



Request for Bid (RFB)
for
Ready Mix Concrete
Bid #2024-12PC

Issued by:

Portage County
Purchasing Department

**All required bid documents/copies must be submitted
No later than 2:00 PM on 3/26/2024 to:**

**Portage County Purchasing
1462 Strongs Ave
Stevens Point WI 54481**

LATE BIDS WILL BE REJECTED
There will be a public opening for this Bid
1462 Strongs Ave
Stevens Point WI 54481

For further information regarding this
RFB contact Chris Schultz
At (715) 346-1393
Email: schultzc@co.portage.wi.gov

Issued: 3/05/2024

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1. General Information and Scope

The County of Portage Wisconsin (County), through its Purchasing Department (Purchasing), requests bids to establish a contract for the purchase of ready mix concrete delivered to various Highway Department projects and job sites as needed for concrete pavement, concrete pavement repairs/replacements, concrete curb & gutter, concrete sidewalk and other appurtenant concrete construction.

The attached Standard Terms and Conditions shall govern this bid unless specifically modified in these bid documents. Conditions of bid that include the word "must" or "shall," describe a mandatory requirement. All specifications are defined as mandatory minimum requirements unless otherwise stated. If no bidder is able to comply with a given specification or condition of bid, Purchasing reserves the right to delete that specification or condition of bid. Failure to meet specification requirements shall disqualify your bid. Vendors may not submit their own contract document as a substitute for these terms and conditions.

Retain a copy of these Bid documents for your files. Should you receive an award, these Bid documents become your contract terms and conditions.

Contract Execution: Portage County utilizes a web based electronic signature program (DocuSign) for the execution of contracts that do not require notarization. By submitting your bid you are agreeing to the use of this program to sign documents should you receive an award. There is no cost to the bidder associated with this process.

Definitions: The following definitions are used throughout the RFB documents:

Bidder/Vendor means a company or individual submitting a bid response to this RFB

Contractor means bidder awarded the contract

County means the County of Portage Wisconsin

Purchasing means the County of Portage Purchasing Department

RFB means Request for Bid

State means the State of Wisconsin

VendorNet means the State of Wisconsin's electronic purchasing information system

2. Contract term

Date of award, through **12/31/2024**, with three (3) one-year renewal options. Any extension must be authorized by mutual agreement of the vendor and the County.

3. Questions

If a vendor discovers any significant ambiguity, error, conflict, discrepancy, omission, or other deficiency in this RFB they shall notify the Procurement Director named below of such error and request a modification or clarification.

Any communications or questions regarding the specifications, or special conditions of bid should be written and submitted to Purchasing as soon as possible, but no later than 2PM on **03/14/2024**. Purchasing will respond to questions, if necessary, by issuing an official addendum, posted on VendorNet and on the Portage County Website. Bidders are responsible for checking these websites for any addenda before submitting a bid. Failure to acknowledge addenda may disqualify your bid.

<https://vendornet.wi.gov/>

<https://www.co.portage.wi.gov>

Any correspondence or questions submitted must include the bid number

Submit questions in writing via email to:

Chris Schultz, Procurement Specialist, e-mail: schultzc@co.portage.wi.gov

Phone: 715-346-1393

4. Method of Bid

Bidder must submit a unit price for each item. All prices must be quoted in U.S. Dollars.

Bids requiring an order minimum shall be disqualified.

Bidder must bid on the enclosed Bid Offer Form.

5. Bid Submission

Bidders must submit **an original and one copy** including all required materials for acceptance of their bid by the date and time listed on the Bid Cover Sheet. Any bids received after that time and date will be rejected. Receipt of a bid by the US mail system does not constitute receipt of a bid by Purchasing, for purposes of this RFB. Also refer to the Bid Response Requirements.

Faxed and e-mailed bids are not accepted. Bids must be mailed or delivered to:

Portage County Purchasing Department

1462 Strongs Ave

Stevens Point WI 54481

All bids are to be packaged, sealed, and show the following information on the **outside of the package**:

-Vendor's Name and Address

-Request for Bid Title

-Request for Bid Number

-Bid Due Date

6. Bid Response Requirements

In order for your bid to be considered, the following information must be provided by the due date and time listed on the bid cover page. Failure to include any required documents will disqualify your bid.

Include an original and a copy:

6.1 Signature and Authority Affidavit Form, Attachment A (Acknowledge addendum(s) if any.)

6.2 References Sheet, Attachment B

6.3 Bid Offer Form, Attachment C

6.4 Manufacturer's/Bidder's warranty statement

The Signature and Authority Affidavit submitted in response to this RFB must be signed by the person in the Contractor's organization who is responsible for the decision as to the prices being offered in the Bid or by a person who has been authorized in writing to act as agent for the person responsible for the decision on prices and services. Failure to provide these forms/information with your bid submittal may disqualify your bid. The County encourages all bidders to print their submission double-sided to save paper

7. Method of Award

Award(s) shall be made on the basis of the lowest **net unit price per item** from a responsive, responsible bidder who meets specifications. Timeliness of delivery may be considered when making this award.

Volume discounts shall not be considered when determining award. However, they shall apply to orders issued on this contract.

8. Bidder/Contractor Qualifications

To be eligible for a contract award, you must be qualified and able to provide the following:

- 8.1 Bidder must be an original manufacturer, or distributor and/or dealer/company authorized by manufacturer to sell their products.
- 8.2 Bidder must supply references of three firms to which similar products/service have been provided during the past three years to a comparable-sized institution or company. If contacted, all of those references must verify that a high level of satisfaction was provided. Use Attachment B to list references.
- 8.3 Bidder must be in the business of ready mix concrete for the past three years.
- 8.4 Contractor should be able to report on a semi-annual basis all products purchased against this contract.
- 8.5 Awarded contractor must provide Purchasing a Certificate of Insurance and maintain the minimum limits specified for the term of the contract. All policies must be issued with a 30-day cancellation notice, by an insurance company licensed to do business in the State of Wisconsin, with a minimum AM Best rating of A+, and signed by an authorized agent.

Maintain worker's compensation insurance as required by Wisconsin Statutes, for all employees engaged in the work.

Maintain commercial liability, bodily injury and property damage insurance against any claim(s) which might occur in carrying out this agreement/contract. Minimum coverage shall be one million dollars (\$1,000,000) liability for bodily injury and property damage including products liability and completed operations. Provide motor vehicle insurance for all owned, non-owned and hired vehicles that are used in carrying out this contract. Minimum coverage shall be one million dollars (\$1,000,000) per occurrence combined single limit for automobile liability and property damage.

9. Specifications

The following specifications are minimum acceptable requirements. Any specific reference to manufacturer(s) and/or catalog/model/stock numbers provided is to establish the design, type of construction, quality, functional capability and performance level desired. The bidder may offer an alternate product believed to be an equal. Any alternate product(s) bid must be clearly identified by manufacturer and catalog, model or stock number. Adequate detailed specifications of the product offered must be included with your bid to establish equivalency and to ensure that the product being bid meets all specifications. Failure to provide product specifications and information may disqualify your bid. The County of Portage shall be the sole judge of equivalency and acceptability. Any attachments, documents, price lists, etc. to support your bid, must include the bid number

Bid specifications may not be revised without an official written addendum issued by Purchasing.

- 9.1 Concrete shall meet State of Wisconsin Department of Transportation (WisDOT) current Section 415, 416 & 501 Standard Specifications (See attachment E) along with all other related current WisDOT standard specifications.
- 9.2 All materials in concrete ready mix shall be approved by the State of Wisconsin Department of Transportation (WisDOT).
- 9.3 Concrete batch plant supplying the concrete ready mix material for this bid shall be approved by the State of Wisconsin Department of Transportation (WisDOT).
- 9.4 All prices shall include transportation, delivery, and any other fees associated.
- 9.5 Delivery shall be same day as call for product.

10. Firm prices

The awarded contractor must hold the accepted costs for the entire contract period. The County will review any adjustment of costs before the beginning of a contract renewal period. Price increase requests must be justified with supporting documentation of industry-wide increases.

11. Orders

The County may use the following methods to purchase from this contract:

- Specific (Purchase) orders may be placed for one-time shipments.
- Purchase Orders, blanket-type, may be issued by Purchasing to allow departmental personnel to call or fax for product or service against the order as needed.
- Purchasing card releases: placed by department personnel using their County purchasing card.

12. Invoicing Requirements

The County's terms are to pay or reject invoices within 30 days of receipt. Before payment is made, it also must verify that all invoiced charges are correct as per this contract. Only properly submitted invoices shall be officially received for payment. Thus, your prompt payment requires that your invoices be clear and complete in conformity with the instructions below.

All invoices must be itemized showing:

- | | |
|--------------------------|--------------------------------------------------------|
| a. purchase order number | d. complete product description as stated on your bid. |
| b. vendor name | e. prices per the contract |
| c. remit to address | |

The original invoice must be sent to the bill-to address shown on the Purchase Order.

Invoices/Purchasing card

Orders placed by the County using a purchasing card must reflect current contract pricing.

13. Contract Cancellation

This Contract may be terminated by either party under the following conditions:

- 13.1 The County may terminate the contract at any time at its sole discretion by delivering 30 days written notice to the Contractor.

If the problem is service performance, Contractor will be warned either verbally or in writing of unsatisfactory performance and intent to cancel this contract. Contractor will be given a period of time to 'cure' the performance. If the performance does not improve, Contractor will be given 5 days written notice that the contract will be cancelled.

Upon termination, the County's liability will be limited to the pro rata cost of the services performed as of the date of termination.

- 13.2 In the event the Contractor terminates the contract, for any reason whatsoever, it will require written certified letter notification delivered to the Purchasing Department not less than 60 days prior to said termination. The Contractor will, in turn, refund the County, within 30 days of said termination, all payments made hereunder by the County to the Contractor for work not completed.
- 13.3 If at any time the Contractor's performance threatens the health and/or safety of the County or the public, the County has the right to cancel and terminate the contract without notice.
- 13.4 If the Contractor fails to maintain and keep in force the insurance as required, the County has the right to cancel and terminate the contract without notice.

14. Appeals Process

Notices of intent to protest and protests must be made in writing. Protestors should make their protests as specific as possible and should identify Wisconsin Statutes or Portage County Ordinance provisions that are alleged to have been violated.

The written notice of intent to protest the intent to award a contract must be filed with Chris Schultz, Procurement Director, Portage County Wisconsin, 1462 Strongs Ave, Stevens Point, WI 54481, and received in his office no later than five (5) working days after the notice of intent to award is issued.

The written protest must be received in his office no later than ten (10) working days after the notice of intent to award is issued.

The decision of the Procurement Director may be appealed to the Corporation Counsel Office within (5) working days of issuance. The appeal must allege a violation of a Wisconsin Statute or a Portage County Ordinance provision.

Attachment A

Signature and Authority Affidavit Form

BIDDING COMPANY NAME: _____

FEIN (Federal Employer ID Number) _____ OR Social Security # (if Sole Proprietorship) _____

Address: _____

City _____ State _____ Zip + 4 _____

Number of years in Business _____

Name the person to contact for questions concerning this bid.

Name _____ Title _____

Phone (____) _____ Toll Free Phone (____) _____

Fax (____) _____ Email Address _____

In signing this bid, we also certify that we have not, either directly or indirectly, entered into any agreement or participated in any collusion or otherwise taken any action in restraint of free competition; that no attempt has been made to induce any other person or firm to submit or not to submit a bid; that this bid has been independently arrived at without collusion with any other bidder, competitor or potential competitor; that this bid has not been knowingly disclosed prior to the opening of bids to any other bidder or competitor; that the above statement is accurate under penalty of perjury.

The undersigned, having familiarized themselves with the conditions affecting the cost of the work, having read completely the specifications, hereby proposes to perform everything required and to provide and furnish labor, materials, equipment, tools and all other services and supplies necessary to produce in a complete and workmanlike manner all of the materials or products described in the specifications relating to this Bid.

I further certify that I have carefully examined the bid documents and all terms herein, and site where the work is to be done and have no agreements to prevent the completion of said work.

Signature

Title

Name (type or print)

Date

This firm hereby acknowledges receipt / review of the following addendum(s) (If any)

Addendum # _____ Addendum # _____ Addendum # _____ Addendum # _____

Attachment B

References

Vendor: _____

Provide company name, address, contact person, telephone number, and appropriate information on the product(s) and/or service(s) provided to customers similar to those requested in this solicitation document. Potential subcontractors cannot be references. Any subcontractor arrangement for the completion of this work shall be listed on a separate page.

Company Name: _____

Address (include Zip + 4) _____

Contact Person: _____ Phone No. _____

E-Mail Address: _____

Product(s) Used and/or Service(s) Provided: _____

Company Name: _____

Address (include Zip + 4) _____

Contact Person: _____ Phone No. _____

E-Mail Address: _____

Product(s) Used and/or Service(s) Provided: _____

Company Name: _____

Address (include Zip + 4) _____

Contact Person: _____ Phone No. _____

E-Mail Address: _____

Product(s) Used and/or Service(s) Provided: _____

Company Name: _____

Address (include Zip + 4) _____

Contact Person: _____ Phone No. _____

E-Mail Address: _____

Product(s) Used and/or Service(s) Provided: _____

Attachment C

Bid Offer Form

Vendor: _____

Please indicate cost per cubic yard (CY) for each grade/type of concrete ready mix below as available by your company

Concrete grade/type	Cost per CY for each grade/type	Additional cost per CY for fiber reinforced concrete for each grade/type	High Early Strength (HES) cost per CY for each grade/type
Grade A			
Grade A2			
Grade A3			
Grade C			
SHES*			XXXXXXXXXXXXXXXXXXXXXXXXXX

*SHES = Special High Early Strength Concrete Pavement and Repair mix per WisDOT specifications

Can you provide same day delivery to job sites? Yes _____ No _____

Is there an additional charge for cold weather concrete? Yes _____ No _____ If yes, list additional cost per CY for all above mixes: _____ If yes, when is cold weather concrete in effect?

Is there an additional charge for a small load? Yes _____ No _____ If yes, list additional cost per CY for all above mixes: _____ If yes, when is the small load charges in effect? _____

Are you able to provide concrete mix designs for all of the above bid concrete mixes if required? Yes _____ No _____

An original and one copy of all required forms are included in the submittal? Yes _____ No _____

Portage County is exempt from Federal Excise and Wisconsin Sales Taxes, 77.54(9a). WI Stats. Portage County's CES number is 008-0000250266-06.

Attachment D

STANDARD TERMS AND CONDITIONS

- 1.0 SPECIFICATIONS:** The specifications in this request are the minimum acceptable. When specific manufacturer and model numbers are used, they are to establish a design, type of construction, quality, functional capability and/or performance level desired, unless otherwise specified. When alternates are bid/proposed, they must be identified by manufacturer, stock number, and such other information necessary to establish an acceptable equivalency. The County shall be the sole and final judge of equivalency.
- 2.0 HOW TO AMEND A REQUEST FOR BID, PROPOSAL OR QUOTE:**
- 2.1** Public Works Projects are subject to Wis Stats 66.0901(5): If a person submits a bid or proposal for the performance of public work under any public contract to be let by a municipality and the bidder claims that a mistake, omission or error has been made in preparing the bid, the bidder shall, before the bids are opened, make known the fact that an error, omission or mistake has been made. If the bidder makes this fact known, the bid shall be returned to the bidder unopened and the bidder may not bid upon the public contract unless it is re-advertised and relet upon the re-advertisement. If a bidder makes an error, omission or mistake and discovers it after the bids are opened, the bidder shall immediately and without delay give written notice and make known the fact of the mistake, omission or error which has been committed and submit to the municipality clear and satisfactory evidence of the mistake, omission or error and that it was not caused by any careless act or omission on the bidder's part in the exercise of ordinary care in examining the plans or specifications and in conforming with the provisions of this section. If the discovery and notice of a mistake, omission or error causes a forfeiture, the bidder may not recover the moneys or certified check forfeited as liquidated damages unless it is proven before a court of competent jurisdiction in an action brought for the recovery of the amount forfeited, that in making the mistake, error or omission the bidder was free from carelessness, negligence or inexcusable neglect.
- 2.2** Non-Public Work Projects: After a Request for Bid/Proposal/Quote has been filed with the Portage County Purchasing Department, the responder may submit an amended response BEFORE THE DUE DATE AND TIME set in the request. All the conditions and provisions of the original Bid/Proposal/Quote will be in effect. No submittals or amendments will be accepted after the due date and time of the request. This does not preclude the County from requesting additional information and/or clarification.
- 3.0 DEVIATIONS AND EXCEPTIONS:** Deviations and exceptions from original text, terms, conditions, or specifications shall be described fully, on the bidder's/proposer's letterhead, signed, and attached to the request. In the absence of such statement, the bid/proposal shall be accepted as in strict compliance with all terms, conditions, and specifications and the bidders/proposers shall be held liable.
- 4.0 QUALITY:** Unless otherwise indicated in the request, all material shall be new, newest model year, and free from defects. Items which are used, demonstrators, obsolete, seconds, or which have been discontinued are unacceptable without prior written approval by the County.
- 5.0 QUANTITIES:** The quantities shown on this request are based on estimated needs. The County reserves the right to increase or decrease quantities to meet actual needs.
- 6.0 DELIVERY:** Deliveries shall be F.O.B. destination freight prepaid and included unless otherwise specified.
- 7.0 PRICING AND DISCOUNT:** The County qualifies for governmental discounts. Unit prices shall reflect these discounts.
- 7.1** Unit prices shown on the bid/proposal or contract shall be the price per unit of sale (e.g., gal., cs., doz., ea.) as stated on the request or contract. For any given item, the quantity multiplied by the unit price shall establish the extended price; the unit price shall govern in the bid/proposal evaluation.
- 7.2** Prices established in continuing agreements and term contracts may be lowered due to general market conditions.

- 8.0 RESPONSES TO REMAIN OPEN:** Responses must remain open and will be deemed to be open and subject to acceptance until awarding of the bid/proposal is finalized, or a minimum of sixty (60) days unless otherwise specified.
- 9.0 ACCEPTANCE-REJECTION:** The County reserves the right to accept or reject any or all bids/proposals, to waive any technicality in any bid/proposal submitted, request clarification of any bid/proposal, award a bid/proposal that is not the lowest price, and to accept any part of a bid/proposal as deemed to be in the best interests of the County.
- 10.0 GUARANTEED DELIVERY:** Failure of the Contractor to adhere to delivery schedules as specified or to promptly replace rejected materials shall render the Contractor liable for all costs in excess of the contract price when alternate procurement is necessary. Excess costs shall include the administrative costs and other costs attributable to the delay.
- 11.0 CONTRACT AND EXECUTION OF CONTRACT:** Unless otherwise specified in the bid/proposal, the successful responder agrees to enter into a contract, a copy of which will be on file in the office of the Portage County Purchasing Department. Contractor shall and will well and truly execute and perform this contract under the terms applicable to the satisfaction of the County, and shall promptly make payment to each and every person or party entitled thereto of all the claims for work or labor performed and materials furnished in the performance of this contract.
- 12.0 ENTIRE AGREEMENT:** These Standard Terms and Conditions shall apply to any contract or order awarded as a result of this request except where special requirements are stated elsewhere in the request; in such cases, the special requirements shall apply. Further, the written contract and/or order with referenced parts and attachments shall constitute the entire agreement and no other terms and conditions in any document, acceptance, or acknowledgment shall be effective or binding unless expressly agreed to in writing by the County.
- 13.0 APPLICABLE LAW AND COMPLIANCE:** This contract shall be governed under the laws of the State of Wisconsin. The Contractor shall at all times comply with and observe all federal and state laws, local laws, ordinances, and regulations which are in effect during the period of this contract and which in any manner affect the work or its conduct. The County reserves the right to cancel this contract if the contractor fails to follow the requirements of s. 77.66, Wis. Stats., and related statutes regarding certification for collection of sales and use tax. The County also reserves the right to cancel this contract with any state or federally debarred contractor or a contractor that is presently identified on the list of parties excluded from federal procurement and non-procurement contracts.
- 14.0 LICENSES AND PERMITS:** Contractor shall have and/or provide any and all licenses and permits required to perform the work specified and furnish proof of such licensing authorization and permits with their bids if required.
- 15.0 ASSIGNMENT:** No right or duty in whole or in part of the Contractor under this contract may be assigned or delegated without the prior written consent of the County.
- 16.0 NONEXCLUSIVE CONTRACT:** Unless otherwise stated, the County reserves the right to purchase work or materials outside of this contract.
- 17.0 NONDISCRIMINATION & AFFIRMATIVE ACTION:** In connection with the performance of work under this contract, the Contractor agrees not to discriminate against any employee or applicant for employment because of age, race, religion, color, handicap, sex, physical condition, developmental disability as defined in s. 51.01(5), Wis. Stats., sexual orientation, gender identity and gender expression, or national origin. This provision shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.
- 18.0 INDEPENDENT CAPACITY:** The parties hereto agree that the contractor, its officers, agents, and employees, in the performance of this agreement shall act in the capacity of an independent contractor and not as an officer, employee, or agent of the County. The contractor agrees to take such steps as may be necessary to ensure that each subcontractor of the contractor will be deemed to be an independent contractor and will not be considered or permitted to be an agent, servant, joint venturer, or partner of the County.

- 19.0 SAFETY REQUIREMENTS:** All materials, equipment, and supplies provided to the County must comply fully with all safety requirements as set forth by the Wisconsin Administrative Code and all applicable OSHA Standards.
- 20.0 WARRANTY:** Unless otherwise specifically stated, equipment purchased as a result of this request shall be warranted against defects by the Contractor for one (1) year from date of receipt. The equipment manufacturer's standard warranty shall apply as a minimum and must be honored by the Contractor.
- 21.0 INSURANCE RESPONSIBILITY:** If insurance is required, satisfactory proof of the existence and carriage of such insurance of the kinds and limits specified will be required.
- 22.0 CANCELLATION:** The County reserves the right to cancel any contract in whole or in part without penalty due to non-appropriation of funds or for failure of the contractor to comply with terms, conditions, and specifications of this contract.
- 23.0 VENDOR TAX DELINQUENCY:** Vendors who have a delinquent Portage County tax liability may have their payments offset by the County.
- 24.0 OPEN RECORDS:** Both parties understand that the County is bound by the Wisconsin Public Records Law, and as such, responses and contracts are subject to and conditioned on the provisions of the law. Contractor acknowledges that it is obligated to assist the County in retaining and producing records that are subject to Wisconsin Public Records Law, and that the failure to do so shall constitute a material breach of the contract, and that the Contractor must defend and hold the County harmless from liability under that law. Except as otherwise authorized, those records shall be maintained for a period of seven (7) years after receipt of final payment under the contract.
- 25.0 MATERIAL SAFETY DATA SHEET:** If any item(s) on an order(s) resulting from this award(s) is a hazardous chemical, as defined under 29CFR 1910.1200, the Contractor shall provide one (1) copy of a Material Safety Data Sheet for each item with the shipped container(s) and one (1) copy with the invoice(s).
- 26.0 ADVERTISING AND NEWS RELEASES:** Reference to or use of the County, any of its departments, officials, or employees, for commercial promotion is prohibited. News releases pertaining to this procurement shall not be made without prior approval of the County. Release of broadcast e-mails pertaining to this procurement shall not be made without prior written authorization of the County.
- 27.0 HOLD HARMLESS:** The Contractor will indemnify, pay the cost of defense including attorney's fees, and save harmless the County and all of its officers, agents and employees from all suits, actions, or claims of any character brought for or on account of any injuries or damages received by any persons or property resulting from the operations of the contractor, or of any of its contractors, in prosecuting work under this agreement.
- 28.0 FOREIGN CORPORATION:** A foreign corporation (any corporation other than a Wisconsin corporation) which becomes a party to this contract is required to conform to all the requirements of Chapter 180, Wis. Stats., relating to a foreign corporation and must possess a certificate of authority from the Wisconsin Department of Financial Institutions, unless the corporation is transacting business in interstate commerce or is otherwise exempt from the requirement of obtaining a certificate of authority. Any foreign corporation which desires to apply for a certificate of authority should contact the Department of Financial Institutions, Division of Corporation, P. O. Box 7846, Madison, WI 53707-7846; telephone (608) 261-7577.
- 29.0 FORCE MAJEURE:** Neither party shall be in default by reason of any failure in performance of this contract in accordance with reasonable control and without fault or negligence on their part. Such causes may include, but are not restricted to, acts of nature or the public enemy, acts of the government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and unusually severe weather, but in every case the failure to perform such must be beyond the reasonable control and without the fault or negligence of the party.

501 Concrete

501.1 Description

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

501.2 Extensive rewrite and reorganization to clarify general concrete material requirements.

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:

Sampling aggregates ^[1]	AASHTO T2
Lightweight pieces in aggregate	AASHTO T113
Material finer than No. 200 sieve ^[1]	AASHTO T11
Unit weight and voids in aggregate	AASHTO T19
Organic impurities in sands	AASHTO T21
Sieve analysis of aggregates	AASHTO T27
Effect of organic impurities in fine aggregate	AASHTO T71
Los Angeles abrasion of coarse aggregate	AASHTO T96
Alkali silica reactivity of aggregates	ASTM C1260
Alkali silica reactivity of combinations of cementitious materials and aggregates	ASTM C1567
Freeze-thaw soundness of coarse aggregate ^[1]	AASHTO T103
Sodium sulfate soundness of coarse aggregates (R-4, 5 cycles)	AASHTO T104
Specific gravity and absorption of fine aggregate	AASHTO T84
Specific gravity and absorption of coarse aggregate ^[1]	AASHTO T85
Flat & elongated pieces based on a 3:1 ratio ^[1]	ASTM D4791

^[1] As modified in [CMM 860](#).

- (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 cement types I, II, and III from manufacturers on the [APL](#). The engineer may accept cement not on the [APL](#) under the department's cement certification program.
 - (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 Expanded supplemental cementitious materials to include silica fume, blended SCMs, and alternative SCMs.

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 Add high range water-reducing admixtures and hydration controlling admixtures.

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, to reduce the amount of mixing water by 12 percent or more, submit a certified report of test or analysis showing conformance to AASHTO M194, type F, except if it also a set retarder, then conform to type G.

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 to suspend cement hydration process for extended periods, conform to AASHTO M194, type B or type D.
- (2) Conduct preliminary trials on-site to determine the required dosage rate.

501.2.6 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; CMM 870.2	2 mL
Alkalinity, maximum of 0.1N HCL to neutralize 200 mL of water; CMM 870.2	15 mL
Maximum sulphate (SO ₄); ASTM D516	0.05 percent
Maximum chloride; ASTM D512	0.10 percent
Maximum total solids; CMM 870.2	
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 sulfate soundness	12
Freeze-thaw soundness	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 & elongated pieces based on a 3:1 ratio ^[1]	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 AASHTO 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 Base aggregate acceptance on new combined aggregate gradation specification limits.

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.
 - Other engineer-approved applications.

501.2.7.4.2 Incorporate optimized aggregate gradation and associated tarantula curve limits from STSP 715-005.

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	FINE AGGREGATE	COARSE AGGREGATE		COMBINED AGGREGATE GRADATION		OPTIMIZED AGGREGATE GRADATION (OAG)
		SIZE NO. 1 AASHTO No. 67 ^[1]	SIZE NO. 2 AASHTO No. 4 ^[1]	STANDARD	100 % PASSING 1-inch sieve	TARANTULA CURVE GRADATION BAND
	(% passing by weight)					(volumetric % retained)
2-inch	—	—	100	100	100	0
1 1/2-inch	—	—	90 - 100	96 - 100	100	<= 5
1-inch	—	100	20 - 55	70 - 99	100	<= 16
3/4-inch	—	90 - 100	0 - 15	55 - 96	95 - 100	<= 20
1/2-inch	—	—	—	48 - 86	75 - 91	4-20
3/8-inch	100	20 - 55	0 - 5	38 - 77	56 - 80	4-20
No. 4	90 - 100	0 - 10	—	30 - 60	42 - 60	4-20
No. 8	—	0 - 5	—	25 - 53	36 - 55	<= 12
No. 16	45 - 85	—	—	20 - 44	27 - 45	<= 12
No. 30	—	—	—	10 - 32	15 - 32	4-20
No. 50	5 - 30	—	—	2 - 14	3 - 14	4-20
No. 100	0 - 10	—	—	0 - 6	0 - 6	<= 10
No. 200	<= 3.5 ^[2]	<= 1.5		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 ^[3]

^[1] Size No. according to AASHTO M43.

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

^[3] 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 Eliminate the historical prescriptive concrete mixes; now just four standard grades.

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 Require a minimum amount of supplemental cementitious materials for all concrete.

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.
- (2) Limit Class F fly ash sources not on the [APL](#) to a maximum 15 percent.
- (3) 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 Allow optimized mix designs with reduced cementitious materials for optimized gradations.

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 cement content of 500 pounds per cubic yard of concrete, except for grades C and E conform to table 501-5.
 - Provide a minimum V_{paste}/V_{voids} 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 according to AASHTO T152 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 AASHTO 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) Add 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 the engineer's 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 Engineer consults with BTS when contractor is using hydration controlling admixture.

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.
- (2) Use the applicable slump specified in [415.2.1](#) for concrete pavements.
 - (3) Perform the slump tests for concrete according to AASHTO 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.

Section 415 Concrete Pavement

415.1 Description

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

415.2 Materials

415.2.1 Concrete

- (1) Furnish grade A, A2, A3, A-FA, A-S, A-S2, A-T, A-IS, A-IP, or A-IT, air-entrained 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. The contractor may use special high early strength concrete as specified for SHES concrete repair and replacement in [416.2](#) for concrete pavement placed in conjunction with the SHES repair and SHES replacement items for repair areas 300 feet long or longer.
- (3) Maintain a uniform consistency in consecutive batches of concrete. Use the following slumps for the technique used:

SLIP-FORMED
2.5 inches or less

NOT SLIP-FORMED
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 AASHTO M153 or AASHTO M213 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 holes factory-punched 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 and as modified for testing in [501.2.9](#).
- (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/m².
 - Loss of water in 72 hours does not exceed 0.40 kg/m².
 - 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.

Add 415.2.6 to specify joint filler material.

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, 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 opaque plastic sheeting or other 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 project 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 honey combed 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) Measure edge slump according to [CMM 8-70](#). 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 the pavement has cured sufficiently to avoid damaging the concrete. The contractor may remove individual forms sooner to saw transverse joints. Fill voids in the formed surface 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. 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.
- (2) 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.
- (3) 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.
- (4) 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.
- (5) 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.
- (6) The contractor may temporarily hand tool joints to reduce the 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 multi-lane 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 in locations 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 and Correction

- (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.

415.3.11 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 [501.2.9](#) 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 operations.

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 issues 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 operations 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 the requirements, except for color and reflectance, specified in [501.2.9](#). 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 the protective material in place until the concrete conforms to the opening criteria specified in [415.3.15](#). If necessary to remove the 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
General purpose concrete (grades A, A2, and A3)	4
General purpose concrete (grades A-FA, A-IP, and A-IT)	5
General purpose concrete (grades A-S, A-S2, A-IS, and A-T)	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 AASHTO T23 and test the cylinders according to AASHTO 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 AASHTO 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 magnetic pulse induction acceptance testing. The department may accept thickness of special units using alternate methods.

415.3.16.2 Pavement Units

- (1) Divide the pavement into basic units 250 feet long, measured along the pavement centerline. Treat fractional units less than 250 feet but greater than or equal to 100 feet long as whole basic units. Include a fractional unit less than 100 feet long as a part of a contiguous basic unit.
- (2) The basic unit is one lane wide, 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.
- (3) Establish special units for areas of fillets, intersections, gaps, and other areas not included in basic units. Also establish special units for shoulders, ramps, and other long areas of constant cross-section less than 10 feet wide. Limit the size of special units to a maximum of 350 square yards.

415.3.16.3 Locating Test Plates

- (1) Locate department-furnished test plates at two random locations, within each pavement unit according to [CMM 8-70.4.7.2](#). Do not place plates within 4 feet of a transverse or longitudinal joint containing steel. Plates may not be required for special units where the engineer employs alternate methods.
- (2) Anchor test plates to the grade with a 16D common nail or other engineer-approved fastener. Designate each plate location with a sequential number and determine the center of each plate to

within 2 feet. Paint the location of the plate center along with the sequential number for each plate location on the hardened concrete.

- (3) Within 5 business days after paving, enter the sequential number and associated position data into the department's materials reporting system (MRS) software available at:

<http://www.atwoodsystems.com/>

415.3.16.4 Acceptance Testing

- (1) The department will measure thickness according to [CMM 8-70.4.7.3](#) at one random location in each unit. If the initial measurement falls within the 80 to 50 percent pay range specified in [415.5.2](#), the department will measure at the second plate in that unit and average the results to determine the pay adjustment. Pavement thinner than the plan thickness by more than 1 inch is unacceptable.
- (2) The engineer will direct the contractor to core the hardened concrete to determine the extent of unacceptable areas. Take cores at points approximately 20 feet in each direction of an unacceptable test result on a line parallel to the centerline or longitudinal axis of the unit. Continue coring in each direction until locating a core that is not unacceptable. The engineer will determine the limits of unacceptable areas, at each end, by drawing lines across the unit of pavement midway between the locations of the last 2 cores.
- (3) Perform coring according to AASHTO T24. The engineer will evaluate the results according to AASHTO T148. Fill core holes with concrete or mortar.

415.3.17 Concrete Crack Repair

- (1) The engineer will inspect concrete pavement and ancillary concrete 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.

Add 415.3.20 to specify joint filling for low-speed urban pavements not requiring tining.

415.3.20 Filling Joints

- (1) Fill contraction and expansion 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](#). Fill both transverse and longitudinal joints as soon as practicable, but only after the engineer inspects them.
- (2) Clean joints of laitance, curing compound, and other contaminants before filling. Sandblast or waterblast exposed joint faces using multiple passes as required to clean joint 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 10 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 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.

Add 415.4(4) to specify measurement for joint filling.

- (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

Revise 415.5(1) to add a bid item for joint filling.

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

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
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
415.4100	Concrete Pavement Joint Filling	SY

- (2) Payment for the Concrete Pavement 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 [415.3.11](#).
- (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](#). Add 415.5.1(6) specify payment for protective covering.

Add 415.5(6) to specify payment for joint filling.

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

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]
> 1/4 inch but ≤ 1/2 inch	80
> 1/2 inch but ≤ 3/4 inch	60
> 3/4 inch but ≤ 1 inch	50

^[1] The department adjusts pay based on the average of 2 measurements per unit as specified in [415.3.16.4\(1\)](#).

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

1. Remove and replace with concrete pavement of conforming thickness. The department will pay for the replaced area at the full contract price.
2. Leave the concrete in place. The department will not pay 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 4-24](#). 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 all 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.

Section 416 Concrete Pavement - Appurtenant Construction

416.1 Description

- (1) This section describes constructing concrete driveways; truck aprons; drilling in tie bars to tie existing to new concrete and drilling in dowel bars to transfer load between existing and new concrete; concrete surface drains; concrete rumble strips; and concrete pavement repair and replacement.

416.2 Materials

416.2.1 General

- (1) Furnish air-entrained concrete conforming to [501](#) as modified for class II concrete in [716](#). Provide QMP for class II ancillary concrete as specified in [716](#).
- (2) Furnish high early strength concrete under the HES bid items. 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. For use in solid form or on the job preparation of admixture solutions, conform to AASHTO M144, type S, grade 1 or grade 2.
 2. For admixture delivered in premixed solution form, conform to AASHTO M144, type L, in a concentration of approximately 30 percent.

416.2.2 Concrete Driveways, Truck Aprons, and Surface Drains

- (1) Use grade A, A2, A3, A-FA, A-S, A-S2, A-T, A-IS, A-IP, or A-IT concrete as specified in [501](#).

416.2.3 Tie bars and Dowel bars

416.2.3.1 General

- (1) Furnish tie bars and dowel bars conforming to [505.2.6](#).

416.2.3.2 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.

416.2.4 Concrete Pavement Repair and Replacement

- (1) Except as specified in [416.3.6](#) for inlaid rumble strips, use grade C, C-FA, C-S, C-IS, C-IP, or C-IT concrete as specified in [501](#).

416.2.5 Special High Early Strength Concrete Pavement Repair and Replacement

416.2.5.1 Composition and Proportioning of Concrete

- (1) For the concrete mixture, use a minimum of 846 pounds of cementitious material per cubic yard of concrete. Determine materials and proportions of the concrete mixture to obtain a minimum compressive strength in the concrete of 3000 psi within 8 hours of placement. The contractor may add one or a combination of admixtures to the ingredients or to the mixture in order to obtain the required minimum strength and required air content. Do not retemper the concrete mixture.
- (2) Provide calcium chloride, if used in the mix, either as a pre-mixed solution or as a job-mixed solution. Ensure that job-mixed solutions contain 1.0 pounds per quart of 77 percent calcium chloride or 0.9 pounds per quart of 90 percent calcium chloride. Do not exceed the manufacturer's recommended maximum dosage. If the engineer requests, provide a written copy of the manufacturer's dosage recommendations.

- (3) Add calcium chloride, in solution, by 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.
- (4) Discharge all 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.

416.2.5.2 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) The engineer will inspect ancillary concrete, as defined in [416.5.2](#) and built under 416, for transverse cracking as specified in [415.3.17](#). Repair cracked concrete as the engineer directs.

416.3.2 Concrete Driveways and Truck Aprons

- (1) Construct concrete driveways and truck aprons conforming to [415.3](#) except the contractor may use engineer-approved wood or plastic forms. Color concrete for roundabout truck aprons red as specified in [405](#).

416.3.3 Placing Tie Bars in Existing Concrete

416.3.3.1 Force Driven

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

416.3.3.2 Epoxied

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

416.3.4 Placing Dowel Bars in Existing Concrete

- (1) Drill holes into the edge of the existing concrete to the dimensions the plans show. Anchor the dowel bars into the existing concrete with an epoxy conforming to [416.2.3.2](#).
- (2) Clean drilling dust, debris, and excess moisture from drill 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.

416.3.5 Surface Drains

- (1) Install and maintain temporary surface drains at locations designated for permanent drains until permanent drains are completed.
- (2) Place and secure steel reinforcement and tie bars in their plan position before placing concrete. Place and cure the concrete conforming to [415.3](#).
- (3) Excavate, prepare the subgrade and aggregate base, and backfill as required to place the drains and restore the grade after placement.

416.3.6 Concrete Rumble Strips

- (1) Mill shoulder rumble strips into new or existing concrete shoulders. Mill or form intersection rumble strips into new concrete pavement or, if inlaid into existing HMA or concrete pavements, into work built under the Concrete Pavement Replacement bid item except use concrete conforming to [416.2.2](#). Do not apply rumble strips across bridges.
- (2) If milling, use a rotary head mill with a cutting tip pattern that will produce a relatively smooth cut of the size, shape, spacing, and alignment the plans show. Ensure that cutting heads are on a suspension independent from the power unit to allow the heads to self-align with slopes and irregularities. Also ensure that the machine has a guidance system that consistently provides the plan alignment of the rumble strips.
- (3) If forming rumble strips into freshly placed concrete, form or finish the concrete to consistently produce the size, shape, spacing, alignment, and smoothness the plans show.
- (4) Before beginning the work, demonstrate to the engineer that the proposed operation achieves the desired surface inside each depression without damaging the pavement. Place rumble strips in the pattern and shape the plans show. For shoulders carrying temporary traffic during construction, do not install rumble strips until after routing traffic back to the mainline.
- (5) At the end of each work day, move equipment and material out of the clear zone and sweep or vacuum the traveled way pavement and shoulder areas. Sweep away or vacuum up milling debris before opening adjacent lanes to traffic. Dispose of waste material as specified in [203.3.4](#); do not place on the finished shoulder surface.

416.3.7 Concrete Pavement Repair and Replacement

- (1) Repair concrete pavement at the locations the plans show or where the engineer directs. Conform to the pavement repair plan details. For individual repair areas at least one lane wide and greater than 15 feet to less than 300 feet long, conform to the pavement replacement plan details.
- (2) Construct conforming to the following:
 - Remove concrete pavement, remove asphaltic patch, and prepare the base as specified under [416.3.8.1](#).
 - Place concrete in repair areas as specified under [416.3.8.2](#). Disregard the same-day requirements for completion of curing and opening to traffic and instead conform to [415.3.12](#) through [415.3.15](#).
 - Place concrete in replacement areas conforming to [416.3.8.3](#) except disregard the same-day requirements for completion of curing and opening to traffic.

416.3.8 Special High Early Strength Concrete Pavement Repair and Replacement

416.3.8.1 General

- (1) Repair concrete pavement at the locations the plans show or where the engineer directs. Conform to pavement repair plan details. For individual repair areas at least one lane wide and greater than 15 feet to less than 300 feet long, conform to pavement replacement plan details.

416.3.8.1.1 Removing Concrete 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) If the contractor damages pavement designated to remain in place, repair damaged pavement as the concrete pavement repair and replacement details show. Ensure that the length of the damage repair and the adjacent planned repair are the same and both are a full lane wide. If damage is done to pavement not adjacent to a planned repair, conform to the minimum removal length the repair and replacement details show and remove and repair the full lane width.
- (3) Remove concrete with minimal disturbance to the aggregate base. At the close of each day's work, ensure that all slabs have been removed from the project limits and stored away from the roadway. Incorporate or dispose of removed pavement as specified in [203.3.4](#).

- (4) 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.

416.3.8.1.2 Removing Asphaltic Patches

- (1) Remove existing asphaltic patches. Saw back the existing pavement full depth in an area of sound concrete as the plans show.

416.3.8.1.3 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.
- (2) Fill low areas or depressions in the base following removal operations with either compacted aggregate base or additional concrete.

416.3.8.2 Placing Concrete in Repair Areas

- (1) Place, cure, and open special high early strength concrete to traffic on the same day removing the old pavement. 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 the 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 the full depth concrete repair to match the edge of existing HMA or concrete pavement and, if the abutting pavement is concrete, match the existing pavement texture. Cure, protect, open to service, and adhere to cold weather concreting as specified in [415.3.12](#) through [415.3.15](#).

416.3.8.3 Placing Concrete in Replacement Areas

- (1) Place, cure, and open special high early strength concrete to traffic by sunset on the same day removing the old pavement. Place each repair in one continuous, full-depth operation conforming to [415.3.6](#) through [415.3.15](#) except date each replacement slab with the month and year of construction.

416.4 Measurement

- (1) The department will measure the Concrete Driveway bid items by the square yard acceptably completed, measured as specified in [415.4](#) for Concrete Pavement including the intersection with the sidewalk and the associated driveway apron. The department will only measure area outside the specified limits for the pavement, curbs, gutters, combination curb & gutter or other structures.
- (2) The department will measure the Concrete Truck Apron bid items by the square yard acceptably completed.
- (3) The department will measure the Drilled Tie Bars and Drilled Dowel Bars bid items as each individual bar acceptably completed.
- (4) The department will measure the Concrete Surface Drains bid items by the cubic yard acceptably completed, based on the dimensions the plans show or the engineer directs.
- (5) The department will measure Concrete Shoulder Rumble Strips by the linear foot acceptably completed, measured as the length along each side of the traveled way from the center of the first groove in a segment to the center of the last groove in that segment. A segment is a series of grooves including 50-foot and shorter gaps as well as skips at transverse joints the plans show. Gaps greater than 50 feet define a new segment. The department will deduct for skips at transverse joints greater than the plans show.
- (6) The department will measure Concrete Intersection Rumble Strips by the square yard acceptably completed, measured to include the area between the milled or cast-in-place grooves, or if inlaid into existing HMA or concrete pavement, the area of the inlay. The department will not deduct the area of embedded fixtures with an area of one square yard as measured in the plane of the pavement surface.
- (7) 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:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
416.0160 - 0199	Concrete Driveway (inch)	SY
416.0260 - 0299	Concrete Driveway HES (inch)	SY
416.0508 - 0520	Concrete Truck Apron (inch)	SY
416.0610	Drilled Tie Bars	EACH
416.0620	Drilled Dowel Bars	EACH
416.1010	Concrete Surface Drains	CY
416.1015	Concrete Surface Drains HES	CY
416.1110	Concrete Shoulder Rumble Strips	LF
416.1180	Concrete Intersection Rumble Strips	SY
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 pay for the Concrete Driveway and Concrete Truck Apron bid items as specified in [415.5.1](#) and [415.5.2](#) for Concrete Pavement. The department will pay separately for coloring concrete as required for roundabout truck aprons under the Coloring Concrete Red bid item.
- (3) Payment for Drilled Tie Bars is full compensation for providing tie bars, including coating; for drilling holes in concrete not placed under the contract; and for epoxying or driving.
- (4) Payment for Drilled Dowel Bars is full compensation for providing dowel bars, including coating; for drilling holes in concrete not placed under the contract; and for epoxying.
- (5) Payment for the Concrete Surface Drains bid items is full compensation for providing surface drains; for steel reinforcement and dowel and tie bars; and for excavating, preparing the subgrade and aggregate base, and backfilling.
- (6) Payment for Concrete Shoulder Rumble Strips is full compensation for milling; for sweeping or vacuuming; and for disposing of waste materials.
- (7) Payment for Concrete Intersection Rumble Strips is full compensation for milling or forming grooves; for sweeping or vacuuming; and for disposing of waste materials. The department will pay separately for new concrete pavement under the Concrete Pavement bid items; and for concrete inlaid in existing HMA or concrete pavement under the Concrete Pavement Replacement bid item.
- (8) 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 and disposing of 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 provided 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 Pavement bid item as specified in [204.5](#) and the Concrete Pavement bid items as specified in [415.5](#).

416.5.2 Adjusting Pay for Ancillary Concrete Crack Repairs

- (1) The department will adjust pay for crack repairs on ancillary concrete. Ancillary concrete includes curb & gutter whether separately or integrally placed, curb, gutter, medians, sidewalks, loading zones, safety islands, steps, concrete surface drains, truck aprons, and driveways. The engineer will allocate responsibility and costs for crack repairs, mobilization for traffic control, and traffic control devices, according to [CMM 4-24](#). The department will adjust pay under the Crack Repair Ancillary Concrete administrative item.
- (2) Pay adjustment for crack repair costs includes mobilization for the repair work; sawing; removals; furnishing and placing materials including dowel bars and steel reinforcement; drilled tie and dowel bars; and all incidentals. The engineer will compute the pay adjustment for repair costs as the contract unit price for the item, times the quantity replaced, multiplied by the appropriate multiplier as follows:

COMPUTED AMOUNT MULTIPLIER PER QUANTITY FOR ANCILLARY CONCRETE

ITEM	SHARED REIMBURSEMENT	TOTAL REIMBURSEMENT
REPLACED	MULTIPLIER	MULTIPLIER
Quantity replaced	6	12

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