U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: CHANGE 2 TO STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS

Date: 11/2/90
Initiated by: AAS-200

AC No: 150/5370-10A
Change: 2

1. PURPOSE. Item P-155, Lime-treated Subgrade, Item P-401, Plant Mix Bituminous Pavements, Item D-701, Pipe for Storm Drains and Culverts, Item D-705, Pipe Underdrains for Airports, Item D-751, Manholes, Catch Basins, Inlets and Inspection Holes, and Item F-162, Chain Link Fences, have been revised to reflect changes in material specifications and new materials. The Notice to Users has been revised to include new ordering information.

Make pen and ink change to the Page Control Chart of Change 1 dated 6/15/90 to read "Remove Pages 169-192 dated 2/27/89" and "Insert Pages 169-192 dated 6/15/90."

The change number and date of change are carried at the top of each page. The changed material is marked by asterisks in the margin.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii–iv	2/17/89	iii–iv	11/2/90
67–70	2/17/89	67	11/2/90
		68	2/17/89
		69	2/17/89
		70	11/2/90
139–140	2/17/89	139	11/2/90
		140	2/17/89
255–258	2/17/89	255–256	11/2/90
		257	2/17/89
		258	11/2/90
261–262	2/17/89	261	11/2/90
		262	2/17/89
265–268	2/17/89	265	11/2/90
		266	2/17/89
		267	11/2/90
		268	2/17/89
271–274	2/17/89	271–273	11/2/90
		274	2/17/89
277 (and 278)	2/17/89	277 (and 278)	11/2/90

LEONARD E. MUDD
Director, Office of Airport Safety and Standards

NOTICE TO USERS

Projects funded under the Airport Improvement Program (AIP) must be developed in accordance with policies, standards, and specifications approved by the Secretary, Department of Transportation. The standards contained in this advisory circular (AC) relate to materials and methods used in the construction of airports.

Since it is not feasible to provide construction specifications that can be applied to all geographical areas of the United States, its territories and possessions, the guide specifications in this AC should be used in developing project specifications. The verbatim incorporation of these standards in contract specifications is not practical because of the numerous decisions which must be made by the Engineer regarding local materials, methods, and requirements. For this reason, the notes (shown between lines of asterisks) elaborate on the options available to the Engineer when preparing a specification and to ensure that sound engineering judgment is applied.

Appropriate changes and additions required by the notes must be made. Where numbers, words, phrases or sentences are enclosed in brackets [ ], a choice or modification must be made. Where blank spaces [ ] occur in sentences, the appropriate data must be inserted. Where entire paragraphs are not applicable, they should be deleted. Additional sentences may be added if necessary. The final project specifications shall not include notes to the Engineer.

The standards should be used to develop construction specifications for either (1) a particular state, or (2) an individual project. They will not be made a part of a contract merely by reference. Pertinent portions should be copied verbatim into the contract documents.

For state specifications, the necessary choices and engineering judgments should be made to develop the standards into specifications for a particular state. On approval by the FAA, these state specifications may be incorporated in construction contracts by reference. The state specifications must be readily available to all parties interested in such contracts.

For individual projects, construction specifications may be produced by making the necessary choices and engineering judgments and developing the standards into specifications for a particular project.

FAA airports field representatives, designated by regional offices, have the authority to approve modifications to standards contained in this AC if the modifications provide acceptable levels of safety, economy, durability and workmanship and are necessary to meet local conditions. When preparing construction contracts for AIP projects, the user should contact these FAA representatives to obtain the mandatory provisions (wage, labor, EEO, etc.) that must be included in all AIP contract proposals. Additional contract clauses may be required to comply with local and state laws relating to advertising, awarding, and administrating construction contracts.

An automated version of this AC is available in Word Perfect 4.2 format or ASCII and provides the user with a means for automatically developing specifications. The automated version is contained on four (4) 360 kilobyte disks and requires an IBM compatible personal computer having one (1) floppy drive or a hard disk drive. Version 2.0 or greater of MS-DOS is the operating system required.

* Disks are available from the National Technical Information Service (NTIS) at a cost of $78.00. To order, make a check or money order payable to NTIS. Mail it with the AC number and title and NTIS Order Number to: *

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ITEM P–155 LIME–TREATED SUBGRADE

DESCRIPTION

155–1.1 This item shall consist of constructing one or more courses of a mixture of soil, lime, and water in accordance with this specification, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans.

MATERIALS

* 155–2.1 **HYDRATED LIME.** Hydrated lime shall conform to the requirements of ASTM C 977. *

155–2.2 **COMMERCIAL LIME SLURRY.** Commercial lime slurry shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity naturally injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of "solids content," shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

a. **Chemical Composition.** The "solids content" of the lime slurry shall consist of a minimum of 70%, by weight, of calcium and magnesium oxides.

b. **Residue.** The percent by weight of residue retained in the "solids content" of lime slurry shall conform to the following requirements:

Residue retained on a No. 6 (3360 micron) sieve ——— Max. 0.0%
Residue retained on a No. 10 (2000 micron) sieve ——— Max. 1.0%
Residue retained on a No. 30 (590 micron) sieve ——— Max. 2.5%

c. **Grade.** Commercial lime slurry shall conform to one of the following two grades:

Grade 1. The "dry solids content" shall be at least 31% by weight, of the slurry.
Grade 2. The "dry solids content" shall be at least 35%, by weight, of the slurry.

155–2.3 **WATER.** Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water shall be tested in accordance with and shall meet the suggested requirements of AASHO T 26. Water known to be of potable quality may be used without test.

155–2.4 **SOIL.** The soil for this work shall consist of materials on the site or selected materials from other sources and shall be uniform in quality and gradation, and shall be approved by the Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 2–1/2 inches (60 mm).

COMPOSITION

155–3.1 **LIME.** Lime shall be applied at the rate specified on the plans for the depth of subgrade treatment shown.

155–3.2 **TOLERANCES.** At final compaction, the lime and water content for each course of subgrade treatment shall conform to the following tolerances:

Material	Tolerance
Lime	+ 0.5%
Water	+ 2%, –0%

WEATHER LIMITATIONS

155-4.1 WEATHER LIMITATION. The lime-treated subgrade shall not be mixed while the atmospheric temperature is below 40° F (4° C) or when conditions indicate that temperatures may fall below 40° F (4° C) within 24 hours, when it is foggy or rainy, or when soil or subgrade is frozen.

EQUIPMENT

155-5.1 EQUIPMENT. The equipment required shall include all equipment necessary to complete this item such as: grading and scarifying equipment, a spreader for the lime or lime slurry, mixing or pulverizing equipment, sheepsfoot and pneumatic or vibrating rollers, sprinkling equipment, and trucks.

CONSTRUCTION METHODS

155-6.1 GENERAL. It is the primary requirement of this specification to secure a completed subgrade containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his/her work, to use the proper amount of lime, maintain the work, and rework the courses as necessary to meet the above requirements.

Prior to beginning any lime treatment the subgrade shall be constructed and brought to grade as specified in Item P-152 "Excavation and Embankment" and shall be shaped to conform to the typical sections, lines, and grades as shown on the plans. The material to be treated shall then be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary grade. Any wet or unstable materials below the secondary grade shall be corrected, as directed by the Engineer, by scarifying, adding lime, and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the Contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material. However, the Contractor shall be required to roll the subgrade, as directed by the Engineer, and correct any soft areas that this rolling may reveal before using the pulverizing machine. This method will be permitted only where a machine is provided which will ensure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine must give visible indication at all times that it is cutting to the proper depth.

155-6.2 APPLICATION. Lime shall be spread only on that area where the first mixing operations can be completed during the same working day. The application and mixing of lime with the soil shall be accomplished by the methods hereinafter described as "Dry Placing" or "Slurry Placing." Whey hydrated lime is specified, the Contractor may use either method.

a. Dry Placing. The lime shall be spread uniformly over the top of the subgrade by an approved screw-type spreader box or other approved spreading equipment. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the job mix formula.

The lime shall be distributed in such manner that scattering by wind will be minimal. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to a proper application. A motor grader shall not be used to spread the lime. The material shall be sprinkled, as directed by the Engineer, until the proper moisture content has been reached.

b. Slurry Placing. The lime shall be mixed with water in trucks with approved distributors and applied as a thin water suspension or slurry. Commercial lime slurry shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime shall be attained by successive passes over a measured section of subgrade until the proper amount of lime has been spread. The amount of

lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the job mix formula. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

155–6.3 MIXING. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as hereinafter described:

a. First mixing. The full depth of the treated subgrade shall be mixed with an approved mixing machine. Lime shall not be left exposed for more than 6 hours. The mixing machine shall make two coverages. Water shall be added to the subgrade during mixing to provide a moisture content above the optimum moisture of the material and to ensure chemical action of the lime and subgrade. After mixing, the subgrade shall be lightly rolled to seal the surface and help prevent evaporation of moisture. The water content of the subgrade mixture shall be maintained at a moisture content above the optimum moisture content for a minimum of 48 hours or until the material becomes friable. During the curing period, the material shall be sprinkled as directed. During the interval of time between application and mixing, lime that has been exposed to the open air for 6 hours or more, or to excessive loss due to washing or blowing will not be accepted for payment.

b. Final Mixing. After the required curing time, the material shall be uniformly mixed by approved methods. If the mixture contains clods, they shall be reduced in size by glading, discing, harrowing, scarifying, or the use of other approved pulverization methods so that the remainder of the clods shall meet the following requirements when tested dry by laboratory sieves:

	Percent
Minimum of clods passing 1½ inch sieve	100
Minimum of clods passing No. 4 sieve	60

155–6.4 COMPACTION. Compaction of the mixture shall begin immediately after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture. The field density of the compacted mixture shall be at least 93 percent of the maximum density of laboratory specimens prepared from samples taken from the material in place. The specimens shall be compacted and tested in accordance with ASTM D 698. The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 2167. Any mixture that has not been compacted shall not be left undisturbed for more than 30 minutes. The moisture content of the mixture at the start of compaction shall not be below nor more than 2 percentage points above the optimum moisture content. The optimum moisture content shall be determined in accordance with ASTM D 698 and shall be less than that amount which will cause the mixture to become unstable during compaction and finishing.

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the Contractor.

155–6.5 FINISHING AND CURING. After the final layer or course of lime-treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling, as directed, with a pneumatic or other suitable roller sufficiently light to prevent hair cracking. The finished surface shall not vary more than 3/8 inch (9 mm)

when tested with a 16–foot (4.8 meter) straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

The completed section shall be moist–cured for a minimum of 7 days before further courses are added or any traffic is permitted, unless otherwise directed by the Engineer. Subsequent courses shall be applied within 14 days after the lime–treated subgrade is cured.

155–6.6 THICKNESS. The thickness of the lime–treated subgrade shall be determined by depth tests or cores taken at intervals so that each test shall represent no more than 300 square yards (250 square meters). When the base deficiency is more than 1/2 inch (12 mm), the Contractor shall correct such areas in a manner satisfactory to the Engineer. The Contractor shall replace, at his/her expense, the base material where borings are taken for test purposes.

155–6.7 MAINTENANCE. The Contractor shall maintain, at his/her own expense, the entire lime–treated subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the Engineer.

METHOD OF MEASUREMENT

155–7.1 The yardage of lime–treated subgrade to be paid for shall be the number of square yards (square meters) completed and accepted.

155–7.2 The amount of lime to be paid for shall be the number of pounds (kg) of hydrated lime (or the calculated dry–lime content of the lime slurry) used as authorized.

BASIS OF PAYMENT

155–8.1 Payment shall be made at the contract unit price per square yard (square meter) for the lime–treated subgrade of the thickness specified. the price shall be full compensation for furnishing all material, except the lime, and for all preparation, delivering, placing and mixing these materials, and all labor, equipment, tools and incidentals necessary to complete this item.

155–8.2 Payment shall be made at the contract unit price per pound (kg) of lime. This price shall be full compensation for furnishing this material; for all delivery, placing and incorporation of this material; and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item P–155–8.1	Lime–treated subgrade—per square yard (square meter)
Item P–155–8.2	Lime—per pound (kg)

TESTING REQUIREMENTS

ASTM D 698	Moisture–Density Relations of Soils and Soil–Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12–in. (305 mm) Drop
ASTM D 1556	Density of Soil in Place by the Sand–Cone Method
ASTM D 2167	Density of Soil in Place by the Rubber–Ballon Method
AASHTO T 26	Quality of Water to be Used in Concrete

MATERIAL REQUIREMENTS

* ASTM C 977	Quicklime and Hydrated Lime for Soil Stabilization *

401-2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242.

401-2.3 BITUMINOUS MATERIAL. Bituminous material shall conform to the following requirements: [ ].

* *

The Engineer shall specify the type and grade of bituminous material, based on geographical location and climatic conditions, as well as the controlling specification. Types of materials are listed below.

Type and Grade Asphalt Cement		Specification
Penetration Grade	60-70 85-100 120-150	ASTM D 946
Viscosity Grade	AC-5 AC-10 AC-20 AC-40	ASTM D 3381
Viscosity Grade	AR-1000 AR-2000 AR-4000 AR-8000	ASTM D 3381
Tar	RT-10 RT-11 RT-12	ASTM D 490

* *

The Contractor shall furnish vendor's certified test reports for each tankload of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall be the basis for final acceptance.

COMPOSITION

401-3.1 COMPOSITION OF MIXTURE. The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

401-3.2 JOB MIX FORMULA. No bituminous mixture for payment shall be produced until a job mix formula has been approved by the Engineer. The formula shall be submitted in writing by the Contractor to the Engineer at least [ ] days prior to the start of paving operations and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. All test data used to develop the job mix formula shall also be submitted. The job mix formula for each mixture shall be in effect until modified in writing by the Engineer. Should a change in sources of materials be made, a new job mix formula must be established before the new material is used.

* *

The Engineer shall specify the number of days. A minimum of 10 days is recommended.

* *

The bituminous mixture shall be designed using procedures contained in Chapter III, MARSHALL METHOD OF MIX DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), current edition, and shall meet the requirements of Tables 1 and 2.

* *

The Marshall Design Criteria applicable to a project shall be specified by the Engineer from the information shown below and inserted into Table 1. Asterisks denote insert points.

Test Property	Pavements Designed for Aircraft Gross Weights of 60,000 lbs. or more or Tire Pressure Greater than 100 psi	Pavements Designed for Aircraft Gross Weights Less than 60,000 lbs. or Tire Pressure Less than 100 psi
Number of Blows	75	50
Stability, pounds (newtons) minimum	1800 (8000)	1000 (4450)
Flow, 0.01 in. (0.25 mm)	8–16	8–20
Percent air voids		
Surface	3–5	3–5
Base	3–5	3–5
Percent voids in mineral aggregate	See Table 2	See Table 2

* *

TABLE 1. MARSHALL DESIGN CRITERIA

TEST PROPERTY	*
Number of Blows	*
Stability, Minimum pounds (newtons)	*
Flow, 0.01 in. (0.25 mm)	*
Percent air voids	*
Percent voids in mineral aggregate	See Table 2

ITEM F-162 CHAIN-LINK FENCES

DESCRIPTION

162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications and the details shown on the plans and in conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

162-2.1 FABRIC. The fabric shall be woven with a 9-gauge **[galvanized steel wire] [aluminum-coated steel wire] [aluminum alloy] [polyvinyl chloride (PVC)-coated steel]** wire in a 2-inch (50 mm) mesh and shall meet the requirements of [ ].

* *

Galvanized steel fabric shall conform to the requirements of ASTM A 392, Class II.

Aluminum-coated steel fabric shall conform to the requirements of ASTM A 491.

* **Aluminum alloy fabric shall conform to the requirements of ASTM F 1183.** *

* **Polyvinyl chloride-coated steel shall conform to the requirements of ASTM F 668, Class 2b.** *

* *

162-2.2 BARBED WIRE. Barbed wire shall be 2-strand 12-1/2 gauge **[zinc-coated] [aluminum-coated]** wire with 4-point barbs and shall conform to the requirements of [ ].

* *

Zinc-coated barbed wire shall conform to the requirements of ASTM A 121, Class 3.

Aluminum-coated barbed wire shall conform to the requirements of ASTM A 585, Class II.

* *

162-2.3 POSTS, RAILS AND BRACES. Posts, rails, and braces furnished for use in conjunction with zinc-coated steel fabric or with aluminum-coated steel fabric shall be of zinc-coated steel or acrylic-coated steel pipe, and those furnished for use in conjunction with aluminum alloy fabric shall be aluminum alloy.

* Line posts, rails, and braces shall be **[galvanized steel pipe] [polymer-coated steel pipe] [vinyl-coated steel] [structural shapes] [roll formed] [aluminum alloy]** conforming to the requirements of [ ]. *

* *

* **Galvanized steel pipe shall conform to the requirements of ASTM F 1083.** *

* **Polymer-coated steel pipe shall conform to the requirements of ASTM A 569. Polymer coating shall be in accordance with ASTM F 1234, Type B.** *

* **The steel used in all structural shapes shall conform to the requirements of ASTM A 572, Grade 45, and shall be galvanized in accordance with the requirements of ASTM F 1234, Type A.** *

* **Roll-formed sections shall be fabricated from material meeting the requirements of ASTM A 570, Grade 45, and shall be galvanized in accordance with the requirements of ASTM A 123, or coated with zinc-5% aluminum mischmetal alloy in accordance with ASTM F 1234, Type C.** *

Aluminum alloy shall conform to the requirements of ASTM B 429, alloy 6063-T6, Schedule 40, for extruded pipe and tube.

Aluminum alloy shall conform to the requirements of ASTM B 221, alloy 6063–T6, for extruded bar, shape, and tube.

* **Vinyl–coated steel shall conform to the requirements of Fed. Spec. RR–F–191/3.**

* *

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Fed. Spec. RR–F–191/3.

* 162–2.4 GATES. Gate frames shall consist of [**galvanized steel pipe**] [**polymer–coated steel pipe**] [**aluminum alloy pipe**] and conform to the specifications for the same material under paragraph 162–2.3. The fabric shall be of the same type material as used in the fence. *

162–2.5 WIRE TIES AND TENSION WIRES. Wire fabric ties, wire ties, and tension wire for use in conjunction with a given type of fabric shall be of the same material identified with the fabric type. The tension wire shall be 7–gauge coiled spring wire coated similarly to the respective wire fabric being used.

Wire fabric ties shall be hog rings, aluminum wire, or galvanized steel wire not less than 9 gauge.

All material shall conform to Fed. Spec. RR–F–191/4.

162–2.6 MISCELLANEOUS FITTINGS AND HARDWARE. Miscellaneous steel fittings and hardware for use with [**zinc–coated**] [**aluminum–coated**] steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. [**All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A 153.**] [**Miscellaneous aluminum fittings for use with aluminum alloy fabric shall be wrought or cast aluminum alloy.**] Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

162–2.7 CONCRETE. Concrete shall be of a commercial grade with a minimum 28–day compressive strength of 2500 psi (13 700 kPa).

162–2.8 MARKING. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gage of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

CONSTRUCTION METHODS

162–3.1 CLEARING FENCE LINE. All trees, brush, stumps, logs, and other debris which would interfere with the proper construction of the fence in the required location shall be removed a minimum width of 2 feet (60 mm) on each side of the fence centerline before starting fencing operations. The material removed and disposed of shall not constitute a pay item and shall be considered incidental to fence construction.

162–3.2 INSTALLING POSTS. All posts shall be set in concrete at the required dimension and depth and at the spacing shown on the plans.

* *

Posts should be spaced not more than 10 feet (3 m) apart and should be set a minimum of 36 inches (90 cm) in concrete footings. If the frost depth is greater than 36 inches (90 cm), the posts should be set accordingly. The posts should have a minimum of 3 inches (75 mm) of concrete cover.

* *

The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within 7 days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

162-3.3 INSTALLING TOP RAILS. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

162-3.4 INSTALLING BRACES. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

162-3.5 INSTALLING FABRIC. The wire fabric shall be firmly attached to the posts and braced in the manner shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the contour of the ground, with the bottom of the fence fabric no less than 1 inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Grading shall be performed where necessary to provide a neat appearance.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched thereon to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6 inches (150 mm) or less.

* *

Openings below the fence may also be spanned with barbed wire fastened to stakes.

* *

162-3.6 ELECTRICAL GROUNDS. Electrical grounds shall be constructed **[where a power line passes over the fence] [at 500-foot (150 m) intervals].** The ground shall be installed directly below the point of crossing. The ground shall be accomplished with a copperclad rod 8 feet (240 cm) long and a minimum of 5/8 inch (15 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction.

* *

The Engineer shall indicate the location of all electrical grounds on the plans.

* *

METHOD OF MEASUREMENT

162-4.1 Chain-link fence will be measured for payment by the linear foot (meter). Measurement will be along the top of the fence from center to center of end posts, excluding the length occupied by gate openings.

Gates will be measured as complete units.

BASIS OF PAYMENT

162–5.1 Payment for chain–link fence will be made at the contract unit price per linear foot (meter).

Payment for driveway or walkway gates will be made at the contract unit price for each gate.

The price shall be full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item F–162–5.1	Chain–Link Fence—per linear foot (meter)
Item F–162–5.2	Driveway Gates—per each
Item F–162–5.3	Walkway Gates—per each

MATERIAL REQUIREMENTS

	ASTM A 121	Zinc–Coated (Galvanized) Steel Barbed Wire	
	ASTM A 123	Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip	
	ASTM A 153	Zinc Coating (Hot–Dip) on Iron and Steel Hardware	
	ASTM A 392	Zinc–Coated Steel Chain–Link Fence Fabric	
	ASTM A 491	Aluminum–Coated Steel Chain–Link Fence Fabric	
*	ASTM A 569	Steel, Carbon (0.15 Maximum, Percent), Hot Rolled Sheet and Strip Commercial Quality	
	ASTM A 570	Hot–Rolled Carbon Steel Sheet and Strip Structural Quality	
	ASTM A 572	High–Strength Low–Alloy Columbium–Vanadium Steels of Structural Quality	
	ASTM A 585	Aluminum–Coated Steel Barbed Wire	
	ASTM B 221	Aluminum–Alloy Extruded Bars, Rods, Wire Shapes and Tubes	
*	ASTM F 668	Poly(vinyl Chloride)(PVC)–Coated Steel Chain–Link Fence	*
	ASTM F 1083	Pipe, Steel, Hot–dipped Zinc–coated (galvanized) Welded, for Fence Structures	
*	ASTM F 1183	Aluminum Alloy Chain Link Fence Fabric	*
	ASTM F 1234	Protective Coatings on Steel Framework for Fences	
*	Fed. Spec. RR–F–191/3	Fencing, Wire and Post, Metal (Chain–Link Fence Posts, Top Rails and Braces)	*
	Fed. Spec. RR–F–191/4	Fencing, Wire and Post, Metal (Chain–Link Fence Accessories)	

ITEM D–701 PIPE FOR STORM DRAINS AND CULVERTS

DESCRIPTION

701–1.1 This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

701–2.1 Materials shall meet the requirements shown on the plans and specified below.

701.2.2 PIPE.

*	Metallic Coated Corrugated Steel Pipe (Type I, IR or II)	ASTM A 760	*
	Galvanized Steel Corrugated Structural Plates and Fasteners for Pipe, Pipe–Arches, and Arches	ASTM A 761	
	Polymer Precoated Corrugated Steel Pipe for Sewers and Drains	ASTM A 762	
	Post–Coated and Lined (Bituminous or Concrete) Corrugated Steel Sewer and Drainage Pipe	ASTM A 849	
*	Fiber–Bonded asphalt, Composite Coated, Corrugated Steel Pipe	ASTM A 885	*
*	Corrugated Aluminum Alloy Culvert Pipe	ASTM B 745	*
	Vitrified Clay Pipe	ASTM C 700	
	Non–Reinforced Concrete Pipe	ASTM C 14	
	Reinforced Concrete Pipe	ASTM C 76	
*	Reinforced Concrete D–Load Pipe	ASTM C 655	*
	Reinforced Concrete Arch Pipe	ASTM C 506	
	Reinforced Concrete Elliptical Pipe	ASTM C 507	
	Precast Reinforced Concrete Box Sections	ASTM C 789 and C 850	
	Bituminous–Coated Corrugated Metal Pipe and Pipe Arches	AASHTO M 190	
	Bituminous–Coated Corrugated Aluminum Alloy Culvert Pipe	AASHTO M 190 and M 196	
	Bituminous–Coated Structural Plate Pipe, Pipe Arch, and Arches	AASHTO M 167 and M 243	
	Aluminum Alloy Structural Plate for Pipe, Pipe Arch, and Arches	AASHTO M 219	
	Polyvinyl Chloride (PVC) Pipe	ASTM D 3034	
	Corrugated Polyethylene Drainage Tubing	AASHTO M 252	
	Corrugated Polyethylene Pipe	AASHTO M 294	

701–2.3 CONCRETE. Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13 780 kPa) at 28 days and conform to the requirements of ASTM C 94.

701–2.4 RUBBER GASKETS. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C 443. Rubber gaskets for PVC pipe shall conform to the requirements of ASTM F 477. Rubber gaskets for zinc–coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D 1056, for the "RE" closed cell grades.

701–2.5 JOINT MORTAR. Pipe joint mortar shall consist of one part portland cement and two parts sand. The portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

701-2.6 OAKUM. Oakum for joints in bell and spigot pipe shall be made from hemp (Cannabis Sativa) line, or Benares Sunn fiber, or from a combination of these fibers. The oakum shall be thoroughly corded and finished.

701-2.7 JOINT FILLERS. Poured filler for joints shall conform to the requirements of ASTM D 1190.

701-2.8 PLASTIC GASKETS. Plastic gaskets shall conform to the requirements of AASHTO M 198 (Type B).

701-2.9 COMPRESSION JOINTS. Materials for compression joints for vitrified clay pipe shall meet the requirements of ASTM C 425.

* *

ASTM C 789 and C 850 are primarily manufacturing specifications. The box section dimensions, compressive strength of the concrete, and reinforcement details shown in the specifications have been designed for a combined earth dead load and AASHTO H 520 live load condition. A modified design will be necessary when aircraft loadings are greater than the H520 loading.

* *

CONSTRUCTION METHODS

701-3.1 EXCAVATION. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 12 inches (300 mm) or one-half inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The width of the excavation shall be at least 1 foot (30 cm) greater than the horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The Engineer shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes that are placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

701-3.2 BEDDING. The pipe bedding shall conform to the class specified on the plans. When no bedding class is specified or detailed on the plans, the requirements for Class C bedding shall apply.

a. Rigid Pipe. Class A bedding shall consist of a continuous concrete cradle conforming to the plan details.

Class B bedding shall consist of a bed of granular material having a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extending up around the pipe for a depth of not less than 30 percent of the pipe's vertical outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10 percent of the pipe's vertical diameter and shall have recesses shaped to receive the bell of bell and spigot pipe. The bedding material shall be sand or selected sandy soil, all of which passes a 3/8 inch (9 mm) sieve and not more than 10 percent of which passes a No. 200 (0.075 mm) sieve.

Class C bedding shall consist of bedding the pipe in its natural foundation to a depth of not less than 10 percent of the pipe's vertical outside diameter. The bed shall be shaped to fit the pipe and shall have recesses shaped to receive the bell of bell and spigot pipe.

	ASTM A 761	Steel Galvanized, Corrugated Structural Plates and Fasteners for Pipe, Pipe–Arches, and Arches	
	ASTM A 762	Precoated (Polymeric) Galvanized Steel Sewer and Drainage Pipe	
	ASTM A 849	Post–Coated and Lined (Bituminous or Concrete) Corrugated Steel Sewer and Drainage Pipe	
*	ASTM A 885	Steel Sheet, Zinc and Aramid Fiber Composite Coated for Corrugated Steel Sewer, Culvert, and Underdrain Pipe	*
*	ASTM B 745	Corrugated Aluminum Alloy Culvert Pipe	*
	ASTM C 14	Concrete Sewer, Storm Drain, and Culvert Pipe	
	ASTM C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe	
	ASTM C 94	Ready Mixed Concrete	
	ASTM C 144	Aggregate for Masonry Mortar	
	ASTM C 150	Portland Cement	
	ASTM C 425	Compression Joints for Vitrified Clay Pipe	
	ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets	
	ASTM C 506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe	
	ASTM C 507	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe	
	ASTM C 655	Reinforced Concrete D–Load Culvert, Storm Drain and Sewer Pipe	
	ASTM C 700	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated	
	ASTM C 789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers	
	ASTM C 850	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less than 2 feet of Cover	
	ASTM D 1056	Flexible Cellular Materials—Sponge or Expanded Rubber	
	ASTM D 1190	Concrete Joint Sealer, Hot Poured Elastic Type	
	ASTM D 3034	Type PSMPoly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings	
	ASTM D 3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals	
	ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe	
	AASHTO M 190	Bituminous–Coated Corrugated Metal Culvert Pipe and Pipe Arches	
	AASHTO M 198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets	
	AASHTO M 219	Aluminum Alloy Structural Plate for Pipe, Pipe–Arches, and Arches	
	AASHTO M 243	Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe–Arches, and Arches	

AASHTO M 252	Corrugated Polyethylene Drainage Tubing
AASHTO M 294	Corrugated Polyethylene Pipe, 12- to 24-in. Diameter

ITEM D–705 PIPE UNDERDRAINS FOR AIRPORTS

DESCRIPTION

705–1.1 This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

705–2.1 GENERAL. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

Perforated Vitrified Clay Pipe	ASTM C 700
Perforated Concrete Pipe	ASTM C 444
Porous Concrete Pipe	ASTM C 654
Polymer Precoated Perforated Corrugated Steel Pipe	ASTM A 762
Perforated Corrugated Aluminum Alloy Pipe	AASHTO M 196
Smooth–Wall Perforated PVC Pipe	ASTM F 758
Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings	ASTM F 949
Perforated Corrugated Steel Pipe	ASTM A 760
Bituminous–Coated Perforated Corrugated Aluminum Alloy Pipe	AASHTO M 196 and M 190
* Corrugated Polyethylene Drainage Tubing	AASHTO M 252 *
Corrugated Polyethylene Pipe	AASHTO M 294

705–2.3 JOINT MORTAR. Pipe joint mortar shall consist of one part portland cement and two parts sand. The portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

705–2.4 ELASTOMERIC SEALS. Elastomeric seals shall conform to the requirements of ASTM F 477.

705–2.5 POROUS BACKFILL. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C 136.

TABLE 1. GRADATION OF POROUS BACKFILL

Sieve Designation (square openings)	Percentage by Weight Passing Sieves	
	Porous Material No. 1	Porous Material No. 2
1½ inch		100
1 inch (225.0 mm)		90—100
⅜ inch (9.5 mm)	100	25—60
No. 4 (4.75 mm)	95—100	5—40
No. 8 (2.36 mm)		0—20
No. 16 (1.18 mm)	45—80	
No. 50 (0.30 mm)	10—30	
No. 100 (0.15 mm)	0—10	

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

CONSTRUCTION METHODS

705-3.1 EQUIPMENT. All equipment necessary and required for the proper construction of pipe underdrains shall be on the project, in first-class working condition, and approved by the Engineer before construction is permitted to start.

705-3.2 EXCAVATION. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The engineer shall determined the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Engineer. The excavation shall not be carried below the required depth; when this is done, the trench shall be backfilled at the Contractor's expense with material approved by the Engineer and compacted to the density of the surrounding earth material.

The bed for the pipe shall be so shaped that at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the pipe bell shall be excavated accurately to size to clear the bell so that the barrel supports the entire weight of the pipe.

The Contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the backfill to at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

705-3.3 LAYING AND INSTALLING PIPE.

a. Clay or Concrete Pipe. The laying of the pipe in the finished trench shall be started at the lowest point and laid upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid without extra compensation.

b. Metal and Fiber Pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

The sections of bituminized-fiber pipe shall be securely fastened together with suitable fittings. When the fiber couplings are tapered, they shall provide a tight, driven fit.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

Item D-705-5.1	[ ] inch [ ]per linear foot (meter)
Item D-705-5.2	Porous Backfill No. 1—per cubic yard (cubic meter)
Item D-705-5.3	Porous Backfill No. 2—per cubic yard (cubic meter)

* *

The Engineer shall specify the size and type of pipe for each pipe size specified in the plans.

* *

MATERIAL REQUIREMENTS

	ASTM A 760	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
	ASTM A 762	Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
	ASTM C 136	Sieve or Screen Analysis of Fine and Coarse Aggregates
	ASTM C 144	Aggregate for Masonry Mortar
	ASTM C 150	Portland Cement
	ASTM C 444	Perforated Concrete Pipe
	ASTM C 654	Porous Concrete Pipe
	ASTM C 700	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
	ASTM D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
	ASTM D 3034	Type PSMPoly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
	ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
	ASTM F 758	Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
	ASTM F 949	Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
	AASHTO M 190	Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
	AASHTO M 196	Corrugated Aluminum Alloy Culverts and Underdrains
*	AASHTO M 252	Corrugated Polyethylene Drainage Tubing *
*	AASHTO M 294	Corrugated Polyethylene Pipe, 12 to 24 in diameter *

ITEM D–751 MANHOLES, CATCH BASINS, INLETS AND INSPECTION HOLES

DESCRIPTION

751–1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Engineer.

MATERIALS

751–2.1 BRICK. The brick shall conform to the requirements of ASTM C 32, Grade SM.

751–2.2 MORTAR. Mortar shall consist of one part portland cement and two parts sand. The portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

751–2.3 CONCRETE. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P–610.

751–2.4 PRECAST CONCRETE PIPE MANHOLE RINGS. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C 478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm).

751–2.5 CORRUGATED METAL. Corrugated metal shall conform to the requirements of AASHTO M 36.

751–2.6 FRAMES, COVERS, AND GRATES. The castings shall conform to one of the following requirements:

a. Gray iron castings shall meet the requirements of ASTM A 48, Class 30B and 35B. *

b. Malleable iron castings shall meet the requirements of ASTM A 47.

c. Steel castings shall meet the requirements of ASTM A 27.

d. Structural steel for grates and frames shall conform to the requirements of ASTM A 283, Grade D.

* e. Ductile iron castings shall conform to the requirements of ASTM A 536. *

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned and given two coats of approved bituminous paint. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A 123.

751–2.7 STEPS. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of bituminous paint, when directed.

CONSTRUCTION METHODS

751–3.1 UNCLASSIFIED EXCAVATION.

a. The Contractor shall do all excavation for structures and structure footings to the lines and grades or elevations, shown on the plans, or as staked by the Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the

Engineer may order, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner which will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After each excavation is completed, the Contractor shall notify the Engineer to that effect; and concrete or reinforcing steel shall be placed after the Engineer has approved the depth of the excavation and the character of the foundation material.

751-3.2 BRICK STRUCTURES.

a. **Foundations.** A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. **Laying Brick.** All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it which can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. **Joints.** All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or pargeted with a coat of mortar not less than 3/8-inch (9 mm) thick before the backing is laid up. Prior to pargeting, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4-inch (6 mm) nor more than 1/2-inch (12 mm) wide and whatever width is adopted shall be maintained uniform throughout the work.

d. **Pointing.** Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. **Cleaning.** Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing down with water and, if necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

f. Curing and Cold Weather Protection. In hot or dry weather, or when directed by the Engineer, the brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry

MATERIAL REQUIREMENT

	ASTM A 27	Mild to Medium–Strength Carbon–Steel Castings for General Application	
	ASTM A 47	Malleable Iron Castings	
*	ASTM A 48	Gray Iron Castings	*
	ASTM A 123	Zinc (Hot–Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip	
	ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars	
*	ASTM A 536	Ductile Iron Castings	*
	ASTM C 32	Sewer and Manhole Brick	
	ASTM C 144	Aggregate for Masonry Mortar	
	ASTM C 150	Portland Cement	
	AASHTO M 36	Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains	

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