate size, source or classification, and type. Set the control limits and warning limits as follows:

1. The control limits are the upper and lower gradation specification limits.
2. Warning limits:
    - There are no upper warning limits for sieves requiring or allowing 100 percent passing.
    - There are no lower warning limits for sieves allowing 0 percent passing.
    - Dense-graded No. 200 sieve: warning limits are 0.5 percent within the upper and lower control limits.
    - Dense-graded for all other sieves: warning limits are 2 percent within the upper and lower control limits.
    - Open-graded 1-inch, 3/8-inch, and No. 4 sieves: warning limits are 2 percent within the upper and lower control limits.
    - Open-graded No. 10, No. 40, and No. 200 sieves: warning limits are 1 percent within the upper and lower control limits.

(4) Maintain a separate fracture control chart for each base aggregate size, source or classification, and type. Set the lower control limit to the value specified in table 301-2. Set the lower warning limit 2 percent above the lower control limit. There is no upper warning limit.

(5) Plot QC and QV test results and the 4-point running average on control charts. Include only QC placement tests in the running average unless a QV test result is out of spec, then include it as specified in 730.3.5(5). Document corrective action on control charts. Update control charts and submit copies to the engineer daily.

730.2 Materials

(1) Provide materials conforming to 301, 305, and 310.

(2) Use the definitions in 301.2.2 and the following:

Stockpile Sampling Coordinated QC or QV sample before beginning placement of aggregate materials.

Loadout Sampling Sample taken from the working face of a stockpile during placement of aggregate materials.

730.3 Testing

730.3.1 General

(1) Test gradation, fracture, liquid limit, and plasticity for each base aggregate size, source or classification, and type. Production tests only apply to small quantity projects under 730.3.4. Use the test methods specified in table 701-1 and conform to the following:

1. Gradation
   - Determine the complete gradation, including P200, using a washed analysis.
   - For 3-inch base, if three consecutive 4-point running averages for percent passing the No 200 sieve are 8.5 percent or less, the contractor may use an unwashed analysis for 9 out of 10 tests; one out of every 10 must be washed. If a single 4-point running average for percent passing the No. 200 sieve exceeds 8.5 percent, resume using a washed analysis until three consecutive running averages are 8.5 percent or less.
2. Fracture
   - Perform fracture testing on the individual component materials before blending.
   - Fracture testing is not required on material classified as quarried stone, reclaimed asphalt, reprocessed material, or recycled concrete.
3. Liquid limit and plasticity
   - Determine the liquid limit and plasticity index using material passing the No. 40 sieve of each individual component material and then on the blended material.
   - Perform plasticity checks, as specified under 730.3.2, by using the Hand Rolling Method detailed in section 5 of AASHTO T90.
   - Liquid limit and plasticity testing are not required on reclaimed asphalt or reprocessed material.

(2) Ensure that both QC and QV stockpile test results conform to the specifications before placing material. If either the QC or the QV test fails, both the QC and QV technicians will resample the stockpile side-by-side and rerun the tests. If either side-by-side test fails, submit a written description of corrective action taken. If the corrective action results in a passing process control test, the department will retest to confirm that the resulting material is conforming.

(3) Stockpile tests[1] can be used for multiple projects. If placement on a project does not begin within 120 calendar days after the date the stockpile sample was obtained, retest the stockpile before placement begins.

[1] Replace the stockpile test with an in-place production test for concrete pavement recycled and processed on-site; test on the first day of production.

(4) Obtain placement samples after the material is bladed, mixed, and shaped, but before watering and compacting, except as follows:

1. Sample 3-inch material and lift thicknesses of 3-inch or less from the stockpile at loadout.
2. Do not sample from material used to maintain local traffic or from other areas of temporary base that will not remain in place after the contract.
3. No placement testing is required on days when only temporary base material is placed. Acceptance of temporary base materials is based on visual inspection.

730.3.2 Contractor QC Testing

(1) Provide stockpile test results to the engineer before placing material.

(2) Split and label each QC sample. Retain the split for 10 calendar days in a dry, protected location. If requested for department comparison testing, deliver the split to the engineer within one business day.

(3) Perform QC gradation, fracture, liquid limit, and plasticity testing of each base aggregate size, source or classification, and type at the following frequencies:

- One stockpile test before placement including gradation, fracture, liquid limit, and plasticity.
- Conduct one gradation test per lot. One lot is defined as 3000 tons of material placed. The contractor may include partial quantities of less than or equal to 750 tons with the previous lot. For partial lots exceeding 750 tons, notify the engineer who will direct additional testing to represent that partial lot.
- One fracture test for each gradation test. When the fracture 4-point running average is above the lower warning limit, the testing frequency may be reduced to one fracture test per ten gradation tests or fraction thereof. The reduced test frequency applies only as long as the running average remains above the lower warning limit.
- One plasticity and liquid limit test for the first gradation test. Thereafter, perform one plasticity check, per ten gradation tests or fraction thereof. If the soil cannot be rolled into a 3 mm-diameter thread, then it is non-plastic (NP) and the complete test need not be performed; report the plasticity Index as NP. If the

material can be rolled into a thread, then perform both complete tests to determine the liquid limit and the plasticity index.

(4) Submit test results to the engineer within 1 business day of sampling, except an aggregate classification with recycled asphalt may be submitted within 3 business days of sampling.

730.3.3 Department QV Testing

(1) The department will notify the contractor's project materials coordinator before obtaining a sample.

(2) The department will split each sample, test half for QV, and retain the other half for 10 calendar days.

(3) The department will conduct QV testing for gradation, fracture, liquid limit, and plasticity of each base aggregate size, source or classification, and type as follows:

1. One stockpile QV test from each source before placement.
2. At least one QV test per 15,000 tons of material placed, or fraction thereof.

(4) The department will provide test results to the contractor within 2 business days of sampling, or for an aggregate classification with recycled asphalt, within 3 business days of sampling.

730.3.4 Small Quantity Testing

730.3.4.1 Contractor QC Testing

(1) For small quantity contracts with <= 750 tons, submit two (2) gradation, fracture, liquid limit, and plasticity production tests or conduct one (1) QC gradation, fracture, liquid limit, and plasticity stockpile test before placement. Production tests are valid for 3 years from the date the production sample was obtained. Begin placement within 3 years of the date sampled.

(2) For small quantity contracts with <= 6000 tons and >750 tons, do the following:

1. Conduct one (1) QC stockpile test before placement including gradation, fracture, liquid limit, and plasticity.
2. Submit two (2) gradation, fracture, liquid limit, and plasticity production tests or conduct one (1) QC gradation, fracture, liquid limit, and plasticity loadout test instead of placement tests. Production tests are valid for 3 years from the date the production sample was obtained; the first day of placement must be within 3 years of the date sampled.
3. If the actual quantity placed is more than 6000 tons, on the next day of placement perform one (1) additional random QC gradation, fracture, liquid limit, and plasticity test for each 3000 tons of overrun, or fraction thereof.

(3) Submit test results to the engineer within two (2) business days of sampling, except an aggregate classification with recycled asphalt may be submitted within 3 business days of sampling

730.3.4.2 Department QV Testing

(1) The department will conform to 730.3.3 but may waive QV testing for contract bid item quantities of 6000 tons or less.

730.3.5 Corrective Action

(1) Do not blend additional material on the roadbed to correct gradation problems.

(2) Consider corrective action when a running average trends toward a warning limit.

(3) Notify the engineer when a running average exceeds a warning limit. When two consecutive running averages exceed a warning limit, the engineer and contractor will discuss appropriate corrective action. Perform the engineer's recommended corrective action and increase the testing frequency as follows:

1. Increase gradation testing to at least one test per 1000 tons placed.
2. Increase fracture testing to at least one fracture test for each gradation test.

(4) If corrective action improves the property in question such that the running average is within the warning limits, the contractor may return to the testing frequency specified in 730.3.2. If corrective action does not improve the property in question, and the running average is still in the warning band, then repeat the steps outlined above starting with engineer notification.

(5) If a QV test result does not conform to the specifications, the engineer will inform the contractor and the QV test will be added to the QC data and included in the running average, as if it were an additional QC test.

(6) If a running average is never established, individual placement tests are used for acceptance.

(7) If an individual QC or QV test result is significantly out of specification limits, notify the other party, stop placing base, suspend other activities that may affect the area in question, and jointly investigate to determine the extent of nonconforming material. Both parties must document the investigative work.

(8) Test results are considered significantly out of spec limits if meeting one or more of the following:

1. A gradation spec limit for the No. 200 sieve is exceeded by more than 3.0 percent.
2. A gradation spec limit for any sieve, other than the No. 200, is exceeded by more than 5 percent.
3. The fracture spec limit is exceeded by more than 10 percent.

(9) The engineer may direct the contractor to remove and replace any nonconforming material. If the engineer allows the nonconforming material to remain in place, it is subject to a pay reduction.

730.3.6 Nonconforming Material

(1) The department will determine the extent of nonconforming material as follows:

1. If an individual QC or QV gradation or fracture test is out of spec and a 4-point running average is never established, the material starting from the first out-of-spec QC or QV test and ending at the first subsequent QC or QV test that is within spec limits is nonconforming.
2. If a gradation or fracture 4-point running average exceeds a control limit, the material starting from the first running average outside of the control limit and ending at the first subsequent running average that is within the control limit is nonconforming.
3. If any individual QC or QV plasticity test is out of spec, the material starting from the first out-of-spec QC or QV test and ending at the first subsequent QC or QV test that is within spec limits is nonconforming.
4. If an individual QC or QV gradation or fracture test is significantly out of spec, the material starting from the first significantly out-of-spec QC or QV test and ending at the first subsequent QC or QV test that is within spec limits is nonconforming, even if the 4-point running average, that includes the significantly out-of-spec test, is within spec limits.

730.4 (Vacant)

730.5 Payment

(1) The department will administer pay reductions for nonconforming material under the Nonconforming QMP Base Aggregate Gradation, Nonconforming QMP Base Aggregate Fracture, and Nonconforming QMP Base Aggregate Plasticity administrative items.

(2) The department will calculate pay reductions for base aggregate with nonconforming gradation and fracture using the nonconforming quantity that remains in place, the bid item contract unit price, and a pay reduction percentage from table 730-1. The department will administer a 50 percent pay reduction for base aggregate with nonconforming plasticity or liquid limit that remains in place.

TABLE 730-1 Pay Reductions for Nonconforming Base Aggregate

% PAY REDUCTION	NONCONFORMING GRADATION		NONCONFORMING FRACTURE
	NO 200 SIEVE	SIEVES OTHER THAN NO 200	
5% to 10%	<= 1.5%	<= 3%	<= 5%
10% to 20%	> 1.5% to <= 3%	> 3% to <= 5%	> 5% to <= 10%
SIGNIFICANTLY OUT OF SPEC[1]			
20% to 40%	> 3%	> 5%	> 10%

[1] The engineer may assess pay reductions for individual QC or QV test results that are significantly out of spec even if the running average is within spec limits.

(3) The department will not apply more than one pay adjustment to a given quantity of material. If a quantity of material is nonconforming in more than one property, the department will apply the greater pay reduction.

740 QMP Ride

740.1 Description

740.1.1 General

(1) This section describes profiling with a non-contact profiler, locating areas of localized roughness, and determining the International Roughness Index (IRI) for each wheel path.

(2) Profile final riding surfaces greater than 1500 feet in continuous length, that are full width, and typically carry moving vehicles. Include the following when they meet the criteria:

- Auxiliary lanes.
- System interchanges that carry traffic from one freeway to another via ramps or connectors.
- Entance ramps, exit ramps, and turn lanes.
- Mainline pavement on county, state, or U.S. highway crossroads reconstructed under the contract.

(3) Include bridges and bridge approaches in profile runs but exclude them from segment IRI calculations. Also exclude the following from segment IRI calculations:

- Roundabouts and pavements within 150 feet of the points of curvature of roundabout intersections.
- Pavements within 25 feet of railroad crossings.
- Pavements within 25 feet of bridges or bridge approaches not constructed under the contract.

(4) The engineer may direct straightedging under 415.3.10 or 450.3.2.9 for pavement excluded from localized roughness under 740.3.4.2(1), for bridges, for roundabouts, and for pavements within 150 feet of the points of curvature of roundabout intersections.

740.1.2 Quality Control Program

740.1.2.1 Quality Control Plan

(1) Conform to 701.1.2.2, except omit items 3, 4, 5, and 9; and include the following:

1. The methods and timing used for monitoring and testing ride quality throughout the placement process/work. Also indicate the approximate timing of acceptance testing in relation to the work.
2. The segment locations of each profile run used for acceptance testing.
3. A traffic control plan.

740.1.2.2 Personnel

(1) Have an HTCP-certified profiler operate the equipment, collect the required data, and analyze the results using the methods taught in the HTCP profiling course. Ensure that an HTCP-certified profiler supervises data entry into MRS software.

740.1.2.3 Equipment

(1) Furnish a profile-measuring device capable of measuring IRI from the list of department-approved profilers on the APL.

(2) Unless the engineer and contractor mutually agree otherwise, arrange to have a calibrated profiler available when paving the final riding surface.

(3) Verify profiler equipment calibration daily using test methods the profiler manufacturer recommends. Notify the engineer before verifying the calibration. If the engineer requests, arrange to have the engineer observe the calibration verification and profiler operation. Maintain records of calibration verification activities; provide those records to the engineer upon request.

740.1.2.4 Documentation

(1) After profiling, compute the segment IRI for each segment and analyze areas of localized roughness using the ProVAL software available for download at:

http://www.atwoodsystems.com/

(2) Prepare the ProVAL ride quality module reports showing the segment IRI for each segment and areas of localized roughness exceeding 200 in/mile on pavements that are not continuously diamond-ground or designated for continuous diamond grinding. Generate the ride quality module reports in ProVAL using the following parameters:

	FIXED INTERVAL (segment IRI)	CONTINUOUS (localized roughness)
BASE-LENGTH	500 feet	25 feet
THRESHOLD	140 in/mile	200 in/mile

(3) Field-locate the areas of localized roughness before the engineer's assessment for corrective action. Document the reasons for areas excluded.

(4) Within five business days after completing profile acceptance runs, unless the engineer and contractor mutually agree to a different timeline, upload the electronic ProVAL project file containing the .ppf files for each profiler acceptance run and ride quality module reports, as PDF files, using MRS software available at:

http://www.atwoodsystems.com/

(5) Notify the engineer when MRS submittal is complete and profiler acceptance run data and ride quality module reports are uploaded into MRS.

740.2 (Vacant)

740.3 Testing

740.3.1 General

(1) Enter the equipment-specific department-approved filter settings and parameters given in the approved profilers list at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/profilers.pdf

740.3.2 Contractor QC Testing

(1) Operate profilers within the manufacturer's recommended speed tolerances. Perform profile runs in the direction of travel. Measure the longitudinal profile of each wheel track of each lane. The wheel tracks are 6.0 feet apart and centered in the travel lane.

(2) Coordinate with the engineer at least 24 hours before making profile runs for acceptance, unless the engineer approves otherwise. The department may require profiling to accommodate staged construction or if corrective action is required.

(3) Mark the beginning and ending points for each profile run on the pavement; ensure markings remain for a minimum of 10 business days after reporting profile data. Measure the profiles of each standard and partial segment. Define primary segments starting at a project terminus and running contiguously along the mainline to the other project terminus. Define segments one wheel path wide and distinguished by length as follows:

1. Standard segments are 500 feet long.
2. Partial segments are less than 500 feet long.

(4) Treat partial segments as independent segments. Document profile runs conforming to 740.1.2.4; categorize segments as follows:

Segments with a posted speed limit of 55 mph or greater:

HMA I	Asphalt pavement with multiple opportunities to achieve a smooth ride. The following operations if performed under the contract are considered as opportunities: - A layer of HMA - A leveling or wedging layer of HMA - Diamond grinding or partial depth milling of the underlying pavement surface.
HMA II	Asphalt pavement with a single opportunity to achieve a smooth ride.
HMA III	Asphalt pavement segments containing any portion of a bridge, bridge approach, railroad crossing, or intersection. An intersection is the area within the points of curvature of the intersection radii.
PCC II	Concrete pavement.
PCC III	Concrete pavement segments containing any portion of a bridge, bridge approach, railroad crossing, intersection, or gap. An intersection is the area within the points of curvature of the intersection radii.
RCDG V	Rural concrete pavement surfaces the contract designates for continuous diamond grinding.

Segments with any portion having a posted speed limit less than 55 mph:

HMA IV	Asphalt pavement including intersections, bridges, approaches, and railroad crossings, entrance ramps, exit ramps, and turn lanes.
PCC IV	Concrete pavement including gaps, intersections, bridges, approaches, and railroad crossings, entrance ramps, exit ramps, and turn lanes.
UCDG V	Urban concrete pavement surfaces the contract designates for continuous diamond grinding.

(5) Notify the engineer when the profiling data has been submitted.

740.3.3 Department QV Testing

(1) The department reserves the right to conduct QV testing to validate the quality of the product on any segment at any time. The department will notify the contractor before testing so the contractor can observe the QV testing.

(2) After completing QV profile runs, the department will review the profiling data with the contractor directly on-site and will identify any areas of immediate concern. The department will analyze the data and provide the test results to the contractor within 10 business days of testing, unless the contractor and engineer mutually agree otherwise.

(3) The engineer and contractor will jointly investigate any testing discrepancies. If the contractor does not respond to an engineer request to resolve a testing discrepancy, the engineer may suspend production until action is taken.

740.3.4 Corrective Action

740.3.4.1 General

(1) Recommend corrective action to the engineer.

(2) Before directing corrective action, the engineer will assess whether a repair will help or hurt the long-term performance. Correct the ride as the engineer directs in writing.

740.3.4.2 Corrective Action for Localized Roughness

(1) The engineer will assess each wheel path for areas of localized roughness within 5 business days of being notified that ProVAL reports are uploaded. For each area that exceeds 200 in/mile, the engineer will do one of the following:

1. Direct the contractor to correct the area to minimize the effect on the ride.
2. Leave the area of localized roughness in place with no pay reduction.
3. Assess a pay reduction for each area in each wheel path as follows:

Length <=25 feet: (localized roughness in/mile - 200) dollars/foot or $250 whichever is least

Length >25 feet: (localized roughness in/mile - 200) dollars/foot or 10 dollars/foot whichever is least

The department will not reduce pay for localized roughness within HMA IV and PCC IV segments.

(2) Re-profile corrected areas to verify that the localized roughness is less than 140 in/mile. Upload a revised ProVAL ride quality module report for corrected areas into MRS software.

740.3.4.3 Corrective Action for Excessive Segment IRI

(1) If an individual segment IRI exceeds 140 in/mile for HMA I, HMA II, and PCC II pavements after correction for localized roughness, the engineer may require the contractor to correct that segment's final surface as follows:

HMA I: Correct to an IRI of 60 in/mile using whichever of the following methods the engineer approves:

- Mill and replace the full lane width of the riding surface excluding the paved shoulder.
- Diamond grinding, conforming to 420.3.2 through 420.3.4 except space grooves 0.06 - 0.09 inches apart, or fine-tooth milling the full lane width of the riding surface including adjustment of the paved shoulders.

HMA II: Correct to an IRI of 85 in/mile using whichever of the following methods the engineer approves:

- Mill and replace the full lane width of the riding surface excluding the paved shoulder.
- Diamond grinding, conforming to 420.3.2 through 420.3.4 except space grooves 0.06 - 0.09 inches apart, or fine-tooth milling of the full lane width of the riding surface including adjustment of the paved shoulders.

PCC II: Correct to an IRI of 85 in/mile using whichever of the following methods the engineer approves:

- Diamond grinding, conforming to 420.3.1 through 420.3.4, of the full lane width of the riding surface including adjustment of the paved shoulders.
- Remove and replace the full lane width of the riding surface.

(2) Re-profile corrected segments to verify that the final segment IRI meets the above correction limits and there are no areas of localized roughness. Upload a revised ProVAL ride quality module report for the corrected areas into MRS software. Segments failing these criteria after correction are nonconforming work under 105.3.

740.3.4.4 Corrective Grinding for Continuous Diamond Ground Work

(1) Do not apply localized roughness criteria to surfaces designated for continuous diamond grinding under 420 or the transitions to existing work not ground under the contract. Instead ensure that the finished ground surface does not include longitudinal surface deviations exceeding 0.3-inch in 25 feet as determined using ProVal's straightedge simulation analysis.

(2) Exclude low areas due to subsidence or other localized causes from the requirements of 740.3.4.4(3). The engineer will review each low area and may direct the contractor to perform corrective grinding to reduce the final segment IRI for that segment.

(3) If an individual segment IRI exceeds 65 in/mile for RCDG V or 115 in/mile for UCDG V, perform corrective grinding on that segment. Re-profile corrected segments to verify the final segment IRI. Ensure that each segment has a segment IRI after corrective grinding as follows:

- Segments with a before-grinding IRI less than or equal to 200 in/mile, provide a final segment IRI that does not exceed 65 in/mile for RCDG V or 115 in/mile for UCDG V.
- Segments with a before-grinding IRI greater than 200 in/mile, provide a final segment IRI as follows:
  - Do not exceed 35 percent of the before-grinding IRI for RCDG V.
  - Do not exceed 115 in/mile or 35 percent of the before-grinding IRI, whichever is greater, for UCDG V.

(4) Submit a revised ProVAL smoothness assurance report after corrective grinding for corrected segments to validate the final segment IRI.

(5) If after performing corrective grinding, a segment contains a bump exceeding 0.3 inch in 25 feet or has a final segment IRI greater than specified, that segment is nonconforming work under 105.3.

740.4 Measurement

(1) The department will measure Incentive IRI Ride by the dollar, calculated as specified in 740.5.2.

740.5 Payment

740.5.1 General

(1) Costs for furnishing and operating the profiler, documenting profile results, and correcting the final surface are incidental to the contract. The department will pay separately for engineer-directed corrective action performed within areas excluded under item 3 of 740.3.4.2(1) as extra work.

740.5.2 Pay Adjustment

(1) The department will pay incentive for ride as follows:

ITEM NUMBER	DESCRIPTION	UNIT
740.0440	Incentive IRI Ride	DOL

(2) Incentive payment may be more or less than the amount the schedule of items shows.

(3) The department will administer disincentives for ride under the Disincentive IRI Ride administrative item.

(4) The department will not assess disincentives on HMA III or PCC III segments. Incentive pay for HMA III and PCC III segments will be based on the category of the adjoining segments.

(5) The department will adjust pay as follows:

- For work placed under the contract: Based on the initial segment IRI for that segment. If corrective action for excessive segment IRI is required, the department will base disincentives on the segment IRI after correction is performed according to 740.3.4.3.
- For continuous diamond grinding of existing concrete: Based on the final segment IRI as specified in 420.3.5.

(6) The department will adjust pay for 500-foot long standard segments nominally one wheel path wide using equation "ride 2.01" as follows:

For HMA I Pavement:	Initial IRI (in/mile)	Pay Adjustment (dollars/500 feet)
	< 30	250
	>= 30 to <35	1750 - (50 x IRI)
	>= 35 to < 60	0
	>= 60 to < 75	1000 - (50/3 x IRI)[1]
	>= 75	-250[1]

For HMA II and PCC II Pavement:	Initial IRI (in/mile)	Pay Adjustment (dollars/500 feet)
	< 50	250
	>= 50 to < 55	2750 - (50 x IRI)
	>= 55 to < 85	0
	>= 85 to < 100	(4250/3) - (50/3 x IRI)[1]
	>= 100	-250[1]

[1] The department will not assess a ride disincentive for HMA pavement placed in cold weather because of a department-caused delay as specified in 450.5.2(3).

For HMA IV and PCC IV Pavement:	Initial IRI (in/mile)	Pay Adjustment (dollars/500 feet)
	< 35	250
	>= 35 to < 45	1125 - (25xIRI)

	>= 45	0
For RCDG V Pavement:	Final IRI (in/mile)	Pay Adjustment (dollars/500 feet)
	< 45	125
	>= 45 to < 55	687.5 - (12.5 x IRI)
	>= 55	0
For UCDG V Pavement:	Final IRI (in/mile)	Pay Adjustment (dollars/500 feet)
	< 50	125
	>= 50 to < 75	375 - (5 x IRI)
	>= 75	0

(7) The department will prorate the pay adjustment for non-standard segments based on their length.