DIVISION 500 - STRUCTURES

SECTION 520 -- PORTLAND CEMENT CONCRETE

Description

1.1 General. This work shall consist of furnishing and placing portland cement concrete as shown on the plans or ordered.

1.2 Classes of Concrete. The following classes of concrete are included in these specifications:

Table 520-1 -- Classes of Concrete

Class	Minimum Expected 28 Day Compressive Strength [1] PSI	Minimum Amt. of Cement Per Cu. Yd. of Concrete [2] LBS	Maximum Water/Cement Ratio [3]	Percent Entrained Air %
AA [4]	4000	658	0.380	5 to 8
AA	4000	658	0.444	5 to 8
A	3000	611	0.464	4 to 7
B	3000	564	0.488	3 to 6
T [5]	3000	620	0.559	---
C	2000	489	0.532	

[1] See 3.1.6 TESTING.

[2] The cement content of concrete to be pumped shall be increased by 0.5 bag per cubic yard (one bag weighs 94 pounds).

[3] For fly-ash mixtures, the water/cement ration of the concrete mix will be based on the water cementitious (cement + fly-ash) ratio of the mix. The water to cementitious ratio shall not exceed those listed in Table 520-1, less 0.02. The maximum water/cement ratios listed for Concrete Class B and T are for design purposes only.

[4] When high range water reducing admixture is specified.

[5] Fly-ash not allowed in Class T.

1.2.1 Unless otherwise shown on the plans, the specified class of concrete shall be used in the following applications.

(a) Footing concrete shall be Class B.
(b) Concrete above footings shall be Class A.
(c) Abutment backwall concrete shall be Class AA.
(d) Concrete bridge decks shall be Class AA.
(e) Concrete foundation seals shall be Class T.

1.2.2 Retarding admixtures and high range water reducing (HRWR) shall not be used in deck concrete when the existing air temperature is below 10 C (50 F) or forecasted to drop below 10 C (50 F) within 24 hours after completion of placement.

1.2.3 The use of high range water reducing admixture may be required or used to expedite construction.

Materials

2.1 Cement.

2.1.1 Portland Cement shall be Type II or Type IV conforming to AASHTO M85 or M 240 as appropriate, unless otherwise shown on the plans or permitted. Mill test reports shall be furnished with each delivery of cement.

2.1.2 Cement used in visible portions of the work shall be the same brand, type and color unless otherwise permitted.

2.1.3 Cement containing lumps or partial set, shall not be used.

2.2 Aggregates.

2.2.1 General.

2.2.1.1 All aggregates shall be thoroughly washed unless otherwise permitted. Aggregates shall be stockpiled for a minimum of 24 hours before use.

2.2.1.2 The Contractor shall make arrangements for the Engineer to secure samples from all stockpiles in sufficient time to complete testing and mix design prior to starting concrete operations. If the stockpiles aggregates are approved, similar aggregates from the same sources will be considered acceptable, subject to restrictions of the item for which the aggregates are to be used. No change in the source or character of the aggregates shall be made without prior notification to and approval by the Engineer. Failure of any test taken prior to starting each placement will result in cancellation of the placement until corrective measures have been taken and the aggregates have been approved.

2.2.1.3 Unless frozen aggregates are dispersed during mixing, they shall not be permitted.

2.2.2 Fine Aggregate.

2.2.2.1 Fine aggregate shall consist of sand, stone screenings or other inert materials with similar characteristics or a combination thereof. Tests for organic impurities shall be in accordance with AASHTO T 21 and T 71.

2.2.2.2 Required Grading:

Table 520-2 -- Fine Aggregate

Sieve Size	Percentage by Weight Passing
3/8 inch	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	10 - 30

No. 100	2 - 10
No. 200	0 - 3

2.2.2.2.1 The gradation of fine aggregate from any source shall be reasonably uniform and the fineness modulus as determined by AASHTO M 6 shall lie between 2.5 and 3.1. Fine aggregate showing a variation in fineness modulus greater than 0.2 above or below that upon which the mix was designed, may be rejected.

2.2.3 Coarse Aggregate.

2.2.3.1 Coarse aggregate shall consist of crushed stone, gravel or other approved inert materials with similar characteristics or combinations thereof, having hard, strong, durable particles free from surface coating and injurious amounts of soft, friable or laminated pieces and free of alkaline, organic or other harmful matter. Material passing the No. 200 sieve as determined by AASHTO T 11 shall not exceed 10 percent by number as determined by Corps of Engineers Specifications CRD-C119, on a 3 to 1 ratio and a minimum of 100 particles. The percent of wear shall not exceed 40 as determined by AASHTO T 96.

2.2.3.2 Required Grading:

Table 520-3 -- Coarse Aggregate

Class of Concrete	A [1], B, and T	A and AA	Overlay
Std. Stone Size	467	67	89
Nominal Size	1-1/2" to No. 4	3/4" to No. 4	3/8" to No. 16
SIEVE SIZE	PERCENTAGE by WEIGHT PASSING		
2 inch	100		
1-1/2 inch	95-100		
1 inch		100	
3/4 inch	35-70	90-100	
1/2 inch			100
3/8 inch	10 - 30	20-55	90-100
No. 4	0-5	0-10	20-55
No. 8		0-5	5-30
No. 16			0-10
No. 50			0-5

[1] 1-1/2 inch maximum size coarse aggregate for Class A concrete may only be used with approval of the Engineer.

2.2.3.3 Unless otherwise specifically permitted, coarse aggregate shall be furnished and stockpiled in a minimum of 2 sizes and the amount of each size to be used shall be determined

by combining the individual gradations of each stockpile mathematically to provide a well graded mixture conforming to Table 520-3.

2.2.4 Fly-Ash and Ground Granulated Blast Furnace Slag.

2.2.4.1 Fly-ash shall normally conform to Class F as described in AASHTO M 295 and shall meet the requirements of 2.2.4.3. If the Contractor proposes to use Class C fly-ash, the Contractor shall submit to the Department its design mix, which shall include the percent substitution, ratio of substitution and water-cementitious ratio, and shall meet the other requirements of this section. Ground Granulated Blast Furnace Slag (GGBFS) shall be Grade 120 slag meeting the requirements of AASHTO M 302.

2.2.4.1.1 Only one source of fly-ash or ground granulated blast furnace slag shall be used on any one project.

2.2.4.2 The Contractor is required to supply the Engineer with written notification as to the details of supply of fly-ash or ground granulated blast furnace slag and a request for acceptance consideration of tile fly-ash or ground granulated blast furnace slag. The notification shall include: Fly-ash or ground granulated blast furnace slag source and the name and address of the company supplying the fly-ash or ground granulated blast furnace slag, and the name and telephone number of the individual who will be responsible for the company in coordinating the sampling and acceptance considerations of the fly-ash or ground granulated blast furnace slag.

2.2.4.3 Requirements. Fly-ash shall conform to the chemical, physical and methods of sampling and testing requirements of AASHTO M 295 except in the optional physical requirement, the multiple factor shall be 120 percent maximum. In addition, the fly-ash shall be subjected to the Air-Entrainment of Mortar Test as listed in ASTM C 311 and shall conform to the requirements as listed in the optional physical requirements of AASHTO M 295 for the uniformity requirements. Ground granulated blast furnace slag shall conform to the chemical, physical, and methods of sampling and testing requirements of Ground Iron Blast Furnace Slag for Use In Concrete and Mortars as listed in AASHTO M 302 except that the slag shall meet the requirement for slag activity index Grade 120.

2.2.4.4 Certification. The Contractor shall furnish the Engineer three copies of the materials test results and certification from each fly-ash or ground granulated blast furnace slag source proposed for use. The certification shall state the fly-ash or ground granulated blast furnace slag used on the project meets the requirement as stated in 2.2.4.3 and shall be for a specific, identifiable quantity.

2.2.4.5 Fly-ash or ground granulated blast furnace slag concrete shall be used only when placing concrete during the months of April to October unless special precautions are taken. Winter use of fly-ash or ground granulated blast furnace slag concrete (November through March) shall be continuously cured and kept from freezing until strength requirements are achieved.

2.3 Chemical Admixtures

2.3.1 Air entraining admixtures shall meet the requirements of AASHTO M 154.If the Contractor requests permission to use an unfamiliar air entraining admixture, evidence shall be submitted to prove that the admixture complies with AASHTO M 154. The evidence shall be based on tests performed in a laboratory of a State Highway Department, the FHWA, or in a laboratory which is regularly inspected by the Cement and Concrete Reference Laboratory of the National Bureau of Standards. Tests may be made upon samples taken from a quantity submitted by the Contractor for use on the project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

2.3.1.1 When using high range water reducing admixture the air entrainment admixture shall be Vinsol Resin or approved equal conforming to AASHTO M 154.

2.3.2 Water reducing admixtures shall meet the requirements of AASHTO M 194, Type A.

2.3.2.1 Water-reducing, high-range admixtures shall conform to AASHTO M 194 Type G.

2.3.2.2 Corrosion inhibitor admixture shall conform to AASHTO M 194 (ASTM C 494) Type C.

2.3.3 Water reducing and retarding admixtures (herein referred to as retarding admixtures), shall meet the requirements of AASHTO M 194, Type D.

2.3.4 Calcium chloride may only be used with specific permission of the Engineer.

2.3.5 Chemical admixtures shall be approved by the Engineer.

2.3.6 Admixtures shall be stored in a suitable building in such a manner as to permit easy access and identification and to protect the admixtures from freezing. Admixtures will be rejected if precipitation has occurred in the container.

2.4 Blank.

2.5 Water.

2.5.1 Water for use in concrete shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 500 parts per million of chlorides as Cl nor more than 1000 parts per million of sulfates as SO4. In addition water used in portland cement concrete shall be free from iron, tannic acid, and other impurities which may cause staining or discoloration.

Water from municipal supplies approved by the State of New Hampshire Department of Environmental Services will not require testing, but water from other sources will be sampled and tested before being used in concrete, once per source unless otherwise directed. Tests shall be made in accordance with AASHTO T 26.

The hydrogen ion concentration (pH) shall be determined electrometrically or colorimetrically and be between pH 4.5 and pH 8.5.

The water shall not contain any impurities in amounts sufficient to cause unsoundness or marked change m the time of setting in the cement with which it is mixed, nor a reduction mortar strength of more than 10 percent compared to the results obtained with distilled water .

2.6 Curing Materials for Concrete.

2.6.1 Burlap shall conform to AASHTO M 182. The use of worn burlap, burlap with holes or burlap reclaimed from uses other than curing concrete, will not be permitted.

2.6.2 Sheet materials shall be waterproof paper, polyethylene film or white burlap-polyethylene sheeting conforming to AASHTO M 171.

2.6.3 Liquid curing compound shall be Type ID, Class B or Type 2, Class B conforming to AASHTO M 148 except as modified herein. The vehicle shall have a resin base and contain no waxy compounds. The compound shall dry to touch within 4 hours when applied at the rate of 1 gallon per 200 square feet of concrete.

2.6.4 Water for curing shall meet the requirements of 2.5, above.

2.7 Preformed Expansion Joint Fillers for Concrete. Preformed Expansion Joint Fillers for Concrete shall conform to AASHTO M 153, Type II, unless Type III is shown on the plans.

2.8 Concrete Bonding Agent. Concrete bonding agent or acrylic bonding agent to be used as shown on the plans or ordered.

2.9 Storage of Concrete Materials.

2.9.1 The handling and storage of concrete materials shall be such as to prevent their segregation or contamination by foreign materials. When directed, the aggregates shall be stored on suitable platforms or on clean, level, paved surfaces if segregation or contamination continues to occur. Aggregates shall be stored in separate stockpiles sufficiently removed from each other to prevent the aggregates from becoming intermixed. To prevent spillage from one bin to the next, buckets used to fill the bins shall not be wider than the clear opening of the bins. Evidence of intermixing, segregation or contamination will because for rejection.

2.9.2 Unless otherwise permitted, cement shall be stored in approved weatherproof silos or buildings which will protect the cement from dampness. The floors of the buildings shall be sufficiently clear of the ground to prevent the absorption of moisture. When storage in the open is permitted, the cement shall be placed on raised platforms and completely covered with a waterproof covering.

2.9.3 The locations of the stockpiles and the facilities for storing cement, shall be subject to approval.

2.10 Concrete Mixes.

2.10.1 The concrete mix shall be composed of a mixture of aggregate, cement, water and chemical admixtures as required. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mix meets the grading requirements of Table 520-4 or Table 520-5.

2.10.2 The concrete mix design limits given in Table 520-4 or Table 520-5 indicate the master ranges of mixes permissible under this specification. No work shall be started on a project until the Engineer approves a mix design appropriate for the raw materials and blends of approved aggregates available for the specific project. The mix design shall be within the master ranges indicated for the particular class of concrete specified. The mix design for each mix shall establish a single percentage aggregate passing each required sieve size in accordance with Table 520-4 and Table 520-5, a cement factor and water cement ratio as shown in Table 520-1. Gradings which range from the maximum of one sieve size to the minimum of the next, will not be permitted. The mix design for each mix shall be in effect until modified in writing by the Engineer.

2.10.2.1 Should a change in sources of material be made, a new mix design shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new mix design.

2.10.3 Master Ranges for Combined Aggregates.

Table 520-4 -- Coarse Aggregate With Specific Gravity Less Than 2.700

	Concrete Classes* A [1], B, and T			Concrete Classes** A, AA		
Sieve Size	Min.	Desired	Max.	Min.	Desired	Max.
	Percentage by Weight Passing			Percentage by Weight Passing		
1-1/2 inch	95	100	100			
1 inch		80			100	
3/4 inch	56	68	80	64	97	100
1/2 inch		57			77	
3/8 inch	38	46	55	51	62	73
No. 4	31	35	39	37	42	47
No. 8		29			34	
No. 16	16	23	30	19	27	35
No. 30		14			17	
No. 50	4	7	10	4	8	12
No.100	1	2	3	1	2	4
No.200			2			2

*Class A[1], B and T based on fine aggregate content of 32 to 36 percent of the total aggregate.
**Class A and AA based on fine aggregate content of 38 to 42 percent of the total aggregate.

See footnote to Table 520-3

Construction Requirements

3.1 Proportioning and Batching

3.1.1 Proportioning

3.1.1.1 All ingredients shall be measured by weight unless otherwise permitted. Scales shall be approved beam type with a separate tare beam or spring-less dial type, accurate to within 0.5 percent of the total load.

3.1.1.2 Cement shall be weighed on a separate scale. Weights for bagged cement when its use is permitted will be assumed to be 94 pounds; fractional bags shall not be used.

3.1.1.3 Aggregate weights shall be dry weights adjusted for moisture.

3.1.1.4 Mixing water shall consist of free moisture on the aggregates, ice if added, and water added to the batch. Water added to the batch shall be measured by weight or an approved volumetric method to an accuracy of 1 percent. Water meters shall be so installed that they are unaffected by pressure or temperature changes in the water supply. Graduated tanks shall be equipped with outside taps and valves for checking their calibration.

3.1.1.5 Each approved admixture shall be added to a separate portion of the fine aggregate or water as recommended by the manufacturer to eliminate premixing of the additives. Separate calibrated standpipes with positive action discharge tubes, readily visible from the batching area, shall be provided at all concrete producing plants regardless of metering devices.

3.1.1.6 The substitution of fly-ash for cement should not be more than 20 percent by weight unless approved. The substitution of ground granulated blast furnace slag for cement should not be more than 25 percent by weight unless approved. The ratio of substitution of cement to fly-ash or ground granulated blast furnace slag shall be 1:1 by weight. Substitution of fly-ash or ground granulated blast furnace slag shall not be made for blended cements and high early strength cements.

3.1.2 Batching.

3.1.2.1 Batch plants shall meet the requirements of AASHTO M 157 except as modified herein. The plants shall have a minimum of 4 bins: one bin for fine aggregate and one bin for each required size of coarse aggregate. Each bin shall discharge efficiently and freely into the weighing hopper.

3.1.2.2 All new, replaced, or major modification of existing batching plants shall be equipped for fully automatic proportioning and batching of all ingredients including admixtures.

3.1.2.2.1 Automatic batching plants shall be controlled by means of an approved automatic batch selector set to accurately deliver in proper sequence the designed mix proportions and admixtures required for the batch. The batch selector controls shall be locked and sealed during operation. Changes in selector controls or weight settings shall not be made without authorization. Provisions shall be made to vary the size of the batch without affecting the proportions of the design mix.

3.1.2.2.2 All batch equipment in automatic plants shall be interlocked to prevent the discharge of any ingredient into the system until all batching controls have been cleared of the previous batch and the discharge gates and supply valves are closed.

3.1.2.2.3 A moisture meter equipped with automatic adjustable compensating controls shall be installed to accurately and continuously measure the moisture content of the fine aggregate. The moisture compensating dial shall automatically adjust the amount of batch water added and the batch weight of the fine aggregate consistent with the variations of free moisture in the fine aggregate.

3.1.2.2.4 If the automatic proportioning devices become inoperable or malfunction during a concrete placement, the plant may operate manually for the completion of the pour. If the breakdown is readily correctable or is due to a condition within the producer's control, the plant will not be permitted to operate. If unavailability of parts or service or any condition beyond the producer's control exists, written permission may be given to operate the plant manually for a specified period. Accuracy shall be maintained as specified in 3.1.1.

3.1.2.2.5 When concrete with high range water reducing admixture is used 5 ounces of an approved high range water reducing admixture per 100 pounds of cement shall be added at the plant, unless otherwise directed.

3.1.3 Consistency.

3.1.3.1 Mortar proportions shall be kept to the lowest that will provide the desired workability. Mixing water shall be kept to the minimum that will produce the required consistency as measured in accordance with AASHTO T 119, as modified in 3.1.5. Slumps shall be kept within the following limits unless otherwise permitted:

Footings and mass concrete	1 inch - 3 inch
Columns and pedestals	2 inch - 4 inch
Decks and sidewalks	2 inch - 3 inch
Tremie concrete	6 inch - 8 inch
Walls over 18 inch thick	2 inch - 3 inch
Walls 18 inches thick and under	2 inch - 4 inch
Pumped concrete (at mixer)	4 inch maximum
Concrete with high range water reducer	5 inch - 7 inch

3.1.4 Air-Entrainment.

3.1.4.1 Air-entrainment of the required percentage shall be obtained by the use of air-entraining admixture unless otherwise permitted. Air content will be determined in accordance with AASHTO 152 except as modified in 3.1.5.1.

3.1.4.2 The percentage of air-entrainment for pumped concrete shall be taken at the discharge end of the pump line.

3.1.5 Testing.

3.1.6.1 When ordered, test cylinders shall be made in accordance with AASHTO T 141 except that the entire sample for test cylinders and testing air-entrainment and slump may be taken at one time from the middle of the batch. Errors in proportioning or mixing as evidenced by excessive slump will be cause for rejection. Cylinders shall be made and cured in accordance with AASHTO T 23. To determine compliance with Table 520-1 cylinders shall be tested in accordance with AASHTO T 22 and the test strength shall be the average compressive strength of at least two cylinders tested at the end of the 28 day curing period.

3.2 Forms and Falsework.

3.2.1 Drawings and data for forms and falsework shall be submitted in accordance with 105.02.A concrete weight of 150 pounds per cubic foot and a live load of 50 pounds per square foot shall be used in calculations. Adequate provisions shall be made for the effect of vibration and impact on the forms and falsework.

3.2.2 Wood forms and bracing materials shall be of approved lumber, mortar tight, and free of imperfections on exposed surfaces. Forms shall have sufficient studs, wales, and stiffbacks to eliminate bulging and shrinking. Surfaces which will be exposed to view in the final structure shall be formed with plywood unless otherwise specified or permitted. Plywood which will not give a concrete finish essentially equal to new plywood shall not be used. All plywood shall be placed with the grain horizontal.

3.2.3 Forms shall be installed to the lines and grades shown on the plans or ordered. Forms for grade lines exposed to view such as top of curbs, walls, bearing areas, and the like, shall be cut to grade unless otherwise permitted. Wood in contact with the concrete shall be treated with an approved form release compound prior to erection. Cleaning and inspection ports shall be provided as ordered.

3.2.4 Ties and anchorages for use in forms above the top of footings shall be fabricated so as to be removed to a minimum depth of 2 inches without injury to the concrete.

3.2.5 Chamfer strips shall be installed as shown on the plans or ordered. Joints which are to receive external waterproofing shall not be chamfered.

3.2.6 Metal forms shall comply with the pertinent requirements of 3.2.2. Projections into the finished concrete surface will not be permitted. Connection devices shall hold the forms rigidly in alignment and shall be removed without injury to the concrete.

3.2.6.1 Forms made of other materials such as fiberglass or plastic may be used when permitted.

3.2.7 Falsework shall be placed on an approved solid footing or piling. Provisions shall be made for adjusting forms to grade and compensating for settlement during placement of concrete. Improper or inadequate bracing shall be satisfactorily corrected.

3.2.8 Stay in place deck forms shall not be allowed unless specifically allowed on the plans.

3.3 Weepers and Drains.

3.3.1 Four-inch weepers at approximately 10 feet on centers shall be placed at the elevations shown or ordered unless otherwise directed. Coarse gravel or stone shall be placed at the inlets and outlets to permit unobstructed flow of the weepers. An approved geotextile patch may be substituted on the inlet end of weepers in place of the coarse gravel or stone.

3.4 Ready-Mixed Concrete.

3.4.1 General.

3.4.1.1 Ready-mixed concrete is defined as portland cement concrete manufactured for delivery in a plastic state. It shall be in compliance with AASHTO M 157 or as modified herein.

3.4.1.2 Ready-mixed concrete shall be mixed and delivered to the point designated by means of one of the following combinations of operations:

(a) Central-mixed concrete. Mixed completely in a stationary mixer and delivered in a truck mixer operating at agitation speed.

(b) Shrink-mixed concrete. Mixed partially in a stationary mixer and the mixing completed in a truck mixer.

(c) Transit-mixed concrete. Mixed completely in a truck mixer.

3.4.1.3 Non-agitating equipment will not be permitted for transportation.

3.4.2 Mixers.

3.4.2.1 Each mixer shall have metal plate or plates attached in a prominent place by the manufacturer, plainly marked with the gross volume of the drum, the capacity of the drum or container in terms of the volume of mixed concrete, and the mixing and agitating speeds. The volume of mixed concrete shall not exceed 63 percent of the total volume of the drum or container when the concrete is in transit or shrink-mixed, or 80 percent of the total volume when the concrete is central-mixed. Stationary mixers shall be equipped with an acceptable timing

device that will not permit the batch to be discharged until the specified mixing time has elapsed.

3.4.2.2 When loaded to capacity, all mixers shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass, and of discharging the concrete with a satisfactory degree of uniformity at a rate which will not inhibit the rate of placement required. The rate of discharge shall be governed by the speed of rotation and not by restrictions of the discharge opening.

3.4.2.3 Mixers will be subject to inspection as frequently as considered necessary. If found unfit to function properly, the mixers will be disapproved for use until correct operating conditions have been restored. The pickup and throw-over blades shall be replaced or repaired when they have become worn 1 inch or more below the original height of the manufacturer's design, or have become loose, broken, bent, scalloped, or otherwise damaged. Any accumulation of hardened concrete shall be removed.

3.4.2.4 The Engineer may make tests for consistency of individual samples at approximately the beginning, the midpoint, and the end of the load. If the concrete is not of uniform quality, the mixer shall not be used until the condition is corrected and the mixer has been re-inspected and approved.

3.4.3 Mixing.

3.4.3.1 Mixers shall be operated with the limits of their capacity as specified in 3.4.2.1 or as designated by the manufacturer of the equipment, whichever is less, and shall not exceed the speed of rotation designated by the manufacturers.

3.4.3.1.1 When high range water reducing admixture is used, the mix shall be delivered with 2 cubic yards less than the manufacturer's rated capacity for mixing as specified in 3.4.2.1.

3.4.3.2 When shrink-mixed or central-mixed concrete is used, mixing time shall be measured from the time all the solid material is in the drum. The batch shall be so charged that some water will enter in advance of the cement and aggregates and all water will be in the drum by the end of the first one fourth of the specified mixing time.

3.4.3.3 Where mixer performance tests have not been made, the minimum mixing time for mixers having capacities less than 1 cubic yard shall be 1 minute. For mixers of greater capacity, the minimum mixing time shall be increased by 15 seconds for each cubic yard of additional capacity or fraction thereof.

3.4.3.4 When shrink-mixed concrete is used, the mixing time in the stationary mixer shall be at least that required to intermingle the ingredients. After transfer to a truck mixer, mixing at mixing speed and turning at agitating speed will be required as specified in 3.4.3.5.

3.4.3.5 When transit-mixed concrete is used, mixing shall be performed at the site of the work unless otherwise permitted. If the required uniformity is not obtained within 100 revolutions of

the mixer after all ingredients are in the drum, that mixer shall not be used until the condition is corrected. Additional revolutions of the mixer beyond the number found to produce the required uniformity shall be at agitating speed except as stated in 3.4.3.7.

3.4.3.6 Each batch of concrete delivered to the placement area shall be accompanied by a time slip issued at the batching plant bearing the time of charging of the mixer drum with cement and aggregates.

3.4.3.7 Water shall not be added after the initial introduction of the mixing water to the batch except when the slump is unsatisfactory. Such additional water as necessary, up to the amount permitted in Table 520-1, may be added to bring the slump within the limits specified in 3.1.3. The drum shall then be turned an additional 30 revolutions at mixing speed. Water shall not be added at any later time unless permitted.

3.4.3.8 Mixing shall begin within the 30 minute period after the cement has been added to the aggregates unless otherwise permitted.

3.4.3.9 When pumps are used, truck mixers shall be scheduled and adjusted to the capabilities of the pumping units and the rate of placement to provide continuous pumping without excessive waiting time before discharge. Whenever possible, pumps shall be placed so that 2 trucks may discharge into the hopper at the same time. Actual discharge shall be such that the last of the load of one is discharged into the hopper with the beginning or middle portion of the other.

3.4.3.10 Additional high range water reducing admixture, not to exceed the manufacturer's recommendation, may be required to be added at the project to reach slump requirements.

3.5 Placing Concrete.

3.5.1 General.

3.5.1.1 The Contractor shall notify the Engineer at least three working days in advance of each concrete placement to allow for sufficient time to schedule required inspection and testing. A pre-pour conference shall be mandatory prior to any deck placement.

3.5.1.2 Concrete shall not be placed without inspection. Concrete so placed will be removed at the Contractor's expense unless authorized by the Engineer.

3.5.1.3 Approval will be required for alignment and grade, formwork and bracing, reinforcing steel and other inclusions, and the cleanliness of the forms prior to placing concrete.

3.5.1.4 If the Contractor proposes to place concrete by pumping, a detailed plan outlining his proposed method of operation shall be furnished along with a list of the pumping units proposed, the manufacturer's specifications and capabilities of the units, slickline diameter and maximum length of same, diameter and length of any flexible lines proposed, and the allowable continuous pumping pressure of each unit. This information shall be furnished seven days in

advance of the scheduled operation to permit study of the equipment and methods proposed and the satisfactory resolution of any questions arising.

3.5.2 Equipment.

3.5.2.1 All equipment used in placing concrete shall be approved for the particular use intended. Equipment which will be in contact with the fresh concrete shall be mortar- tight and free of caked-on mortar and other contaminants. If other methods are not satisfactory, sandblasting will be required for cleaning.

3.5.2.2 Crane buckets for placing concrete shall be low-slump type unless otherwise permitted. Hooks for handling buckets shall be equipped with a safety device to prevent accidental disengagement.

3.5.2.3 Chutes, when permitted, shall be of approved materials and installed so as to prevent segregation. Any sign of segregation will result in rejection of chuting and utilization of an alternate approved method of placement.

3.5.2.4 Aluminum shall not be used in any equipment where it would be in contact with the fresh concrete.

3.5.2.5 When pumping concrete, the number and lengths of flexible lines shall be kept to the minimum required for distribution. Transition sections used to reduce the diameter of lines shall be of slickline material and shall be as long as possible.

3.5.3 Placing.

3.5.3.1 Concrete shall be placed in its final location as soon as possible after mixing. Any concrete that is not in place 1-1/2 hours after the cement has been added to the aggregate shall not be used unless otherwise permitted. Segregation of the mix or displacement of materials inside the forms will not be permitted.

3.5.3.2 Concrete shall be placed in layers not to exceed 12 inches and placing intervals shall not exceed 30 minutes unless otherwise permitted. Concrete which has attained a partial set shall not be used.

3.5.3.3 In the event of unscheduled stoppage of the work, vertical bulkheads shall be installed to insure a minimum depth of 6 inches of concrete in the next lift of concrete when placement is resumed. See 3.6.2 also.

3.5.3.4 Care shall be taken to keep the concrete pressure on ties and forms within the design limits. Concrete shall not be dropped a distance of more than 5 feet unless contained within a tremie, elephant trunk, or other approved system.

3.5.3.5 Concrete which has attained its initial set shall not be disturbed by personnel, equipment, or other construction operations for a minimum period of 72 hours unless otherwise permitted.

3.5.3.6 Defective sections of concrete shall be removed and replaced or repaired as directed.

3.5.4 Consolidation.

3.5.4.1 Unless otherwise permitted, consolidation of all concrete shall be achieved by the use of approved internal vibrators with a frequency range of 7,000 to 10,000 impulses per minute. Vibrators used in concrete containing epoxy coated reinforcing steel shall be equipped with a non-metallic-coated head. Concrete shall not be moved excessive distances by the use of vibrators.

3.5.4.2 Vibrators shall be inserted vertically into the fresh concrete and withdrawn slowly. Vibration shall continue until consolidation is achieved and stopped before segregation occurs or water is forced to exterior concrete surfaces in appreciable amounts.

3.5.4.3 Concrete shall not be placed at a rate greater than that which can be thoroughly consolidated by the vibrators in use. The number of vibrators required will be based on the maximum predicated rate of placement. At least one reserve vibrator shall be furnished.

3.5.5 Depositing Concrete Under Water

3.5.5.1 Retarding admixture shall be used conforming to 2.3. Unless otherwise specifically permitted, all concrete placed in water shall be placed by tremie. Slump shall comply with 3.1.4.

3.5.5.1.1 Pumping for underwater placement of concrete shall also be into a tremie unless specific permission is given for direct placement by pump lines. Placement by direct pumping, if permitted, will require the hose to be securely fastened to the cofferdam frame at all times to eliminate surging of the hose in the concrete. If at any time the procedure becomes unacceptable, the remainder of the concrete shall be placed by a tremie. Tremie equipment shall be available on site prior to the start of pumping operations.

3.5.5.2 A tremie shall consist of a watertight tube attached to a hopper of approved size with an adequate working space provided around the hopper. The tremie shall be attached to a crane or other approved hoisting equipment to permit lifting and lowering the tremie with sufficient rapidity to control and stop the flow of concrete as required. The equipment shall be capable of moving the tremie over the entire surface of the placement area.

3.5.5.3 At the start of placing operations, and at any time thereafter that the tremie is withdrawn from the concrete, and approved watertight plug shall be inserted into the discharge end of the tremie. The tremie shall be lowered until it rests on the bottom or in freshly deposited concrete. It shall then be checked for leaks. If watertight, the tremie tube and hopper shall immediately be filled with concrete. The hoisting mechanism shall then raise up the tremie to permit the discharge of the concrete without removal from freshly deposited concrete. The

tremie shall then be lowered to stop the flow of concrete before it has dropped below the level of the bottom of the hopper. The hopper shall again be filled and the process repeated until the desired intermediate or final grade is attained. Top concrete surfaces shall be approximately horizontal.

3.5.5.4 Concrete foundation seals shall be placed as shown on the plans or ordered. The elevation of the top of the seal and the required depth may need to be determined after the excavation is completed.

3.5.5.5 Test cores of approximately 2 inch diameter shall be taken through all concrete deposited underwater on rock. The cores shall penetrate a minimum of 1 foot into the rock. One core shall be taken near each corner and one shall be taken near the center. Should evidence of voids, seams or unsatisfactory concrete be discovered, additional cores shall be taken as ordered. Unsatisfactory material shall be removed and replaced or repaired as directed.

3.5.6 Substructure

3.5.6.1 All substructure concrete shall be placed in the dry unless otherwise permitted. Footings shall be placed at the elevations shown on the plans or ordered.

3.5.7 Superstructure

3.5.7.1 Compliance with superstructure concrete placing sequences shown on the plans will be mandatory unless prior approval is secured for an alternate sequence. If a pouring sequence is not shown, the Contractor shall submit his proposed pouring sequence for approval. Sufficient concrete placing units shall be furnished to maintain plasticity requirements.

3.5.7.1.1 When pumping concrete for decks, a sufficient number of pumps including standby units shall be available on site to insure uninterrupted concrete delivery to the placement area.

3.5.7.2 Concrete operations on steel structures shall not start until all temporary falsework and bracing have been removed unless otherwise permitted.

3.5.8 Box Culverts

3.5.8.1 Construction joints shown on the plans or permitted shall be perpendicular to the base slab and normal to the culvert axis. Weepers and drains shall comply with 3.3.

3.6 Joints.

3.6.1 General.

3.6.1.1 All joints not exposed to view in the final structure shall be waterproofed in accordance with 538.

3.6.2 Construction and Contraction Joints.

3.6.2.1 Joints shown on the plans or permitted shall be keyed, doweled, or both as shown or directed. Sizes and spacing shall be as shown or ordered. Horizontal joints will not be permitted unless shown on the plans or occasioned by breakdown of plant or equipment in which case, in addition to 3.5.3.3, planed lumber shall be inserted into the fresh concrete to produce a horizontal line in surfaces which will be exposed to view.

3.6.2.2 When fresh concrete is to be bonded to previously placed concrete, the abutting surface shall be abraded by sandblasting and cleaned by compressed air prior to coating with bonding agent.

3.6.2.3 Where bonding is not desired, the existing concrete shall be coated with an approved form release compound before the adjacent concrete is placed.

3.6.3 Expansion Joints.

3.6.3.1 Expansion joints shall be constructed at the locations shown and in conformity with the details shown on the plans or ordered.

3.6.3.2 Open joint shall be formed at the locations shown on the plans. Inserts shall be fabricated so as to permit removal without damage to the work.

3.7 Concreting in Cold Weather.

3.7.1 General.

3.7.1.1 When the average daily temperature falls below 35 degrees F for more than 1 day, protective measures shall be taken to prevent damage to the concrete from freezing. The Contractor shall submit his proposed protective methods for approval. Concrete shall be protected from freezing for a minimum of 5 days.

3.7.2 Insulation.

3.7.2.1 Insulation shall be an approved blanket, batt of board insulation with a thermal conductivity of less than 0.25 BTU per hour per square foot for a thermal gradient of 1 degree F per inch.

3.7.2.2 Concrete delivery temperature shall be 50 degrees F to 70 degrees F for sections 24 inches or less in thickness and 40 degrees F to 55 degrees F for sections thicker than 24 inches unless otherwise permitted.

3.7.2.3 Insulation shall be applied to the forms in an approved manner similar to those shown in Figure 1 and Figure 2 and with the thickness requirements stipulated in Table 520-6. Insulation with breaks or tears shall be rejected unless satisfactorily repaired. Openings for thermometers shall be provided where ordered. See Figure 3 for typical locations.

3.7.3 Housing and Heating

3.7.3.1 Housing for cold weather concreting shall consist of a framework covered with weathertight plastic or canvas and shall be large enough to completely enclose the work to be heated and to accommodate the heating required elements.

3.7.3.2 Heaters shall be of approved type and shall be furnished in sufficient quantity to maintain the required temperature without creating hot spots in the concrete.

3.7.4 Concrete

3.7.4.1 Concrete shall be brought to the required temperature by the use of heated mixing water or heated aggregates or both. The maximum allowable temperature of water shall be 160 degrees F and the maximum allowable temperature for aggregates shall be 100 degrees F. The heated water shall be added to the aggregates prior to the addition of the cement.

3.7.4.2 If the air temperature and transporting distance prevent the delivery of the concrete at the required temperature without exceeding the maximum allowable temperature in 3.7.4.1, the placement shall be cancelled until such time as the requirements can be met.

3.7.4.3 Forms, reinforcing steel, existing concrete and all other materials which will be in contact with the fresh concrete shall be brought to a temperature of 50 degrees F and all frost shall be removed within the limits of the foundation prior to the placing of the concrete.

3.7.4.4 Concrete shall be placed in the forms as soon as possible after delivery and as rapidly as possible without exceeding form and tie capacities. Tarpaulins or other approved materials shall be used to cover the top openings in forms to prevent heat loss. Only that portion of the form required for placement shall be opened and the opening re- covered between trucks unless otherwise permitted.

3.7.4.5 Finishing shall be completed as rapidly as possible. On areas where item 534.3 is not used, liquid curing compound shall be applied to exposed surfaces immediately after finishing. After the concrete has set, plastic shall be placed over the exposed areas. When insulation is used, a covering of approved insulation or a layer of hay and a tarpaulin shall be placed over the plastic and secured in place.

3.7.4.6 The concrete temperature shall be maintained between 50 degrees F and 100 degrees F for the first 72 hours and between 40 degrees F and 100 degrees for the next 48 hours. The concrete shall then be permitted to cool at a rate not to exceed 1 degree F per hour until it reaches the atmospheric temperature.

3.7.4.7 During cold weather, cofferdams shall remain dewatered and the concrete kept from freezing for 24 hours following placing. After 24 hours, the contractor may allow the cofferdam to flood.

3.7.4.8 Concrete with high range water reducing admixture shall be placed when the air temperature is 50 degrees F and rising. It may be placed when hot water is used and the concrete temperature is maintained in accordance with 3.7.4.6.

Table 520-6 – Insulation Requirements for Concrete Walls, Piers, Abutments, and Floor Slabs Above Ground

	Wall Thickness	Minimum Air Temperature Allowable	
Concrete Class	Feet	For 1" Insulation* (Degrees F)	For 2" Insulation (Degrees F)
B	0.5		14
	1.0		-26
	1.5		-65
	2.0	-10	
	3.0	-20	
	4.0	-23	
	5.0	-25	
A	0.5		6
	1.0		-41
	1.5		-89
	2.0	-22	
	3.0	-34	
	4.0	-38	
	5.0	-40	
AA	0.5		0
	1.0		-56
	2.0	-33	
	3.0	-48	

3.8 Concreting in Hot Weather.

3.8.1 General.

3.8.1.1 The Contractor shall maintain the plastic concrete below 85 degrees F. This may require the addition of ice to the mixing water, sprinkling the forms and reinforcing steel, scheduling the concrete placements for early morning or evening hours, or any other approved methods.

3.8.1.2 After placement, the concrete shall be maintained below 100 F by sunshades, windscreen, fog spray, wet burlap, or other approved methods.

3.8.1.3 If excess water demand or too rapid setting is anticipated, a water-reducing or retarding admixture may be added to the mix in the amounts ordered.

3.8.1.4 When daytime air temperatures exceed 85 degrees F, concrete temperature exceeds 80 degrees F, and in the opinion of the Engineer, satisfactory surface finish cannot be achieved, nighttime or early morning placement may be required. No additional compensation will be allowed for this work.

3.9 Finishing Plastic Concrete.

3.9.1 Surfaces Other Than Decks.

3.9.1.1 All upper horizontal surfaces such as the top of wings, bearing pedestals. and the like shall be finished by placing an excess of material in the forms and screeding off the excess after compaction. The surface shall then be finished by the use of wood, magnesium. cork, canvas, or steel floats as directed.

3.9.1.2 Catwalks shall receive a magnesium float finish.

3.9.1.3 Sidewalks shall receive a broom finish by lightly dragging a broom transversely across the finished concrete to roughen the surface unless otherwise directed. Surfaces beneath bridge rail posts, light pole bases, and the like shall not be broomed.

3.9.1.4 All finishing shall be performed by persons experienced in the use of finishing equipment.

3.9.2 Concrete Decks.

3.9.2.1 All concrete decks shall be finished by the use of approved, self-propelled finishing machines, capable of adjustment for crown and width, and capable of raising the screeds to clear the concrete when required unless specific written permission is given for an alternate method.

3.9.2.2 Screed rails shall be set and checked for the finishing machine to ride on. The rails shall have sufficient rigidity and support to prevent deflection. After the rails are set, the finishing machine shall be placed on the rails and operated over the entire deck as many times as necessary to assure the required depth of concrete and the proper clearances to the reinforcing steel prior to starting the placement.

3.9.2.3 The finishing machine shall follow closely behind the placing and consolidating operation and the placing and finishing operations shall be continuous. See 3.5.3.2.1.

3.9.2.4 All work behind the finishing machine shall be performed from work-bridges. Work-bridges shall have independent movement capability and shall not be attached to the finishing machine. Walking in the concrete behind the finishing machine will not be permitted.

3.9.2.5 As soon as the bleeding has stopped or the sheen has started to disappear, the concrete shall be given a final surface finish by scraping or dragging with an approved float at least 3 ft in length. The float shall be placed on the outer edge of the finished concrete and moved

transversely the full width of the deck. The finished edge shall be parallel to centerline. Each subsequent pass shall lap the preceding pass by at least 1/2 the length of the float.

3.9.2.6 Thc finished concrete shall have the required crown and grade and the surface shall not vary from either by more than 1/8 inch in 10 ft. Sharp projections shall not be left which might damage the waterproofing materials.

3.10 Curing Concrete.

3.10.1 All exposed surfaces of concrete shall be cured in accordance with the requirements of Table 520-7. All water used to wet cure concrete shall conform to 2.5.

TABLE 520-7-CONCRETE CURING

Type of Construction	Curing Method	Curing Period (Days)	Minimum Number of Days Before Membrane Application	
			Horizontal	Vertical
Bridge Decks w/o HRWR	c	7	14	14
Concrete w/ HRWR	c	3	5	5
Concrete w/ Fly-Ash	a,b	7*	14	7
Concrete treated w/ 534 or 537	a	7		
All other concrete	a,b	7	14	7

*May be extended if design strength is not achieved, see 3.10.2.

Cure Method "a" - Concrete shall be kept moist until it can support curing covers at which time it shall be completely covered with a vapor-proof barrier conforming to 2.6.2. Water shall be reapplied as necessary to keep the surface of the concrete wet for the entire 7day cure period.

Cure Method "b"- Immediately after finishing, all exposed surfaces shall be treated with a liquid curing compound conforming to 2.6.3 at the rate of 1 gallon per 200 square feet or by fog spray sprinkling or ponding of water conforming to 2.5 or any combination of the above, when the weather permits.

Cure Method "c" - The surface shall receive a wet burlap cure for at least 72 hours. Failure to apply wet burlap conforming to 2.6.1 within 30 minutes after the concrete has been deposited shall be cause for rejecting the work. During the first 24 hours, the burlap shall be kept continuously wet by means of an approved automatic sprinkling system. After 24 hours, the Contractor may cover the wet burlap with a 4 mil minimum polyethylene film for an additional 48 hours in lieu of using a sprinkling or wetting system although wetting under the polyethylene may be

required. For concrete bridge decks without HRWR the cure shall continue for an additional 4 days.

3.10.2 Fly-Ash Concrete

3.10.2.1 When curing concrete with fly-ash, the 7 day curing period specified in 3.10.1 shall be extended, if necessary, to assure the concrete attains the design strength.

3.10.2.2 The concrete cylinders for mixes containing fly-ash shall be made and sealed by covering with water tight caps, and remain on site under environmental conditions similar to that of the structure until 24 hours prior to testing. The curing shall be in accordance with the procedure as specified in AASHTO T 23, Section 9.4, except that the cylinders shall only be stripped prior to testing.

3.10.2.3 Precautions shall be taken to assure that the concrete cylinders are not subjected to a more severe environmental condition than the structure.

3.10.2.4 All cylinders shall be laboratory tested immediately after stripping. Laboratory moist curing is not permitted.

3.11 Loading Concrete.

3.11.1 Removing Forms.

3.11.1.1 Unless otherwise permitted, load bearing forms may not be removed until concrete test cylinders have attained 80 percent of their minimum expected compressive strength. If not controlled by such tests, the following periods may be used as a guide: For deck slabs, centering, and falsework, 14 days; for all other parts, 3 days or as directed.

3.11.1.2 The provisions of 3.10 shall apply if forms are removed prior to completion of the curing period.

3.11.2 Loading Restrictions.

3.11.2.1 Nothing shall be placed on the concrete prior to the minimum time periods specified in Table 520-8.

TABLE 520-8 CONCRETE LOADING

Type of Construction	Minimum Time to Loading after Placement of Concrete
Substructure concrete including footings	80% of design strength or 7 days
Box culvert base slabs	5 days
Superstructure concrete	- 3 days and 1800 psi for curb placement - 80% of design strength for light vehicular loads when permitted - 14 days and 3200 psi respectively for membrane and paving placement; and - 28 days and 4000 psi for legal traffic loads

3.12 Finishing

3.12.1 General

3.12.1.1 Surface finishes shall be classified as follows:

Class 1, Ordinary Finish

Class 2, Rubbed Finish

3.12.1.2 Class 1, Ordinary Finish. Fins and projections shall be removed from all surfaces except those which will not be exposed. On all exposed surfaces the cavities produced from ties, honeycomb spots, broken corners or edges, and all other holes and defects shall be thoroughly cleaned and saturated with water for not less than 3 hours. These areas shall then be carefully pointed and trued with mortar composed of the same brand of cement and fine aggregate mixed in proportions of the concrete being finished. Mortar used in pointing shall not be more than 1 hour old. The mortar patches shall be cured as specified in 3.10. All expansion joints in the completed work shall be carefully tooled and free of mortar. The joint fillers shall be left exposed for their full length with clean, true edges.

3.12.1.3 Class 2, Rubbed Finish. After removal of forms, holes and imperfections shall be filled with mortar conforming to 3.12.1.2. After the mortar has thoroughly set, the concrete shall be saturated with water for at least 3 hours. The surfaces shall then be rubbed with a medium coarse Carborundum stone and a small amount of mortar until all voids have been filled and all marks and projections have been removed and the surface is uniform. This surface shall be left until all concrete to be rubbed above it has been similarly treated.

3.12.1.3.1 A Class 2, rubbed finish, shall be given to all copings and also to any other concrete that contains imperfections and which will be exposed to view unless otherwise permitted. All other surfaces shall receive a Class 1, ordinary finish.

3.12.1.4 Holes which will not be exposed to view may be filled with asphalt cement when permitted.

3.12.1.5 After all concrete surfaces have received their initial rubbing, the next procedure shall consist of rubbing the concrete with a fine Carborundum stone and water until a smooth uniform texture is obtained.

3.12.1.6 The final procedure shall consist of rubbing the concrete with dry burlap to remove loose powder. Should the final surface be unsatisfactory, a repetition of the above procedures will be required.

Methods of Measurement

4.1 Concrete "Class B and T" will be measured by the cubic yard unless otherwise indicated, and in accordance with the following:

4.1.1 Except as specified below, the volume will be computed to the nearest 0.1 of a cubic yard by the prismoidal method using the dimensions as shown on the plans or as ordered. No allowance or measurements will be made for materials not entering permanently into the work or those used without proper authorization. No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel, expansion joint materials, scuppers, weepers, conduits, or the tops of piles.

4.1.1.1 Concrete Class T will be measured to the neat lines as shown on the plans. Seals on ledge will be measured to the ledge limit ordered to be removed.

4.1.1.2 When the Engineer determines that it is impracticable to measure the volume by dimensions, the volume will be based on the actual yield as determined in the field in accordance with AASHTO T 121.

4.2 Concrete above footings (Class A) and concrete bridge decks (Class AA) will be measured as units.

4.2.1 If changes in the work which change the volume of concrete to be furnished are ordered by the Engineer, the unit will be adjusted as follows:

4.2.1.1 A factor developed by dividing the number of cubic yards ordered by the estimated quantity shown on the plans shall be applied to the unit.

4.3 When more than one unit is specified in the contract, separate item numbers will appear for each separate and complete unit.

Basis of Payment

5.1 The accepted quantities of concrete "Class B and T" will be paid for at the contract price complete in place.

5.2 Concrete above footings (Class A) and concrete bridge deck (Class AA) will be paid for at the contract lump sum complete in place.

5.3 Foundation Seal.

5.3.1 Seals shown on the plans will be paid for at the contract unit price per cubic yard for 520.6.

5.3.2 Seals ordered, but not shown on the plans, will be paid for at the contract unit price per cubic yard for Class T concrete if Class T is included in the proposal.

5.3.3 Seals requested by the Contractor and permitted, but not deemed necessary, will not be paid for.

5.4 Waterproofing of construction joints shown on the plans or ordered will be paid for as noted.

5.5 Reinforcing steel will be paid for under 544.

5.6 Weepers and concrete admixtures will be subsidiary.

Pay items and units:

520.	Concrete Class ___	Cubic Yard
520.12	Concrete Class, Above Footing	Unit
520.6	Concrete Class T, Foundation Seal	Cubic yard
520.7	Concrete Bridge Deck	Unit

SECTION 534 -- WATER REPELLENT

Description

1.1 A water repellent of the type specified shall be applied to the concrete surface shown on the plan or as ordered.

Materials

2.1 Boiled linseed oil mixture shall conform to AASHTO M 233 and shall be composed of 50 percent double boiled linseed oil and 50 percent petroleum spirits, by volume.

2.2 Silane and siloxane shall be tested in accordance with National Cooperative Highway Research Program Report 244, "Concrete Sealer for Protection of Bridge Structures" and shall meet the following criteria:

2.2.1 A reduction in chloride retention content in concrete shall be a minimum of 87 percent when applying silane at a rate 100 square feet per gallon or siloxane at a rate of 125 square feet per gallon.

2.2.2 During the soaking period test, a weight gain of not more than 0.82 percent shall occur after 21 days.

Construction Requirements

3.1 General. All caulking, patch, and joint sealers shall be installed prior to application of the water repellent. Concrete surfaces shall have cured a minimum of 14 days and shall be dry prior to the application of water repellent. Resin or wax base curing compound shall not be used on new concrete where sealers are to be applied.

3.2 Surface preparation shall be by a sand or water blasting of the surface to remove dust, dirt, oil, wax, other coating efflorescence and other foreign materials.

3.3 Linseed oil. Water repellent with linseed oil may be applied on horizontal surfaces by any approved means. If a sprayer is used, the nozzle shall be held within 18 inches of the concrete or as directed. On vertical surfaces the mixture may be applied by spraying, brushing, or rolling and applications shall be started at the base and coated upward to the top.

3.3.1 Two coats of linseed oil mixture shall be applied. The first shall be at a rate sufficient to obtain maximum penetration, taking care to prevent the material from discoloring curbs or other parts of the work. The second coat shall be applied as a seal coat, with attention given to the lighter appearing areas. The rate of application shall be approximately 0.025 gallons per square yard for the first coat and 0.015 gallons per

square yard for the second coat, or an average of approximately 25 square yards per gallon. The second application shall not be made until the concrete has regained its dry appearance and in any event not until at least 24 hours passed.

3.3.2 The linseed oil -- petroleum spirits mixture is flammable and all due precautions shall be observed.

3.4 Silane-Siloxane. Water repellent (silane-siloxane) shall be applied at the rate recommended by the manufacturer.

3.4.1 A test application shall be performed on the surface to be treated, to insure compatibility, using the same equipment to be used on the project. After a minimum of three days, the Engineer shall test for waterproof effectiveness by applying water to the surface. If the water beads up and is not readily absorbed, the test is positive.

3.4.2 Vertical surfaces shall have water repellent (silane-siloxane) applied in two applications, wet on wet, beginning at the bottom. After allowing the first application to penetrate the concrete surface approximately three to five minutes, apply second coat in the same manner. Less material will be required to saturate the surface on the second application. The combined application shall not exceed the rate specified above.

3.4.3 Water repellent (silane-siloxane) shall be applied only when the substrate surface temperature is 45 F and rising. Sealer shall be maintained between 65 F and 85 F during application. Do not apply when substrate surface temperature exceeds 85 F.

3.4.4 The Contractor shall follow the manufacturer's instructions in the method of preparation of the concrete and application of the sealer.

Method of Measurement

4.1 Water repellent with linseed oil will be measured by the gallon in accordance with 3.3.1.

4.2 Water repellent (silane-siloxane) will be measured by the gallon in accordance with 3.4.

Basis of Payment

5.1 The accepted quantity of water repellent will be paid at the contract unit price per gallon, complete in place.

Pay Items and units:

534.1	Water Repellent with Linseed Oil	Gallon
534.3	Water Repellent (Silane-Siloxane)	Gallon

SECTION 544 - REINFORCING STEEL

Description

1.1 This work shall consist of furnishing and placing reinforcing steel as shown on the plans or ordered.

Materials

2.1 Bar reinforcement shall be Grade 60 or as shown on the plans.

2.1.1 Billet-steel bars shall conform to AASHTO M 31.

2.1.2 Rail-steel bars shall conform to AASHTO M 42.

2.2 Welded steel wire fabric shall conform to AASHTO M 55.

2.3 Bundled reinforcement shall be used only as shown on the plans or with written permission.

2.4 Foreign steel. The use of foreign steel will be permitted only after approval by the Engineer upon suitable certification from a recognized domestic laboratory.

2.5 Epoxy Coated Reinforcing Steel.

2.5.1 Epoxy coated reinforcing steel shall meet the requirements of AASHTO M 284.

2.5.2 A written certification by the manufacturer of the powdered epoxy resin attesting to the AASHTO M 284 requirements shall be furnished for each lot to the Engineer by the Contractor.

2.5.2.1 The certificate shall also contain the insignia or other similar statement that the plant is a currently approved fusion-bonded epoxy coating applicator, as defined by the Concrete Reinforcing Steel Institute (CRSI) Plant certification Program.

2.5.3 The epoxy coating applied to the bars shall be uniform and smooth and shall provide a film thickness of 10 mils +/- 2 mils after curing.

2.5.4 All chair and bar supports used for the installation of the epoxy coated reinforcing bars shall be either (1) coated with the powder resin, (2) coated with an acceptable plastic material, or (3) coated with a material approved in writing by the Engineer.

Construction Requirements

3.1 Bar List. The Highway Department's bar list and bending schedule is made for the purpose of arriving at an estimate of quantities. The Contractor shall verify the quantity, size, and shape of the bar reinforcement against the structure drawings and make the necessary corrections, if any, before ordering. Errors in the bar list and bending schedule shall not be cause for adjustment of contract unit price.

3.2 Surface condition of reinforcement. The reinforcing steel, at the time concrete is placed, shall be free of dirt, paint, oil, or other organic materials that may adversely affect or reduce bond. Metal reinforcement coated with firmly bonded rust, mill scale, or a combination of both shall be considered satisfactory provided the minimum dimensions and weight of a hand wire-brushed test specimen are not less than the applicable specification requirement. Rust or mill scale which is difficult to remove by vigorous scrubbing with a wire brush shall be considered firmly bonded to the steel.

3.3 Bending. Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on the plans or permitted. Only competent people shall be employed for cutting and bending, and proper appliances shall be provided for such work. Should the Engineer approve the application of heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

3.4 Placing and fastening. Reinforcing steel shall be free from mortar and other objectionable substances, shall be accurately placed as shown or ordered, and shall be securely blocked and tied unless otherwise permitted. Blocking shall be by rust-resistant chairs unless otherwise permitted. Tack welding will be prohibited except upon special written approval of the Engineer. This provision also prohibits welding form ties to the reinforcement.

3.5 Splices. Reinforcing steel shall be furnished in the full lengths indicated on the plans unless otherwise permitted. Splices shall be made as shown on the plans or as permitted. No splices will be permitted at points where the section does not provide a minimum distance of 2 inches between the splices and the nearest adjacent bar or surface of the concrete. The bars shall be rigidly clamped or wired at all splices. Sheets of metal mesh shall overlap each other sufficiently to maintain uniform strength and shall be securely fastened at the ends and edges.

3.5.1 Splices made with mechanical connectors shall be as detailed on the plans or as permitted and shall develop at least 125% of the specified yield strength of the reinforcing bar being spliced. The minimum concrete cover over the reinforcing steel as shown on the plans shall be maintained
at the mechanical splice.

3.5.1.1 The Contractor shall submit two mechanical connectors connecting two (12 in) sections of reinforcing steel of each size per lot per project. Connector and reinforcing steel assemblies will be tested by the Department.

3.6 Handling, fabrication, and repair of epoxy coated reinforcing steel shall be in conformance with the applicable sections of AASHTO M 284/M 284M.

3.6.1 Amend section 12.2 of AASHTO M 284/M 284M to read as follows:

12.2 Damage caused to epoxy coated bars during the shipment and handling at the project site need not be repaired in cases where the damaged area is 1/8 by 1/8 in or smaller and the sum of all damaged areas in each 1 ft length of bar does not exceed 0.25 percent of the bar surface area in each 1 ft length of bar. All damaged areas larger than 1/8 by 1/8 in shall be repaired. The total bar surface area covered by patching material shall not exceed 5 percent.

3.6.2 If stored outdoors, the bars shall be covered for protection against the elements and in such a manner that condensation does not form on the bars. The bars shall not be exposed to sunlight for periods exceeding three months.

3.7 Epoxy coated reinforcing steel which requires cutting shall be sawn. No flame-cutting will be allowed. Cut ends of bars shall be recoated with epoxy as soon as possible and before visible oxidation occurs.

Method of Measurement

4.1 Reinforcing steel of the type specified will be measured by the pound by computing the theoretical weights of the reinforcing steel placed as shown on the plans or ordered, based on the following table:

Table 1 -- Reinforcing Steel Weights

Size Bar #	3	4	5	6	7	8	9	10	11	14	18
Lb. per Lin. Ft.	0.376	0.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313	7.65	13.60

Basis of Payment

5.1 General. The accepted quantity of reinforcing steel of the type specified will be paid for at the contract unit price per pound complete in place. No allowance will be made for clips, wire, or other material used for fastening reinforcement in place and no allowance will be made for additional splices or permitted substitutions.

5.1.1 For mechanical splice bars no allowance will be made in excess of the length detailed on the plans for the additional weight required to manufacture and provide a mechanical splice to the plan specifications.

5.2 Structural steel. In reinforced concrete structures that have no structural steel bid items, structural steel will be paid for at the unit price per pound bid for reinforcing steel, unless otherwise indicated in the contract.

Pay items and units:

544	Reinforcing Steel	Pound
544.11	Reinforcing Steel-Mechanical Connectors	Pound
544.2	Reinforcing Steel-Epoxy Coated	Pound
544.21	Reinforcing Steel-Epoxy Coated Mechanical Connectors	Pound
544.3	Reinforcing Steel	Unit

SECTION 570 -- STONE MASONRY

Description

1.1 This work shall consist of furnishing all materials and constructing masonry of approved stones, laid with or without cement mortar, as shown on the plans or ordered.

Materials

2.1 Stone shall be furnished in accordance with Table 570-1.

Table 570-1 -- Stone for Stone Masonry

Stone	Source	Quality	Dress and Cut	Finish	
				Top and Bottom	Vertical Face Joints
Ashlar	approved quarry having the required quantity	compact, hard and practically non-absorbent; texture and color as indicated on plans or ordered	to exact dimensions	fine	fine
Squared	approved quarry having the required quantity	compact, hard and practically non-absorbent; texture and color as indicated on plans or ordered	roughly squared and to approximate dimensions	rough for at least 12 in. depth	rough for at least 9 in. depth
Rubble	field quarry, or rock excavation	approved, sound, clean, and free from structural defects	unsquared, roughly dressed	--	--

2.1.1 Ashlar and Squared Stone.

2.1.1.1 Stones shall have their edges pitched to a true line with tops and bottoms parallel and cut to lie on their natural beds. The bottom beds shall be the full size of the stone and hollow beds or overhanging tops will not be permitted.

2.1.1.2 When specified as random or broken-ranged, stone shall have vertical joints unless otherwise indicated on the plans.

2.1.1.3 Size of stone shall be as indicated on the plans.

2.1.1.4 Surface finish shall be as shown on the plans in accordance with the following schedule:

(a) Smooth finished: surfaces in which the variations from the pitch line do not exceed 1/16 inch.
(b) Fine finished: surfaces in which the variations from the pitch line do not exceed 1/4 inch.
(c) Rough finished: surfaces in which the variations from the pitch line do not exceed 1/2 inch.
(d) Scabbled: surfaces in which the variations from the pitch line do not exceed 3/4 inch.
(e) Rock faced: surfaces on which there are no tool marks and which have irregular projection beyond the pitch line of not more than 1-1/4 inches.
(f) Weather-faced: surfaces which have been exposed to the weather for sufficient time to become weather beaten in appearance.
(g) Seam-faced: surfaces which are formed by seams in the natural ledge before stone is quarried.

2.1.1.5 All stone shall be so finished that no holes or portions of holes will show on surfaces which will be exposed in the finished work.

2.2 Cement mortar shall conform to 707.

2.3 Stone masonry anchors shall be of the shapes and dimensions shown on the plans. The minimum ultimate tensile strength shall be 42,000 psi. Anchors shall be zinc-coated (galvanized) in accordance with ASTM A 525, coating designation G 90.

Construction Requirements

3.1 Classification.

3.1.1 Stone masonry shall be classified by pattern: ranged, broken ranged, or random.

(a) Ranged masonry shall be laid up in regular courses of uniform height throughout their entire lengths. When the height of courses is varied, it shall be regularly diminished from bottom to top masonry.
(b) Broken-ranged masonry shall be laid up with courses not continuous throughout their entire lengths.
(c) Random masonry shall be laid up without courses.

3.1.2 Stone masonry shall be classified by type of stone and thickness of joints, in accordance with Table 570-2.

Table 570-2 - Stone Masonry Classification

Class of Masonry	Type of Stone	Joint Material	Max. thickness (inches)
Ashlar	Ashlar	Cement mortar	1/2
Mortar Squared Stone	Squared	Cement mortar	1
Dry Squared Stone	Squared	Dry (closely and lightly pinned)	--
Mortar Rubble	Rubble	Cement mortar	1-1/2
Dry Rubble	Rubble	Dry (closely and lightly pinned)	--
Copings	Squared (sawn Finish)	Cement mortar	1/2

3.2 Laying Stone.

3.2.1 All shaping and dressing of stone shall be done before it is placed.

3.2.2 When required, the contractor shall submit details of falsework or centering for approval.

3.2.3 No stone in broken-ranged or random work shall be laid in a structure until at least 50 percent of the amount required for the structure has been delivered at the site.

3.2.4 Stone shall be carefully set without jarring stone already laid and shall be handled with a lewis or other suitable device which will not mar the stone. Rolling or turning of stone on masonry already in place will not be permitted.

3.2.5 Stone to be laid in cement mortar shall be thoroughly cleaned before being set, and the bed to receive it shall be well cleaned. The thickness of all joints and beds shall be uniform throughout. Spalls shall not be used as pinners in mortar beds or joints. When any stone is disturbed or mortar joint broken, the stone shall be taken up, and after all mortar has been cleaned from the stone, bed, and joints, it shall be reset in fresh mortar.

3.2.6 All stones shall be well bedded with the face joints properly pointed before the mortar has set, unless otherwise permitted. When permitted, joints to be pointed after mortar has set shall be raked out to a depth of 2 inches before mortar has set and when pointed, shall be moistened and filled with mortar well driven in. All pointing, shall be finished with an approved pointing tool to form the type of joint indicated on the plans or ordered.

3.2.7 The masonry shall be kept wet during the pointing and in hot or dry weather shall be protected from the sun and kept wet for a period of 3 days after completion unless otherwise permitted or ordered. The exposed surfaces of the stones shall not be smeared with mortar. The joints shall be wiped free of loose mortar. Stone shall not be set when containing frost or during freezing weather unless permitted.

3.3 Bond

3.3.1 Stretchers shall have a depth of bed of not less than 1-1/2 times their height. They shall have a length not less than their height, nor less than 3 feet, nor more than 3-1/2 times their height, unless otherwise indicated on the plans.

3.3.2 Headers shall have a length of 1-1/2 times their height and shall extend entirely through masonry having a thickness of 4 feet or less. In masonry having a thickness greater than 4 feet, the depth of headers shall not be less than 2-1/2 times their height when the course is 18 inches or less in height, and not less than 4 feet in courses of greater height. Headers shall hold into the heart of the wall the same size shown on the face, bonding not less than 12 inches with the core or backing. Headers shall be placed over stretchers equally dividing the spaces between headers of adjoining courses with no joints coming immediately over or under headers. Headers shall be spaced not more than 8 feet apart, and there shall be at least 1 header to every 2 stretchers unless otherwise indicated on the plans.

3.4 Copings. Stone for copings shall be selected. Copings shall be as shown on the plans.

3.5 Cores and backing. Cores or backing shall be of stone or concrete masonry as indicated on the plans.

3.5.1 Stone backing shall be laid as specified for face stone, with headers interlocking with face headers when the thickness of the masonry permits. Stone in backing or cores shall break joints with the face stone and bond not less than 12 inches with the face stone and with each other. Stone backing or cores shall be carried up with face stone and at least 50 percent of the stone shall be of the same size and character as the face stone and shall have parallel ends. When stone is laid in cement mortar, the beds shall be full and shall not exceed 1 inch in thickness, and the joints shall be completely filled and shall not exceed 4 inches in thickness.

3.5.2 Concrete backing or cores shall be of the class shown on the plans and as specified in 520. The concrete shall be so worked and compacted that all spaces around stones are completely filled and an adequate bond with the stone is secured. Construction joints in the concrete, required by intermittent placing, shall be located not less than 6 inches below the top bed of any course of the stone facing. The concrete shall be so placed that the stone masonry facing is not disturbed.

3.6 Metal dowels and cramps. Dowels and cramps shall be of the material, size and shape, and located as indicated on the plans or ordered. Holes for dowels or cramps shall be drilled in the stones before they are placed unless otherwise permitted. Cramps shall be countersunk flush with the top of the stone in which they are set. This work shall be subsidiary.

3.7 Culvert headwalls and retaining walls. In addition to applicable construction requirements, unless otherwise specified on the plans or in the special provisions, culvert headwalls and retaining walls to be constructed of mortar rubble masonry or dry rubble masonry shall conform to the following requirements: At least 75 percent of the stone shall be larger than 6 inches x 9 inches x 12 inches. No dressing, finishing, or coursing will be required. The stone shall be set without disturbing stone already in place. Stone to be laid in mortar shall be clean and moist and shall be placed on a full mortar bed. The stones shall be bonded in a workmanlike manner.

3.8 Weepers. Unless otherwise indicated on the plans, the Contractor shall furnish and place 4 inch weepers in all closed abutments and retaining walls. These weepers shall be approximately 10 feet apart and placed at the elevation which will best drain backfill. French drains of stone or coarse gravel shall be placed adjacent to the fill face of such walls and at such elevations as will permit drainage to and outletting into the weepers.

3.9 Stone Masonry Arches.

3.9.1 Masonry for rings shall be ashlar or mortar squared stone unless otherwise indicated on the plans. Voussoirs shall be full size and shall have a bond of not less than the depth of the stones. Their beds shall be dressed to bring them to radial planes and to permit them to rest properly on the centering. The inside faces of stone backing or spandrel walls and extrados shall be given a finishing coat of 1:2-1/2 cement mortar trowelled smooth, and waterproofed as indicated on the plans.

3.9.2 Masonry in arch rings shall be placed in such a manner as to load the ring uniformly about the center or as indicated on the plans.

Method of Measurement

4.1 Stone masonry except copings will be measured by the cubic yard, to the nearest 0.1 of a cubic yard. The dimensions as shown on the plans or as ordered will be used in computing the stone masonry yardage for payment.

4.2 Stone coping will be measured by the linear foot, to the nearest 0.1 of a foot.

Basis of Payment

5.1 The accepted quantity of each class of stone masonry except copings will be paid for at the contract unit price per cubic yard complete in place, with the exception that masonry steps including the parapet walls will be paid for at 1.5 times the contract unit price per cubic yard for the class of stone masonry involved.

5.2 The accepted quantity of stone coping will be paid for at the contract unit price per linear foot complete in place.

Pay items and units:

570.1	Ashlar Masonry	Cubic Yard
570.2	Mortar Squared Stone Masonry	Cubic Yard
570.3	Dry Squared Stone Masonry	Cubic Yard
570.4	Mortar Rubble Masonry	Cubic Yard
570.5	Dry Rubble Masonry	Cubic Yard
570.6	Stone Coping	Linear Foot
570.9	Resetting Masonry Wall	Cubic Foot

SECTION 572 -- STONE WALL

Description

1.1 This work shall consist of reconstructing stone walls where shown on the plans or as ordered.

Materials

2.1 Stone from the existing stone wall shall be utilized to reconstruct the wall at the specified location.

2.1.1 Any special stone features such as lintels, gate posts, copings markers, etc. shall be retained for resetting.

2.2 Any added stone shall conform to the type used in the original wall.

2.3 Gravel for surface preparation shall meet the requirements of 209.

Construction Requirements

3.1 The reconstructed stone wall shall match the existing wall as closely as possible.

3.1.1 The Contractor shall, by photographs and measurements acceptable to the Engineer, record the width, height and configuration of the existing wall prior to removal. These photographs and measurements along with the prevailing width, height and configuration shall be used to guide the reconstruction of the wall. These records shall be made at intervals of not more than 500 feet and at locations where characteristics of the wall change. The photographs shall become the property of the City at the end of the project.

3.2.1 When existing wall sections designated for reconstruction are in such disrepair that the original wall configuration cannot be determined, these sections shall be rebuilt to match abutting wall segments.

3.2 The stone wall reconstruction shall be supervised by a person with experience in dry masonry construction.

3.3 Care shall be taken to keep weathered faces exposed.

3.4 The Contractor shall retain all stone from existing wall for reuse. Additional stones that may be necessary shall be blended with the existing stones in order to reproduce the appearance of the existing wall.

3.5 The Contractor shall carefully replace chinking, blocking, bond stones and headers, as appropriate to the original style of wall, to ensure the maximum stability of the wall.

3.6 The Contractor shall carefully duplicate special features of the original wall, such as lintels, gate posts, openings, copings, markers, etc.

3.7 The ground surface shall be prepared by removing brush, vegetation, topsoil and unsuitable material. The area shall be rough graded to obtain a reasonably firm and level surface.

Method of Measurement

4.1 Reconstructing stone walls will be measured by the linear foot, to the nearest 1 foot, along the center line of the reconstructed wall.

4.2 Clearing and grubbing will be measured as provided in 201.

4.3 Gravel required for surface preparation will be measured by the cubic yard, complete in place. Limits of gravel will be as shown on the plans, or as ordered.

Basis of Payment

5.1 The accepted quantity of reconstructed wall will be paid for at the contract unit price per linear foot complete in place.

5.1.1 Any additional stone required to complete the reconstruction will be subsidiary.

5.1.2 Reconstruction of special features as defined in 3.6 will be subsidiary.

5.1.3 Photographs and measurement records of the existing wall will be subsidiary.

5.2 Ground surface preparation will be subsidiary.

5.2.1 When special site preparation such as clearing and grubbing or gravel base courses are ordered, this work will be paid under appropriate items of the contract. If appropriate items are not included in the contract, this work will be paid as provided in 109.04.

Pay items and units:

572.1	Reconstructing Stone Wall, One Stone Wide	L.F.
572.2	Reconstructing Stone Wall, Multiple Stones Wide	L.F.
572.3	Reconstructing Stone Wall, Double Faced with Loose Fill	L.F.

SECTION 583 -- RIPRAP

Description

1.1 This work shall consist of a protective covering of stone constructed at the locations shown on the plans or ordered.

Materials

2.1 Field stone, quarry stone, or rock fragments used for riprap shall be sound, of approved quality, and free from structural defects. These stones shall have approximately rectangular shapes with one reasonably flat side for the top surface and shall have minimum dimensions and volumes as listed below:

2.1.1 Riprap A, 1 foot thick. Seventy-five percent of the stones shall have a minimum volume of 2 cubic feet; the remainder shall have a minimum volume of 1/2 cubic foot.

2.1.2 Riprap B, 1-1/2 feet thick. Seventy-five percent of the stones shall have a minimum volume of 8 cubic feet.

2.1.3 Riprap C, 2 feet thick. Seventy-five percent of the stones shall have a minimum volume of 12 cubic feet.

2.1.4 Riprap D, 2-1/2 feet thick. Seventy-five percent of stones shall have a minimum volume of 18 cubic feet.

2.2 Gravel blanket material shall conform to 209.2.1.3.2.

Construction Requirements

3.1 Riprap stones shall be individually laid upward from the toe of the slope with the larger stones at the toe of the slope. The stones shall be laid with close joints roughly perpendicular to the slope. Open joints shall be filled with spalls.

3.2 When a gravel blanket is shown or ordered, the gravel shall be placed in layers not exceeding 12 inches in depth unless otherwise ordered.

3.3 The finished surface shall be reasonably uniform in appearance, approximately parallel to and within 6 inches of the lines and grades shown or ordered.

Method of Measurement

4.1 Riprap will be measured by the cubic yard and computed to the nearest 0.1 of a cubic yard by multiplying the actual area of the accepted and approved riprap by the

nominal depth as shown or ordered.

Basis of Payment

5.1 The accepted quantity of riprap of the type specified will be paid for at the contract unit price per cubic yard complete in place.

5.2 Gravel blanket material specified or ordered will be paid for under 209.

5.3 The accepted quantity of excavation required for placing riprap and for placing any underlying gravel blanket will be paid for under the item of excavation being performed. Excavation above refers only to excavation of original ground or to material ordered removed not shown on the plans.

5.4 Free borrow will not be required to replace the accepted quantity of stone obtained from the excavation. However, when the plans do not call for borrow, but the quantity of material removed from excavation for use under this item requires the Contractor to furnish borrow to complete the work, such borrow will be subsidiary.

Pay Items and Units:

583.1	Riprap A	Cubic Yard
583.2	Riprap B	Cubic Yard
583.3	Riprap C	Cubic Yard
583.4	Riprap D	Cubic Yard

SECTION 585 -- STONE FILL

Description

1.1 This work shall consist of furnishing and placing a dense stone fill at the locations shown on the plans or ordered.

Materials

2.1 Stone for stone fill shall be approved quarry stone, or broken rock of a hard, sound, and durable quality. The stones and spalls shall be so graded as to produce a dense fill with a minimum of voids.

2.1.1 Class A stone shall be irregular in shape with approximately 50 percent of the mass having a volume of 12 cubic feet, approximately 30 percent of the mass ranging between 3 and 12 cubic feet, approximately 10 percent of the mass ranging between 1 and 3 cubic feet, and the remainder of the mass composed of spalls.

2.1.2 Class B stone shall be irregular in shape with approximately 50 percent of the mass having a minimum volume of 3 cubic feet, approximately 40 percent of the mass ranging between 1 and 3 cubic feet, and the remainder of the mass composed of spalls.

2.1.3 Class C stone shall consist of clean, durable fragments of ledge rock of uniform quality, reasonably free from thin or elongated pieces. The stone shall be made from rock which is free from topsoil and other organic material. The stone shall be graded as follows:

Sieve Size	Percentage by Weight Passing
12 inch	100
4 inch	50 - 90
1-1/2 inch	0 - 30
3/4 inch	0 - 10

2.1.4 Class D stone shall conform to 520.2.2.3, Table 3 – Coarse Aggregate, Standard Stone Size No. 467.

2.1.5 Spalls for filling voids shall be stones or broken rock ranging downward from a maximum size of 1 cubic foot.

2.2 Gravel blanket material shall conform to 209.2.1.3.2.

2.3 Geotextile shall conform to 593.

Construction Requirements

3.1 Stones and spalls for stone fill shall be deposited and graded to eliminate voids and obtain a dense mass throughout the course. The spalls shall be tamped into place using an equipment bucket or other approved method.

3.1.1 When stone fill is placed on a slope, the stones shall be deposited in such a manner as to not unnecessarily dislodge the underlying material.

3.1.2 When stone fill is placed on a geotextile, it shall be deposited in such a manner so as to maintain the integrity of the geotextile.

3.2 When gravel blanket is shown or ordered, the gravel shall be placed in layers not exceeding 12 inches in depth unless otherwise ordered.

3.3 The completed surface shall approximate the lines and grades shown or ordered. When ordered, stone placed over 1 foot outside or above such lines and grades shall be removed.

Method of Measurement

4.1 Stone fill will be measured by the cubic yard and in accordance with 109.01.

Basis of Payment

5.1 The accepted quantity of stone fill of the class specified will be paid for at the contract unit price per cubic yard complete in place.

5.2 Gravel blanket material specified or ordered will be paid for under 209.

5.3 Geotextile specified or ordered will be paid under 593.

5.4 The accepted quantity of excavation required for placing stone fill and for placing any underlying gravel blanket will be paid for under the item of excavation being performed. Excavation above refers only to excavation of original ground or to material ordered removed not shown on the plans.

5.5 Free borrow will not be required to replace the accepted quantity of stone obtained from the excavation. However, when the plans do not call for borrow, but the quantity of material removed from excavation for use under this item requires the Contractor to furnish borrow to complete the work, such borrow will be subsidiary.

Pay Items and Units:

585.1	Stone Fill, Class A	Cubic Yard

585.2	Stone Fill, Class B	Cubic Yard
585.3	Stone Fill, Class C	Cubic Yard
585.4	Stone Fill, Class D	Cubic Yard

SECTION 586 -- PLACING EXCAVATED ROCK

Description

1.1 This work shall consist of placing excavated rock in designated locations and to the thickness or shape shown on the plans or ordered.

Materials

2.1 The material shall be approved from excavation within the project or an off-site source.

Construction Requirements

3.1 The rock shall be close-packed and keyed together to be stable. The surface shall conform approximately to the specified lines and grades. Where ditches and channels are being lined or covered, the rock shall be left in such a position that the required waterway area is obtained. Rejected rock remaining outside of the lines and grades shown or ordered shall be removed. Fine grading will not be required.

Method of Measurement

4.1 Excavated rock placed under this item will be measured by the cubic yard.

Basis of Payment

5.1 The accepted quantity of excavated rock placed will be paid for at the contract unit price per cubic yard complete in place.

5.2 The accepted quantity of excavation required for placing excavated rock will be paid for under the item of excavation being performed. Excavation above refers only to excavation of original ground or to material ordered removed not shown on the plans.

Pay item and unit:

586	Placing Excavated Rock	Cubic Yard
586.1	Placing Excavated Rock in Stockpiles	Cubic Yard
586.2	Placing Excavated Rock for Channel Protection	Cubic Yard
586.3	Placing Excavated Rock for slope Protection	Cubic Yard
586.4	Placing Excavated Rock for Rock Lined Ditches	Cubic Yard

SECTION 593 -- GEOTEXTILES

Description

1.1 This work shall consist of furnishing and installing geotextile fabric as shown on the plans or as ordered.

Materials

2.1 Woven Geotextile shall be used as ordered by the engineer if required to stabilize the base material and shall be one of the following products:

2.1.1 Carthage FX-66 as manufactured by Carthage Mills, Cincinnati, OH.

2.1.2 Mirafi 600X as manufactured by Mirafi Inc., Charlotte, NC.

2.1.3 Amoco 2006 as manufactured by Amoco Fabrics & Fibers Company, Atlanta, GA.

2.1.4 Exxon GTF-300 as manufactured by Exxon Chemical Company, Atlanta, GA.

2.2 Equivalent. Approval of a product as an equivalent to any of the above may be given on the basis of analysis and test results of samples and formulations submitted by the manufacturer to the Engineer. Request for approval shall be made in sufficient time for the materials to be evaluated.

2.3 Certification. Prior to, or at the time of field delivery, the contractor shall submit 3 copies of a certificate of compliance as specified in 106.04.

2.3.1 Supplementing the above certificates, the Engineer shall be furnished with a copy of the manufacturer's certificate of materials showing the physical properties, chemical composition, methods of testing and other relevant data.

2.3.2 In addition to the above, each roll shall be clearly labeled so as to easily identify the product in the field. The label shall include as a minimum the manufacturer's name, product name and number, and the contract item name and number.

2.4 Staples or pins required to hold the geotextile prior to placing overlying materials shall be those prescribed by the manufacturer.

Construction Requirements

3.1 Protection of Geotextile. To prevent damaging the fabric, the Contractor shall exercise necessary care while transporting, storing and installing the fabric. Prior to installation, the fabric shall be protected from weather, direct sunlight or other ultra-violet

exposure, dust, mud, dirt, debris and other elements which may affect its performance. Fabric which is torn, punctured or otherwise damaged shall not be placed. After placement, fabric shall not be left uncovered for more than 5 days. Traffic or construction equipment will not be permitted directly on the geotextile.

3.2 Placement of Geotextile. The geotextile shall be placed in accordance with the plans, the manufacturer's requirements and the following:

3.2.1 Prior to placement of the fabric, the site shall be prepared to provide a smooth surface which is free from debris, obstructions, and depressions which could result in gaps, tears or punctures in the fabric during cover operations. The fabric shall be unrolled loosely and positioned as evenly as possible on the surface to eliminate wrinkles and folds.

3.2.2 Adjacent sheets shall be overlapped by a minimum of 18 inches. Larger overlaps may be required by the Engineer if gaps between adjacent sheets occur during placement of overlying material. Successive lengths of fabric shall be placed in such a manner that the fill being placed will not be pushed below the fabric. Pins or staples may be used to anchor the fabric as directed by the Engineer. The fabric should be pinned in a loose condition so that it easily conforms to the ground surface.

3.2.3 The ends of the fabric shall be buried to prevent cavitation and subsequent erosion along the edges.

3.3 Repair of Geotextile. Fabric which is damaged after placement shall be replaced, repaired by stitching or patched. Patches shall be of the same materials as the placed geotextile. The patch shall be joined to the existing fabric using overlapped seams as directed by the Engineer.

3.4 Covering Operation. Placement of the fill above the geotextile shall be in accordance with the plans, the geotextile manufacturer's requirements and the following:

3.4.1 Following placement of fabric along the bottom of the excavation, the fill shall be placed and compacted as directed by the Engineer. Any ruts occurring during construction shall be filled with additional fill and compacted to the specified density.

3.4.2 Necessary care shall be taken to avoid tearing or puncturing the fabric. Fabric which is damaged as a result of
careless or improper placement of structural fill, grading techniques or excessive equipment traffic shall be repaired or replaced at the expense of the Contractor.

Method of Measurement

4.1 Geotextile will be measured by the square yard as determined by actual surface measurements of the length of and width of material in place. Additional material used

for overlaps, seams and repairs will not be measured.

Basis of Payment

5.1 The accepted quantity of geotextile will be paid for at the contract unit price per square yard complete in place. The cost of pins, staples and seams is considered subsidiary to the geotextile installation.

Pay Item and Unit:

593.2	Geotextile, Woven	Square Yard