

SECTION 500

RIGID PAVEMENT

SECTION 501 - PORTLAND CEMENT CONCRETE PAVEMENT

501-1 DESCRIPTION

This work shall consist of a pavement composed of air-entrained Portland Cement Concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the ENGINEER.

501-2 MATERIALS

501-2.1 GENERAL. Prior to construction, CONTRACTOR shall submit for approval by the ENGINEER a Certified Analysis of materials listed in Subsections 501-2.2, 501-2.2(a), 501-2.7, 501-2.8, 501-2.9, and 501-2.13.

501-2.2 PORTLAND CEMENT. The cement used in the work shall be air entrained Portland Cement, Type 1A, meeting the requirements of ASTM C150 or Portland Cement, Type 1, meeting the requirements of ASTM C150 with admixtures for producing air entrainment meeting the requirements of ASTM C260.

501-2.2a FLY ASH. The CONTRACTOR shall have the option of substituting fly ash for Portland Cement in the concrete mixture up to a maximum of 20 percent by weight. Each source of fly ash shall be approved by the ENGINEER prior to use. Fly ash shall conform to the requirements of ASTM C311, ASTM C618, and ASTM C684, Class C fly ash. The ASTM C618, Class C fly ash chemical and physical specifications shall be as follows:

Chemical Requirements

Silicon dioxide (SiO ₂) plus aluminum oxide (Al ₂ O ₃) plus iron oxide (Fe ₂ O ₃), min %	50.0
Sulfur Trioxide (SO ₃), max %	5.0
Moisture content, max %	3.0
Loss on ignition, max %	6.0

Supplementary Optional Chemical Requirement

Available alkalis, as Na ₂ O, max %	1.5
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Physical Requirements

Fineness:	
Amount retained with wet-sieve (No. 325 sieve), max %	34.0
Pozzolanic activity index:	
With Portland Cement, at 28 days, min, percent of control	75.0
Water requirement, max %	105.0
Soundness:	
Autoclave expansion or contraction, max %	0.8
Uniformity requirements:	
The specific gravity and fineness of individual samples shall not vary from the average established by the 10 preceding tests, or by all preceding tests if the number is less than 10, by more than:	
Specific gravity, max variation from average, %	5.0
Percent retained on (No. 325) Wet Sieve, max variation from average	5.0

Supplementary Optional Physical Requirements

Increase of drying shrinkage of mortar bars at 28 days, max %	0.03
Uniformity Requirements:	
In addition when air-entraining concrete is specified, the quantity of air-entraining agent required to produce an air content of 18.0 Vol % of mortar shall not vary from the average established by the 10 preceding test or by all preceding tests if less than 10, by more than, %	20.0
Reactivity with Cement Alkalies:	
Mortar Expansion at 14 days, max %	0.020

Fly ash that fails to meet the requirement of the tests shall not be used unless specified otherwise by the ENGINEER.

A complete chemical and physical analysis must be submitted to the CITY OF MANDAN's Engineering Department for approval 14 days prior to use. Also a recent complete chemical and physical analysis must be submitted each month during its use after approval.

A test result of loss on ignition and amount retained on No. 325 Wet Sieve must accompany each truckload of fly ash (25 tons or less), and these results must be on file at the ready mix producer's office. Random checks and samples shall be taken to

insure testing accuracy. Any extensive error in test results could cause the material's use to be discontinued.

No fly ash will be allowed which contains oil residue or chemical pollution control contaminates.

Each source of fly ash shall be approved by the ENGINEER prior to use. If more than one source of fly ash is used on a project, each shall be stored and used separately.

Fly ash shall not be substituted for Portland Cement on any work after October 1 of any calendar year, unless requested by the CONTRACTOR and approved by the CITY ENGINEER.

The ENGINEER shall have the right to sample and test the fly ash as deemed necessary during the course of the construction season. The fly ash shall be tested in accordance with ASTM C311.

501-2.3 AGGREGATE. The CONTRACTOR shall notify the ENGINEER of the source of the coarse and fine aggregate which is proposed for use on the contract. Sufficient time shall be allowed so that sampling and testing can be completed prior to the beginning of construction. During the construction period, the CONTRACTOR shall at all times make available to the ENGINEER the sampling of aggregate. All aggregate shall meet the requirements of these specifications.

501-2.4 COARSE AGGREGATE. Except as noted herein, the coarse aggregate used shall conform to the requirements of ASTM C33, Class 4M. Coarse aggregate shall consist of gravel or broken stone composed of strong, hard, durable, uncoated pebbles or rock fragments washed clean and free from injurious amounts of shale, coal, clay lumps, soft fragments, dirt, glass, organic, or any other deleterious substances.

Coarse aggregate shall be graded from coarse to fine within one of the following limits when tested in conformity with ASTM C136. Either gradation may be used, but once adopted, no change in gradation will be made during course of the work.

COARSE AGGREGATE SIZE

Square Mesh	Percent by Weight Passing	Percent by Weight Passing
2"		
1½"	100	
1"	95-100	100
¾"		90-100
½"	25-60	
⅜"		20-55
No. 4	0-10	0-10
No. 8	0-5	0-5
No. 200	0-1	0-1

501-2.5 FINE AGGREGATE. Except as noted herein, the fine aggregate shall conform to the requirements of ASTM C33. Fine aggregate shall be natural sand, consisting of hard, strong, sharp, uncoated grains, free of dust, lumps, mica, shale, organic matter, or other deleterious substances.

Fine aggregate shall be graded within the following limits when tested in conformity with ASTM C136.

FINE AGGREGATE SIZE

SQUARE MESH SIEVE SIZE	PERCENT BY WEIGHT PASSING	SQUARE MESH SIEVE SIZE	PERCENT BY WEIGHT PASSING
MORTAR SAND		CONCRETE SAND	
No. 4	100	3/8"	100
No. 8	95-100	No. 4	95-100
		No. 8	80-100
		No. 16	50-85
		No. 30	25-60
		No. 50	5-30
No. 100	25 (max.)	No. 100	0-10
No. 200	10 (max.)		

The quality, sampling, and testing of mortar sand for use in cement mortar shall conform to ASTM C144.

501-2.6 WATER. Water used in mixing concrete shall be clean and shall not contain deleterious amounts of acids, alkalies, or organic materials. Water shall be subject to test and approval by the ENGINEER.

501-2.7 ADMIXTURES. Substances other than cement, water, aggregates, and air-entraining agents shall not be used in the concrete except as otherwise required or when permitted in writing by the ENGINEER. Air-Entraining Admixtures shall conform to ASTM C260. Unless otherwise provided in the Plans or Special Provisions, no reduction will be made in the specified cement content of the concrete mixture by reason of using any admixtures. Admixtures containing calcium chloride must be preapproved and conform to ASTM D98. No admixture shall be used which interferes with proper control of the entrained air content of concrete. Permission to use any admixtures may be withdrawn at any time if the properties of the admixture are not uniform or if satisfactory results are not being obtained.

Should the CONTRACTOR request and obtain permission to use admixtures for its own benefit, no additional compensation will be allowed for the cost of furnishing the admixtures and incorporating them into the concrete mixture.

Should the ENGINEER direct the CONTRACTOR to use admixtures when their use is not required by these Specifications or by the Plans or Special Provisions, furnishing the

admixtures and incorporating them into the concrete mixture will be paid for as extra work as provided in Section 126.

501-2.8 EXPANSION JOINT MATERIAL. Premolded Bituminous Fiber Expansion Joint Material shall be used in expansion joints and shall consist of preformed strips of one continuous piece per joint which have been formed from cane or other suitable fibers of cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder. Said joint materials shall conform to ASTM D1751 (premolded material). Closed cell polyethylene expansion joint filler shall conform to ASTM D1056. Vinyl expansion joints shall be ProFlex from Oscada Plastics, Inc. or approved equal and shall conform to ASTM D1752. The cost for all expansion joint material shall be considered incidental.

501-2.9 JOINT SEALING MATERIAL. Joint sealing material shall conform to the following:

<u>Type of Sealant</u>	<u>ASTM or NDDOT Specification</u>
Hot-poured, elastic	D1190
Hot-poured, polymeric asphalt based	D3405 or NDDOT 826.02A Type 2
Hot-poured, elastomeric	D3406
Cold applied elastomeric	C920
Preformed polychloroprene elastomeric	D2628 (6 celled)
Silicone sealant	D5893 or NDDOT 826.02B Type 5

501-2.10 REINFORCEMENT AND BAR STEEL. Reinforcing steel, except as otherwise specified, shall be grade 60 deformed bars rolled from take out billet stock and shall conform to the requirements of ASTM A615.

Dowel bars shall be intermediate grade plain bars rolled from take out billet stock and shall conform to the requirements of ASTM A663 or A675.

Wire mesh reinforcement shall comply with the requirements of ASTM A185.

Bar supports and spacers shall be constructed of steel and of suitable design and strength to hold reinforcement accurately in place before and during the placing of concrete. Hy-chairs shall be of welded steel construction, and all spacers, bar supports and chairs shall be approved by the ENGINEER. The cost for all Reinforcement Steel shall be considered incidental.

Tie wire shall be No. 16 gauge annealed wire.

501-2.11 JACKING MATERIALS. Slabjacking materials shall consist of Portland Cement, sand-free loam topsoil, powder limestone, or lime sludge, which shall become fluid like when mixed with water.

A preferred mixture is lime sludge or powder limestone. Powder limestone shall contain a minimum of 90% calcium and magnesium carbonates, grated so that 100% pass a 60

mesh screen, 85% pass a 100 mesh screen, and 60% pass a 200 mesh screen. Portland Cement shall contain about a 5:1 ratio of limestone to cement. Topsoil shall be a good loam soil relatively free of sand, clay, pebbles, and roots.

Material shall be the consistency of a thick cream that tends to flow freely and fill all voids and openings, yet should have a sufficient internal resistance (stiffness) that the amount of lift may be controlled.

Cement content may vary with each individual application; some jobs may only contain 5% cement, others as much as 15%. A high cement content mix may be used when it is desirable to have the mix set up quickly.

501-2.12 SELECT BACKFILL. The material furnished under this item shall be bedding material in accordance with Section 801-2.9 or recycled concrete "readywash" type material and shall be mechanically tamped in place in layers not exceeding 6 inches in depth.

501-2.13 CURING COMPOUNDS. Curing compounds shall conform to ASTM C309, Type 2 white pigmented or AASHTO M148 Type 1.

501-3 CONSTRUCTION REQUIREMENTS

501-3.1 GENERAL. The CONTRACTOR shall furnish all labor, materials, and services necessary for and incidental to the completion of all work as shown on the drawings and specified herein. All machinery and equipment owned or controlled by the CONTRACTOR shall be of sufficient size to meet the requirements of the work and shall produce satisfactory work. All work shall be subject to the inspection and approval of the ENGINEER. The CONTRACTOR shall employ at all times a sufficient force of workmen of such experience and ability that the work can be completed in a satisfactory and workmanlike manner.

Identify an acceptable concrete wash out area(s). Dumping concrete or concrete waste within the CITY's right-of-way or easements including the storm water system or on adjacent properties is prohibited without the written consent of the CITY or the affected property owner.

501-3.2 MATERIALS STORAGE.

(a) Portland Cement. Portland Cement shall be stored as specified in ASTM C150. The Portland Cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment and in a suitable weather tight building that will protect the Portland Cement from becoming damp and minimize warehouse set. Storage shall be of such capacity to provide ample space for consignments of cement as may be required to carry on the work in accordance with approved progress schedules.

(b) Aggregates. Aggregates shall be stored in such a manner as to afford good drainage, prevent the intrusion of foreign matter, and preserve the gradation. Any material which has deteriorated or which has been damaged shall not be used for concrete.

To avoid changes in consistency, the aggregates shall be obtained from a source which will insure uniform quality and grading during any single day's operation, and they shall be delivered to the work and handled in such manner that variations in moisture content will not interfere with the steady production of concrete of uniform quality and consistency.

(c) Fly Ash. Fly ash shall be stored in weather tight facilities to be approved by the ENGINEER.

501-3.3 ADVANCE DESIGN OF CONCRETE MIXES. Designs and tests for each concrete mix to be used under this contract shall be made using aggregates which have been approved for this work. Except as otherwise specified, mixes shall be designed in accordance with ACI 613 to attain the required strengths using the various slumps (including the maximum allowable), the various size aggregates expected to be used in the work and the admixtures as called for by the ENGINEER. The concrete mixes shall be designed by an independent testing laboratory and shall be incidental to other items.

Advance tests of each of the proposed mixes shall be made in accordance with ASTM C192. Six (6) standard 6-inch diameter compression test cylinders shall be made for each mix design, three (3) shall be tested at seven (7) days and three (3) at twenty-eight (28) days. The 7-bag mix design shall have nine (9) standard 6-inch diameter compression test cylinders. Three (3) shall be tested at 3 days, three (3) shall be tested at 7 days, and three (3) shall be tested at 28 days. Concrete tested shall contain all required and/or proposed admixtures and in addition to the testing required by ASTM C192 shall be tested for air content by ASTM C231.

The advance mix designs and the results of tests on cylinders made from advance mix designs is required before work of concrete placing is started. Tests for aggregates as required in Subsection 501-2.4 may be made a part of these tests if suitably referenced on the reports which shall be issued at seven (7) and twenty-eight (28) days.

The above tests shall be repeated if necessary because of changes in materials or unsatisfactory results. The mix design and the advance testing of aggregates specification may be waived at the request of the CONTRACTOR and with the ENGINEER's approval if a mix design approved by the CITY OF MANDAN is being produced by an established ready mix plant with suitable records of mixes and testing, and if the plant certifies that it will continue to use the same materials involved in the recorded testing. The CONTRACTOR shall pay for all advance design and testing as required per 501-3.3 including tests for aggregates and flexural strength.

501-3.4 FIELD QUALITY CONTROL. The CONTRACTOR shall engage an independent testing laboratory approved by the ENGINEER to test consistency,

proportioning, and strength of the concrete mixture. The CONTRACTOR shall be responsible for scheduling the testing firm. The time and location of testing shall be at the discretion of the ENGINEER. The independent testing laboratory personnel testing in the field shall be responsible for notifying the CONTRACTOR and the ENGINEER in the field immediately of failures. If any test have not met the specifications, testing shall continue on all batches until the specific ranges have been met and the limits of the area not meeting the requirements is established.

The cost of testing, including retesting of failed tests, shall be considered incidental. All tests requested by the ENGINEER, other than frequencies specified below, shall be considered extra items.

For construction of new concrete pavements, tests shall be taken for each 75 cubic yards (CY).

For new and repaired driveways or sidewalks, tests shall be taken ever 60 cubic yards (CY), and no less than 2 per week or less than 60 cubic yards (CY) utilized.

For new and repaired valley gutters, tests shall be taken for each new valley gutter constructed or a valley gutter repaired in place..

The concrete test shall be taken for each 150 cubic yards of concrete pavement repair material placed.

One concrete test shall be taken for each 200 linear feet (LF) of repaired curb and gutter placed, not to include through the driveway.

Where less than 1,000 linear feet (LF) of new curb and gutter is placed, one concrete test shall be taken for each side of the street.

Where more than 1,000 linear feet (LF) new curb and gutter is placed, one test shall be taken for each 1,000 LF of new curb and gutter placed on each side of the street.

A set of three standard diameter compression test cylinders shall be cast in the field in accordance with ASTM C31 and C172 for each sample taken. The cylinders cast from the given 6-bag mixtures sample shall be tested in the laboratory, one at 7 days and the remaining two at 28 days with the required minimum strength of the concrete being 3,500 lbs./sq. in. at 28 days. Seven-bag mixtures shall be tested in the laboratory, one at 3 days, one at 7 days, and the remaining one at 28 days. One additional test cylinder shall be taken during cold weather construction as defined in Section 501-3.7. This cylinder shall be cured on the job site under the same conditions as the concrete it represents and tested in the laboratory after 28 days. Each sample taken or cylinders shall also be tested for slump in accordance with ASTM C143 and air content in accordance with ASTM C231. The maximum allowance slump of the concrete mixture shall be 4 inches unless otherwise approved by the ENGINEER. The air content shall fall within the range of 5 percent to 7 percent. Concrete test specimens for flexural strength shall be made at the discretion of the ENGINEER according to ASTM C31.

Concrete beams may be tested for minimum flexural strength of 590 psi according to ASTM C78. Flexural strength testing shall be considered extra to other bid items. Concrete not meeting required specifications for slump or air content during placement may be accepted or rejected at the discretion of the ENGINEER.

Written reports of all tests shall be supplied to the ENGINEER and the CONTRACTOR by the testing laboratory as soon as possible. To expedite construction, it is necessary that the CONTRACTOR and ENGINEER be furnished with the results of all tests as soon as testing is completed.

The availability of the independent testing laboratory when needed and speed of testing and reporting are to be considered the responsibility of the CONTRACTOR.

During the course of concrete construction, it may be deemed necessary by the ENGINEER to verify concrete composition and/or thickness. This will be accomplished by coring the completed and in place concrete. The CONTRACTOR shall remove and replace the samples at no extra charge. If the concrete is deficient in composition, compaction, or thickness, satisfactory correction shall be made immediately.

Should the CONTRACTOR require any of the above verification sampling, the CONTRACTOR agrees to assume all costs incurred, including the testing of the sample.

The pavement shall not be opened to traffic prior to seven (7) days after construction and not before flexural strengths of 500 psi and compressive strengths of 3,500 psi are attained or without approval by the ENGINEER.

501-3.5 PROPORTIONING MATERIALS. Concrete shall be composed of Portland Cement, fly ash, fine aggregate, coarse aggregate, admixtures, and water as specified. The mix shall be designed in accordance with Subsection 501-3.3 of these specifications.

The amount of water specified shall include the surface moisture carried by the aggregates at the time of mixing. This amount of water shall be determined by tests made by the CONTRACTOR, and the quantity of mixing water to be added to the batch shall be added to that found to be carried by the aggregates to total the rate specified. The number of tests required and the consequent changes in the amount of mixing water to be added will depend on the control exercised in the gradation and moisture contents of the aggregate.

The amount of water shall also include that liquid added to the batch in the form of admixtures.

The amounts and proportions of fine and coarse aggregates to be used in each mix shall be such as to produce a plastic, workable mix, free from harshness, which can be readily placed into the corners and angles of the forms and around reinforcement and other embedded work without undue accumulation of water laitance on the surface, and

such that there will be no honeycombing in the structure.

Proportions of fine and coarse aggregates shall be such that the ratio for the coarse to the fine aggregate shall not be less than one (1) nor more than two (2). On all work under these specifications, a cubic yard of concrete shall contain not less than six (6) sacks (564 lbs.) of cement or cement and fly ash mixture.

501-3.6 BATCHING AND MIXING CONCRETE. Mixing of concrete shall be done in a rotary batch mixer of a type acceptable to the ENGINEER. The volume of the mixed material for each batch shall not exceed the manufacturer's rated capacity of the mixer.

The batch materials shall be delivered to the mixer measured accurately to the required proportions and shall be mixed continuously for not less than one and one-half (1½) minutes after all materials including water are in the mixer during which time the mixer shall rotate at the speed recommended by its manufacturer. The entire batch shall be discharged before recharging the mixer. The mixer shall be cleaned as required to insure adequate and complete mixing.

In lieu of jobsite mixing, ready mixed concrete meeting the requirements specified herein and all applicable requirements of ASTM C94 may be approved provided the quantity and rate of delivery of materials will be such as to permit unrestricted progress of the work in accordance with the placing schedule. When the air temperatures are above 90°F, the concrete shall be discharged within one (1) hour. When air temperatures are below 90°F, the concrete shall be discharged within a maximum of one and one-half (1½) hours or 300 revolutions of the drum, whichever comes first, after the introduction of the mixing water to the cement and aggregates.

Truck mixers shall be equipped with a means by which the number of revolutions of the drum, blades, or paddles may be readily verified.

Two copies of complete data concerning mixing and transportation methods shall be submitted to the ENGINEER for approval.

501-3.7 COLD WEATHER. When the temperature is below 40°F for more than three (3) days, or when there is a probability that such temperature will occur during the twenty-four (24) hour period after placing, special provisions shall be taken. Except as otherwise specified, mixing, placing, and protection shall be in accordance with the latest edition of the Portland Cement Association Manual entitled "Design and Control of Concrete Mixtures." Curing shall be specified in Subsection 501-3.14.

Frozen concrete shall be immediately removed upon direction of the ENGINEER and replaced with new concrete at no expense to the Owners.

In order to maintain the temperatures specified, the concrete shall be entirely enclosed with tarpaulins, polyethylene plastic sheets, commercial insulating blanket, or bat insulation, and all fuel and suitable heating equipment and the necessary labor and supervision shall be furnished. Unvented heaters shall not be used. Only commercial

insulating blanket or bat insulation will be permitted as a covering without addition of heat. Full responsibility for the protection of the work shall be under this section.

During freezing weather, temperature records shall be kept by the CONTRACTOR and furnished to the ENGINEER daily showing the temperature at four-hour intervals of the outside air, of the air in the coldest part of the enclosure near the concrete, of the concrete as it is placed, and of the concrete in place at such points as the ENGINEER may direct.

501-3.8 HOT WEATHER. Concrete materials shall be placed at the lowest practicable temperature except as specified in Subsection 501-3.7 for cold weather. When hot weather conditions exist that would seriously impair the quality and strength of the concrete, the concrete shall be placed in accordance with the latest edition of the Portland Cement Association Manual entitled "Design and Control of Concrete Mixtures," except as otherwise specified herein.

During hot weather conditions, the temperature of the concrete immediately before it is placed in the forms shall be between 50°F and 90°F.

Shaved ice may be used in the mixing water to reduce the temperature of the concrete at the mixer, but there shall be no ice in the concrete when it is discharged from the mixer.

Retarder admixes shall not be used to control the setting time of the concrete.

501-3.9 SUBGRADE. Subgrades for placing concrete shall be prepared in accordance with Section 200 "Earthwork" and shall be damp but not wet before the concrete is placed. Hand tamping of subgrades will not be permitted. Approved mechanical type shall be used. A minimum of 4 inches of subgrade preparation and compaction testing shall be incidental to other items.

The CONTRACTOR shall engage an independent testing laboratory approved by the ENGINEER to perform subgrade compaction tests. Subgrade compaction tests in accordance with ASTM D1557 shall be performed and reported at the following frequencies:

- a. One for every 12 lots of new sidewalks, driveways, and/or driveway widenings.
- b. One for every 20 repairs of sidewalks, driveways, curb and gutters, and valley gutters.
- c. One for every 400 square feet (SF) of full depth pavement repair.
- d. Two for each new construction unit where 1,000 linear feet (LF) or less of curb and gutter is constructed.
- e. One for each valley gutter placed.

f. One for each 750 square yards (SY) of concrete pavement placed.

Should it become necessary to require an additional number of initial compaction tests, over and above the number specified, the ENGINEER will consider additional testing as extra work.

501-3.10 NON-BITUMINOUS BASE COURSE. Base Courses, when called for on the plans or designated by the ENGINEER, shall be prepared in accordance with Section 300 "Base Courses" and shall be damp but not wet before concrete is placed.

501-3.11 FORMS. After the subgrade and base course, if required, have been graded and compacted, the forms shall be set and secured in such a manner as to prevent bulging away from a true line when poured and tamped with concrete, and said forms shall be constructed of wood or steel. If made of wood, they shall not be less than one and 1 ½ inches and one side planed smooth. The top edge of each form shall be true and straight and when set and secured shall conform to the grade of the finished pavement. All forms shall be clean and coated with oil or other approved material before the concrete is placed. Forms shall have a depth not less than the depth of the concrete to be constructed.

501-3.12 PLACING CONCRETE. The subgrade shall be sprinkled directly ahead of the placing of concrete. The concrete shall be placed on the moist subgrade and spread uniformly to the required depth with as little handling as possible and shall be mechanically vibrated to the forms or header boards to prevent voids and honeycombed surfaces. The concrete shall be consolidated so as to produce a uniformly dense concrete and so as to flush sufficient mortar to the surface to permit a proper finish without additional water added to the surface. Excessive water, laitance, or other inert material shall be floated from the surface.

501-3.13 SURFACE FINISH. Concrete pavement surfaces shall be wood-floated to a true and even plane and steel troweled. The CONTRACTOR shall provide factory made straight edges, ten (10) feet in length for use in checking forms and final finish of all pavement sections. The maximum allowable deviation from a true plane shall be 1/4 inch in 10 feet on the top and face of forms and all exposed surfaces of the finished pavement section.

New Pavements: After surface irregularities have been removed, and before the concrete attains an initial set, a seamless strip of stiff-fiber artificial grass carpet shall be dragged longitudinally along the full width of the pavement. The surface texture shall be uniformly roughened leaving corrugations in the surface that are uniform in appearance. The width of material in the drag shall be in contact with the full width of the pavement. The drag shall be operated off of a string line with its leading edge attached to bridge riding on the forms or adjacent slabs. The drag shall be maintained clean and free from encrusted mortar. A drag that cannot be cleaned shall be replaced with new fabric.

Repaired Pavements: After the irregularities have been removed and before the concrete attains an initial set, a broom shall be drawn transversely across the pavement. The brooming shall be sufficient to leave significant marking in the pavements.

501-3.14 PROTECTION AND CURING. All concrete work shall be carefully protected from sun, wind, storms, and travel until thoroughly set, and the CONTRACTOR will be held responsible and must make good at the CONTRACTOR's expense any damage from any cause until approved and accepted by the ENGINEER. A chemical curing agent shall be used, provided it is applied in accordance with the manufacturer's specifications and conforms to ASTM C309, Type 2 (white pigmented).

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Avoid premature drying by either applying an approved curing compound in accordance with manufacturer's recommendations and approved by the ENGINEER, or by completely covering concrete with an approved moisture barrier to reduce evaporation.
- C. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- D. Grade site to maintain positive drainage away from new concrete.

501-3.15 CONTRACTORS STAMPS OR NAME PLATE. The CONTRACTOR shall mark in each 3,000 square feet of pavement, either by stamping or inlaying, an approved metal plate, with CONTRACTOR's name, address, and year in which the pavement was constructed. The stamped letter shall be 1 inch high and ¼ inch deep. If a metal plate is used, the top of the plate shall be flush with the top of the pavement. CONTRACTOR's stamp must be approved by the ENGINEER prior to beginning of the construction year. CONTRACTOR shall be responsible for changing date on the stamp each year.

501-3.16 CONCRETE DISPOSAL. The disposal area(s) for this item shall be within a 9-mile radius of the project when said area is specified on the plans, in the Special Provisions, or by the ENGINEER. When a disposal area is not specified, the CONTRACTOR shall be required to provide such an area which shall be approved by the ENGINEER or haul to the City of Mandan Landfill Facility and pay the required disposal fees.

501-3.17 SAWING CONCRETE. All concrete sawing designated on the plans and/or as directed by the ENGINEER shall have a minimum depth of 3 inches.

Prior to sawing, an inspection of the adjacent slab shall be made to determine if any hairline cracks exist. If any hairline cracks exist, the saw cut line may be positioned so the cracked area may be removed.

501-3.18 SELECT BACKFILL. The material furnished under this item shall be bedding material in accordance with Section 801-2.9 or recycled concrete "readywash" type material and shall be mechanically tamped in place in layers not exceeding 6 inches in depth.

501-3.19 BACKFILL. The newly constructed concrete pavement shall be backfilled within 14 days and compacted in accordance with Section 202.

501-3.20 Joints. Joints in concrete pavement shall be of the design specified and shall be constructed at the spacings and locations shown. The CONTRACTOR shall be responsible to establish joint locations as approved by the ENGINEER.

Transverse Contraction Joints. The contraction joints shall consist of weakened planes created by either sawing, inserting preformed inserts, or forming grooves in the pavement surface on small areas. The location of the grooves to be formed or sawed shall be clearly and accurately marked on the plastic concrete surface by the CONTRACTOR. When specified, the contraction joints shall include a load transfer device.

Sawed contraction joints shall be cut to the required dimensions with proper equipment. Concrete saws shall be adequately powered and furnished with suitable blades to effectively cut pavement joints to required dimensions. Each blade of multiple-blade saws shall be maintained in accurate alignment to the other blades. A device shall be provided to guide the saw along the required joint alignment. Manual guidance of the saw will be permitted if specified results are obtained. A sufficient amount of sawing equipment shall be available to maintain required progress and provide prompt replacement in case of breakdown. Adequate artificial lighting shall be provided for night sawing.

The time and sequence of sawing shall be adjusted so all joints are cut before uncontrolled cracking occurs, and to permit sawing without excessive raveling. Joints shall be sawed within 24 hours to prevent uncontrolled cracking. Uncontrolled cracking that occurs shall be routed, cleaned, and sealed according to 601-3.24, at the CONTRACTOR's expense. Immediately after sawing, the joint shall be flushed with water under sufficient pressure to remove residue left by the sawing operation. If an uncontrolled crack occurs within 5 feet of a proposed joint location before or during sawing, the joint shall be omitted and sawing of the joint discontinued. Any joint sawed within 5 feet of an uncontrolled crack shall be repaired at the CONTRACTOR's expense. When sawing is performed before removing side forms, the initial saw cut shall extend to within ½ inch or less of the side forms. If the forms have been removed, the saw cut will be extended to the edges of the slab. Any curing media removed during sawing shall be immediately replaced.

Formed Contraction Joints. A formed contraction joint shall be constructed by installing an approved preformed insert into the plastic concrete before final surface finishing. The inserts shall be vibrated into place or installed in a groove formed by a

vibrating cutting bar. The inserts' top edges shall be flush with the concrete surface. Any voids, depressions, or ridges of concrete caused by installing inserts shall be filled or removed by hand-finishing methods and the surface across the joint shall be straight edged according to 501-3.13. The groove formed by the inserts shall be perpendicular to the pavement surface, true to the required alignment, and continuous along the full length of the joint. Inserts, except those designed to remain, shall be removed without damage to adjacent concrete.

When specified for use with transverse contraction joints, the dowel bars shall be held in the specified position parallel to the slab surface and to the centerline within a tolerance of 1/8 inch per foot vertically and horizontally. The dowel bar assembly shall be an approved metal supporting device securely staked to the roadbed and shall hold the dowel bars at the correct spacing, alignment and elevation. The position of these load transfer devices shall be accurately marked with steel pins, or other precise methods, to locate the transverse joint over the center of the dowels. After the dowel bar assembly is staked and the roadbed and the dowel bars are held firmly in place, the assembly ties running parallel to the dowel bars shall be removed to allow for free movement of the dowel bars.

A thin uniform coat of multipurpose lithium grease, NLGI Grade #2, shall be used as the release agent. The release agent shall be applied to the entire length of the dowel bars within two hours of being covered with concrete.

Transverse Construction Joints. A transverse construction joint shall be installed at the end of each day's pour and whenever the elapsed time between placement of successive batches or loads of concrete exceed 45 minutes. Transverse construction joints shall be installed halfway between two normally spaced transverse joints.

The transverse construction joint shall be formed by installing an approved dowel splicer bar basket assembly. The assembly shall hold the dowel splicer bars parallel to the centerline and slab surface. The dowel splicer bars shall be placed with a tolerance of 1/8 inch per foot vertically and horizontally. The assembly shall be staked perpendicular to the centerline and marked. The CONTRACTOR shall pave over the assembly far enough to maintain the elevation of the top of the slab. A full depth saw cut shall be made to expose the dowel splicer bar, the excess concrete shall be disposed of and the threaded dowel extension bar shall be installed.

After the adjacent slab is placed, the construction joint shall be sawed and sealed as specified.

Other Concrete Joints. Other concrete joints shall be formed by an approved header shaped to conform to the cross section of the slab being placed. The header shall be rigid and secure to prevent bulging or displacement while adjacent concrete is being placed and finished. The face of the header in contact with the concrete shall be perpendicular to the pavement surface and shall be at right angles to the pavement centering. A two-piece or other approved header shall be designed to accommodate proper placement of any dowel bars or reinforcement extending across the joint and to

allow removal without damage to the concrete.

The concrete adjacent to the header shall be thoroughly consolidated by an internal vibrator or other approved methods. Segregated or improperly consolidated concrete shall be removed after the pavement has been finished, and the surface adjacent to the header shall be edged to the specified radius.

Longitudinal Weakened Plane Joints. Planes of weakness for longitudinal joints shall be created by sawing grooves in the pavement surface. Grooves shall be sawed to meet dimensions shown and shall be true to the required alignment of the joint.

Longitudinal Construction Joints. The longitudinal joint between adjoining, separately constructed lanes of pavement shall be constructed as shown on the plans. This joint shall be a keyed joint with tie bars. Tie bars across longitudinal construction joints shall be at the locations, spacing, and depth shown. Tie bars may be bent at right angles against the form to the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed. The tie bars may be inserted through small, accurately positioned holes in the side forms. Two-piece connectors may also be used, if approved by the ENGINEER.

All dowel bars, drilled in dowels, dowel bar baskets, tie bars, headers, dowel bar basket assemblies, and sawing of longitudinal and transverse joints shall be considered incidental to concrete pavements placed or repaired and accepted by the ENGINEER.

501-3.21 EXPANSION JOINTS. Expansion joints, which are specified to be sealed, shall be constructed with the top of the expansion joint material 1/2 inch to 3/4 inch lower than the adjacent concrete or form.

501-3.22 SEALING OF JOINTS. All joints specified herein or in the standard details shall be sealed within fourteen (14) days of the construction.

Just before sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound. Joint faces shall be dry when seal is applied. Material for seal applied hot shall be stirred during heating to prevent localized overheating.

The joint filling shall be done without spilling material on the exposed surface of the concrete. Any excess material on the surface of the concrete shall be removed immediately and the concrete surface cleaned. The use of sand or similar material to cover the seal shall not be permitted. Joint sealing material shall not be placed when the air temperature in the shade is less than 32°F, unless approved by the ENGINEER.

501-3.23 DRILLED IN DOWELS. Dowels shall be drilled into widened, existing, or repaired concrete pavements. Transverse dowels shall be 1¼" x 18" long smooth or #9 x 18" deformed (reinforcing bar).

Holes drilled for dowels shall be located at mid depth of the slab and spaced at 12 inches on center in accordance with the standard details or as directed by the ENGINEER. Transverse doweled holes shall be air blown clean to the back of hole. For smooth dowels, inject high-viscosity epoxy (meeting AASHTO M-235 Class III) into the back of the hole with a pressurized caulking apparatus. Insert 1¼" x 18" smooth dowel to allow air to escape and ensure completely filled holes with bars permanently fastened to the existing concrete. Apply small form to face of hole to keep epoxy from flowing out and remove it prior to placing concrete. Align smooth dowel bars with the pavement direction parallel to the plane of the surface. Lightly coat the end of smooth dowel, extending into the concrete with grease.

Longitudinally #6 x 18 inches deformed bars (grade 40) shall be installed at 4 feet on center. Drills shall be mounted on a rigid frame to provide proper position and alignment. The holes shall be a maximum diameter of 1 3/8 inches transversely and 7/8 inch longitudinally. Dowel bars shall be located at mid-depth of the slab and spaced as indicated on the details or as directed by the ENGINEER. The cost for drilled in dowels shall be considered incidental.

501-2.23A DRILLED IN DOWELS FOR OTHER THAN CONCRETE PAVEMENT.

Dowels or reinforcing steel shall be drilled into all widened, existing, or repaired concrete slabs or curbs. Dowels shall be ½ x 12" long smooth or deformed #4 x 12" (reinforcing bar)

Holes drilled for dowels or deformed bars shall be 5/8 inch in diameter and shall be centered on the slab thickness and perpendicular to the surface of the slab and spaced at 12 inches on center for transverse joints and every 2 feet for longitudinal joints or as directed by the ENGINEER.

501-3.24 JOINT AND CRACK SEALING. Random cracks narrower than ½ inch and existing joints in Portland Cement Pavement and Curb and Gutter shall be sealed as directed by the ENGINEER. Before sealing, each joint shall be thoroughly cleaned mechanically of all dust, dirt, concrete scale, or other foreign matter and blown out with a jet of compressed air. The joint face shall be clean and dry when the joints are sealed. Joints shall not be sealed when the air temperature is below 40°F.

Joints shall be sealed within 1/4 inch of the surface.

501-3.25 SAW AND SEAL. Repaired working joints and random cracks on Portland Cement Pavements and Curb and Gutters shall be sawed and sealed as follows:

Random Cracks (for uncontrolled cracks only, not settled or displaced cracks)

Saw and seal any single, transverse uncontrolled crack that penetrates the full slab length.

All uncontrolled cracking and repaired working joints shall be sawed and sealed to the following dimensions:

Sawed Joint Width, Inches	Sealant Bead Thickness, Inches	Backer Rod Diameter, Inches	Minimum Sawed Joint Depth, Inches	Backer Rod Placement Depth, Inches
1/2	1/4	5/8	1 1/4	1/2
5/8	5/16	3/4	1 1/2	9/16
3/4	3/8	1	1 3/4	7/8
7/8	7/16	1	1 3/4	11/16
1	1/2	1 1/4	2	3/4

Joints shall be sawed to the nearest 1/8 inch in width and to the nearest 1/4 inch in depth.

The joint shall be cleaned of any materials such as rocks, dirt, oil, asphalt, paint, rust, and blown out with compressed air immediately prior to installing sealant. Backer rod, if utilized, shall be 25 percent larger than joint width and installed full width of joint repair. Sealant shall be installed from inside the joint with an approved mechanical device. Sealant shall be filled to 1/4 inch below pavement surface. Sealant shall conform to Section 501-2.9. Joints to be sealed by this method will be marked by the ENGINEER.

Compression joint material within 1/2 inch from surface of pavement shall be removed and sealed, which will be paid at the unit price bid for joint and crack sealing.

501-3.26 FULL DEPTH SLAB REPAIR. This work shall consist of removal and replacement of full depth concrete pavement as follows:

Except where joints form the edge of the repair, the edges of the repair area shall be sawn full depth with a diamond or carborundum blade. If the full depth cuts are made in more than one pass, the final depth cut shall be made immediately following the partial depth cuts. Transverse cuts shall be made perpendicular to centerline, and longitudinal saw cuts shall be made parallel to centerline. Saw cuts which extend into concrete which will remain shall be only long enough to guarantee a full depth cut of the repair area and shall be sealed according to 501-3.24. Concrete shall be removed within 24 hours of the sawing. When the repair area is repaired, the edges shall be reasonably free of frays or spalls at the pavement surface. The cost of removing, hauling, and disposing of existing concrete and sealing saw cut overruns shall be included in the unit price bid for full depth repair.

Existing concrete shall be removed with minimum disturbance of existing subgrade. All voids which existed below the repair area shall be filled and compacted with material meeting requirements of Section 302 of City of Mandan Standard Specifications – Stabilized Gravel Base as directed by the ENGINEER. The cost of hauling, placing, and compacting the material shall be incidental to the full depth repair items. Any over depth removal unauthorized by the ENGINEER shall be replaced and compacted as above at the CONTRACTOR's expense.

At joints designated by the ENGINEER, dowel bars shall be drilled transversely and longitudinally at full depth repair areas into existing concrete faces and sealed in accordance with Section 501.

Specifications for concrete mix and placement shall conform to Section 501 with the following exception:

Concrete for full depth repair shall be a 7.4 bag mix with a minimum water content of 4.75 gal./bag of cement. The cement used for repair work shall be Type III cement meeting the requirements of AASHTO M75. Water reducing and set acceleration may be achieved through the use of a commercial admixture which meets AASHTO Specification M194 Type A, C, or E. A design of this concrete mix shall be submitted in accordance with 501-3.3. Existing joints whether longitudinal or transverse through an area removed for full depth repair shall be sawed within 72 hours of concrete placement and sealed in accordance with 501-3.24 "Joint and Crack Sealing." Mechanical jointing will not be allowed in these repair areas.

501-3.27 CURB AND GUTTER REPAIR. This item shall include standard curb and gutter (8" or 6" gutter) and standard curb removed and replaced. Curb and gutter removed shall be removed to the closest joint. If the curb is cracked, a joint shall be sawed. The joint shall be no closer than 5 feet to the existing joint in place. All joints not broken adjacent to the repair shall be sawed.

501-3.28 CASTING ADJUSTMENTS. Construction materials, methods, and measurements and payments shall conform to Section 1206.

501-3.29 WRAPPED UTILITY BOXES. Construction materials, methods, and measurements and payments shall conform to Section 1206.

501-3.30 CONDUIT. Conduit as specified in Section 1001-2.3 and paid by Section 1001-4.11 shall be installed 24 inches below top of curb or above the existing street light wires and below all new concrete pavements where street light wires are planned to be installed or are existing. For driveway widenings, the existing duct shall be extended using similar materials as in place. When street lighting wire splicing is required and approved by the ENGINEER, splices, in conformance with Section 1001, shall be installed at the outside edges of new concrete and shall be paid for as an extra cost.

All conduit installed on new or repair work shall be indicated by stamping the concrete with the letter "C" on either side of the improvement and over the conduit. The letter "C" shall be 2 3/8 inches high and 3/16 inch in thickness and stamped 1/4 inch deep.

501-4 MEASUREMENT AND PAYMENT

501-4.1 AIR-ENTRAINED PORTLAND CEMENT CONCRETE PAVEMENT. Air Entrained Portland Cement Concrete Pavement shall be measured by the square foot (SF) as indicated and paid for at the unit price bid for "PCC Pavement" complete in

place and accepted by the ENGINEER. Pavement thickness shall be as designated in the bid item.

501-4.2 JOINT AND CRACK SEALING. Joint and Crack Sealing shall be measured by the linear foot (LF) and paid for at the price bid for "Joint and Crack Sealing" complete in place and accepted by the ENGINEER.

501-4.3 SAW AND SEAL JOINTS. Saw and Seal Joints shall be measured by the linear foot (LF) and paid for at the price bid for "Saw and Seal Joints" complete in place and accepted by the ENGINEER.

501-4.4 FULL DEPTH REPAIR. Full Depth Repair shall be measured by the square foot (SF) and paid for at the price bid for "Full Depth Repair" for area sawed, removed, replaced, and sealed complete in place and accepted by the ENGINEER.

501-4.5 SAWING CONCRETE. Sawing concrete shall be measured by the linear foot (LF) and paid for at the unit price bid for "Concrete Sawing" completed to the required depth and approved by the ENGINEER.

501-4.10 SELECT BACKFILL. Select Backfill when listed on the proposal form shall be measured by the ton (TON) and paid for at the unit price for "Select Backfill" complete in place and accepted by the ENGINEER.

501-4.11 ADDITIONAL PORTLAND CEMENT. During the course of construction, the ENGINEER may need to require the use of additional Portland Cement in the concrete mix. When requested and used, all cement greater than six (6) sacks (564 lbs.) per cubic yard of concrete except for full depth repairs shall be measured by the sack (94/lbs.) and paid for at the unit price bid for "Additional Portland Cement" complete in place and accepted by the ENGINEER.

501-4.12 Cold Weather Protection -- Curb & Gutter. Cold weather protection of curb and gutter when listed on the proposal form shall be measured by the "Lineal Foot" (LF) and paid for at the unit price bid for "Cold Weather Protection -- Curb & Gutter" complete in place and accepted by the Engineer.

501-4.13 Cold Weather Protection -- Concrete Pavement. Cold weather protection of curb and gutter when listed on the proposal form shall be measured by the "Square Foot" (SF) and paid for at the unit price bid for "Cold Weather Protection -- Concrete Pavement" complete in place and accepted by the Engineer.

SECTION 502 – POZZOLINIC PORTLAND CEMENT

502-1 DESCRIPTION

This work shall consist of a base course composed of pozzolonic air entrained Portland Cement Concrete, constructed on a prepared subgrade in accordance with these specifications and in conformity with dimensions and typical cross sections shown on the plans and with lines and grades established by the ENGINEER.

502-2 MATERIALS

502-2.1 GENERAL. Prior to construction, the CONTRACTOR shall submit for approval by the ENGINEER a Certified Analysis of materials listed in Subsections 502-2.2, 502-2.3, and 502-2.5.

502-2.2 PORTLAND CEMENT. Portland Cement shall meet the requirements of Subsection 501-2.2.

502-2.3 AGGREGATE. The CONTRACTOR shall notify the ENGINEER of the source of the aggregate which is proposed for use on the contract. Sufficient time shall be allowed so that sampling and testing can be completed prior to the beginning of construction. During the construction period, the CONTRACTOR shall at all times make available to the ENGINEER samples of aggregate.

The aggregate used shall conform to the requirements of ASTM C33. The aggregate shall be tough, durable, and sound, and shall consist of crushed stone, crushed gravel, gravel, sand gravel, sand, or other natural granular and approved material which have essentially the same qualities and meet all the requirements when combined within the following limits for gradation.

Square Mesh Sieve Size	Percent By Weight Passing
$\frac{3}{4}$ "	100
$\frac{1}{2}$ "	70-100
No. 4	40-70
No. 8	30-60
No. 16	22-50
No. 30	15-41
No. 50	10-30
No. 100	6-20
No. 200	4-10
Max. % Shale & Soft Rock	5
Max. % Clay (0.005 mm)	5
Max. L. A. Abrasion Loss	40

502-2.4 WATER. Water shall meet the requirement of Subsection 501-2.6.

501-2.5 FLY ASH. Fly Ash shall meet the requirements of Subsection 501-2.2a.

502-3 CONSTRUCTION REQUIREMENTS

502-3.1 GENERAL. The CONTRACTOR shall furnish all labor, materials, and services necessary for and incidental to the completion of all work as shown on the drawings and specified herein. All machinery and equipment owned or controlled by the CONTRACTOR which is proposed for use on the work shall be of sufficient size to meet the requirements of the work and shall be such as to produce satisfactory work; all work shall be subject to the inspection and approval of the ENGINEER. The CONTRACTOR shall employ at all times a sufficient force of workmen of such experience and ability that the work can be prosecuted in a satisfactory and workmanlike manner.

Identify an acceptable concrete wash out area(s). Dumping concrete or concrete waste within the CITY’s right-of-way or easements including the storm water system or on adjacent properties is prohibited without the written consent of the CITY or the affected property owner.

502-3.2 MATERIALS STORAGE.

(a) Cement. Cement storage shall meet the requirements of Subsection 501-3.2 (a).

(b) Aggregates. Aggregate storage shall meet the requirements of Subsection 501-3.2 (b).

(c) Fly Ash. Fly ash shall be stored in weather tight facilities to be approved by the ENGINEER.

502-3.3 ADVANCE DESIGN OF CONCRETE MIXES. Design and tests for each concrete mix to be used under this contract shall be made using aggregates which have been approved for this work. Mixes shall be designated in accordance with the following: to attain the required strength at the allowable slumps and air content using the specified aggregates, water, and fly ash.

Cement	70 lbs.
Fly Ash	400 lbs.
Water Reducing Admixture	19 oz.
Air Entrained Admixture	9 oz.
Aggregate	3100 lbs.
Water	35 gal.

Advance tests of the proposed mix shall be made in accordance with ASTM C192. Six (6) standard 6-inch diameter compression test cylinders shall be made for the mix design, three (3) to be tested at seven (7) days and three (3) to be tested at fourteen (14) days. Concrete tested shall contain all required and/or proposed admixtures and in

addition to the testing required by ASTM C192 shall be tested for air content by ASTM C231.

The advance mix design and approved results of seven (7) day tests on cylinders made from the advance mix design is required three (3) days prior to concrete placement. The required minimum strength of the concrete shall be 1200 psi at seven (7) days.

Tests for aggregates as required in Subsection 501-2.4 and 501-2.5 may be a part of these tests. The above tests shall be repeated if necessary because of changes in materials or unsatisfactory results.

502-3.4 CONCRETE TESTING. During the process of the work and for each different mix of concrete, a set of three (3) standard 6-inch diameter compression test cylinders shall be made in the field and tested for each day's operation where fifteen cubic yards (15 CY) of concrete or more are placed. The cylinders comprising one set will be made from the same sample of concrete and one (1) cylinder tested at seven (7) days, one (1) at fourteen (14) days, and one (1) at twenty-eight (28) days. The required minimum strength of the concrete shall be 1200 psi at seven (7) days, 1500 psi at fourteen (14) days, and 2000 psi at twenty-eight (28) days.

Slump tests made in accordance with ASTM C143 shall be made as necessary to maintain desired concrete consistency. Slump tests shall also be made and recorded for each sample of concrete used in making test cylinders. The maximum allowable slump of the concrete mix shall be 4 inches. Air content in accordance with ASTM C231 shall also be tested and recorded for each sample of concrete used in making test cylinders. The air content shall fall within the range of 4 percent to 7 percent.

If test cylinders show a strength at twenty-eight (28) days which fails to meet the specified strength for the class of concrete from which the sample is taken, then the concrete presented by such test cylinder shall be further tested by the ENGINEER. If such further tests indicate that concrete has been placed which does not meet the compressive strength requirements established by this specification, the concrete shall be rejected and shall be removed and replaced with new work of the specified strength unless otherwise instructed by the ENGINEER. All testing shall be incidental and any replacement shall be done at the CONTRACTOR's expense including retesting.

502-3.5 PROPORTIONING MATERIALS. Concrete shall be composed of Portland Cement, fly ash, aggregate, and water admixtures as specified. The mix shall be designed in accordance with Subsection 502-3.3 of these specifications.

The amount of water specified shall include the surface moisture carried by the aggregates at the time of mixing. This amount of water shall be determined by tests made by the CONTRACTOR and the quantity of mixing water to be added to the batch shall be added to that found to be carried by the aggregates to total the rate specified. The number of tests required and the consequent changes in the amount of mixing water to be added will depend on the control exercised in the gradation and moisture contents of the aggregates.

The amount of water shall also include the liquid added to the batch in the form of admixture.

The amount and proportion of aggregate to be used in each mix shall be such to produce a plastic, workable mix, free from harshness, which can be readily placed into the corners and angles of the forms and around reinforcement and other embedded work without undue accumulation of water or laitance on the surface, and such that there will be no honeycombing in the structure.

502-3.6 BATCHING AND MIXING CONCRETE. Batching and mixing concrete shall meet the requirements of Subsection 501-3.6.

502-3.7 COLD WEATHER. Cold weather shall meet the requirements of Subsection 501-3.7.

502-3.8 HOT WEATHER. Hot weather shall meet the requirements of Subsection 501-3.8.

502-3.9 SUBGRADE. Subgrade shall meet the requirements of Subsection 501-3.9.

502-3.10 NON-BITUMINOUS BASE COURSE. Non-bituminous base course shall meet the requirements of Subsection 501-3.10.

502-3.11 FORMS. Forms shall meet the requirements of Subsection 501-3.11.

502-3.12 PLACING CONCRETE. Placing concrete shall meet the requirements of Subsection 501-3.12.

502-3.13 SURFACE FINISH. Concrete pavement surfaces shall be wood-floated to a true and even plane. The CONTRACTOR shall provide factory made straightedges, 10 feet in length for use in checking forms and final finish of all pavement sections. The maximum allowable deviation from a true plane shall be ¼ inch in 10 feet on the top and face of forms and all exposed surfaces of the finished pavement section.

502-3.14 PROTECTION AND CURING. Protection and curing shall meet the requirements of Subsection 501-3.14.

502-3.15 JOINTS. Contraction joints shall be sawed to a minimum depth of one and one half inches 1½ inches. Contraction joint spacing shall be a maximum of 8 feet.

502-4 MEASUREMENT AND PAYMENT

502-4.1 POZZOLONIC PORTLAND CEMENT CONCRETE. Pozzolonic Portland Cement Concrete shall be measured by the cubic foot (CF), square yard (SY), or square foot (SF) as indicated on the proposal and paid for at the unit price bid complete in place and accepted by the ENGINEER.

SECTION 503 – CONTROLLED DENSITY FILL (CDF)

503-1 DESCRIPTION

This work shall consist of placement of a controlled density fill which is a mixture of coal fly ash, water, sand, and Portland Cement that flows like a liquid, sets up like a solid, is self-leveling, and requires no compaction or vibration to achieve maximum density.

503-2 MATERIALS

503-2.1 PORTLAND CEMENT. Portland Cement shall conform to the requirements of ASTM C150, Type 1. If for any reason cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

503-2.2 FLY ASH. Fly Ash shall conform to ASTM C618, Class C or F.

503-2.3 FINE AGGREGATE (SAND). Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces performance characteristics of the ASTM specified herein will be accepted, except as follows:

Sieve Size	Percent Passing by Weight
<u>3/4 inch</u>	<u>100</u>
No. 200 (0.075mm)	0-12

503-2.4 WATER. Water used in mixing shall be free of oil, salt, acid, alkali, sugar, vegetable matter, or other substances injurious to the finished product.

Dyes and other methods of coloring the backfill material may be incorporated if desired.

503-3 CONSTRUCTION REQUIREMENTS

503-3.1 PROPORTIONS. The CONTRACTOR shall submit, to the ENGINEER, a mix design including the proportions and source of material, admixtures, and dry cubic yard batch weights. The mix shall contain up to 100 pounds of cement and 300 pounds of fly ash per cubic yard, with the remainder of the volume composed of sand, water, and any approved admixtures.

a. COMPRESSIVE STRENGTHS

CDF shall be designed to achieve a 28-day compressive strength of 80 to 130 psi when tested in accordance with ASTM C39. There should be no significant strength gain after 28 days. Test specimens shall be made in accordance with ASTM C31 except that the samples will not be rodded or vibrated and shall be air cured in their molds for the duration of the cure period. The air content, tested in accordance with ASTM C231, shall fall within the range of 10 percent to 12 percent.

b. CONSISTENCY.

Consistency of the fresh mixture shall be such that the mixture may be placed without segregation. A desired consistency may be approximated by filling an open-ended 3-inch diameter cylinder, 6 inches high to the top, with the mixture and the cylinder immediately pulled straight up. The correct consistency of the mixture will produce an approximate 8-inch diameter circular – type spread without segregation. Adjustments of the proportions of materials should be made to achieve proper solid suspension and flowable characteristics, however, the theoretical yield shall be maintained at 1 cubic yard for the given batch weights.

503-3.2. PLACEMENT

a. PLACEMENT. CDF may be placed by any reasonable means from a mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed in such a manner that structures or pipes are not displaced from their desired final position and intrusion of CDF into undesirable areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as approved by the ENGINEER. Each placement of CDF shall be as continuous as possible. If CDF is placed in more than one layer, the base layer shall be free of surface water and loose or foreign material prior to placement of the next layer.

b. LIMITATIONS OF PLACEMENT. CDF shall not be placed on frozen ground. Mixing and placing may begin when the air temperature is at least 35 degrees and rising. At the time of placement, CDF shall have a temperature of at least 40 degrees. Mixing and placement shall stop when the air temperature is 40 degrees and falling or when the anticipated air temperature will be 35 degrees F or less in the 24-hour period following proposed placement.

503-3.3 CURING AND PROTECTION

a. CURING. The air content of the CDF should be maintained at temperatures above freezing for a minimum of 72 hours. If the CDF is subject to temperatures below 32 degrees, the material may be rejected by the ENGINEER if damage to the material is observed.

b. PROTECTION. The CDF shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi is obtained. The CONTRACTOR shall be responsible for providing evidence to the ENGINEER that the material has reached the desired strength. Acceptable evidence shall be based upon the CONTRACTOR's testing firm compressive test results.

503-4 MEASUREMENT AND PAYMENT

503-4.1 CONTROLLED DENSITY FILL. When not incidental to other items, Controlled Density Fill shall be measured by the cubic yard (CY) or other method indicated on the

proposal and paid for at the unit price bid complete in place and accepted by the ENGINEER.