

I - Measurement and payment

Mobilization and Demobilization:

Payment will be made for costs for assembling all plant and equipment at the site preparatory to initiating the work and for removing it there from when the drilling and grouting program has been completed. Sixty (60) percent of the contract lump-sum price for mobilization and demobilization will be paid following completion of moving onto the site, including complete assembly, in working order, of all equipment necessary to perform the required drilling and grouting operations. The remaining forty (40) percent of the contract lump sum will be paid when all equipment has been removed from the site.

Unit of measure: lump sum.

Drilling Grout Holes:

Drilling of grout holes will be measured for payment on the basis of the linear feet of holes actually drilled.

Unit of measure: linear foot.

Pipe and Fittings:

No payment will be made for costs associated with grout and drain hole pipe and fittings remaining in the permanent work.

Portland Cement in Grout:

Payment will be made for costs associated with Portland cement in grout.

Portland cement in grout will be measured for payment on the basis of the number of bags (94 pounds) of cement used in the grout satisfactorily placed in grout holes and in, or wasted when such wasting is not due to the Contractor's negligence.

Unit of measure: 1 cubic foot bag (94 pounds).

Fly Ash in Grout:

Payment will be made for costs associated with fly ash in grout.

Fly ash in grout will be measured for payment on the basis of the number of cubic feet (74 pounds) of fly ash used in the grout satisfactorily placed in grout holes.

Unit of measure: 1 cubic foot bag (74 pounds).

Microfine Cement in Grout:

Payment will be made for costs associated with microfine cement in grout.

Microfine cement in grout will be measured for payment on the basis of 20 kg (44 lb.) of microfine cement used in the grout successfully placed in grout holes.

Unit of measure: bags 20 kg (44 lb).

Sand in Grout:

Payment will be made for costs associated with sand in grout.

Sand in grout will be measured for payment on the basis of the number of cubic feet of sand, dry rodded measurement, used in the grout satisfactorily placed in grout holes or in exploratory holes.

Unit of measure: cubic foot.

Admixes in Grout:

No payment will be made for costs associated with admixes in grout.

Placing Grout:

The operation of placing grout will be measured for payment on the basis of the number of cubic feet of materials, satisfactorily placed, exclusive of water and admixes and regardless of the proportions of the mixes, measure individually as specified in unit price pay items "Portland Cement in Grout", "Fly Ash in Grout", "Microfine Cement", and "Sand in Grout".

II - SYSTEM DESCRIPTION

This section of the specifications covers; drilling, washing and pressure testing grout holes; making grout connections; furnishing, handling, transporting, storing mixing and injecting the grouting materials; backfilling holes;; care and disposal of drill cuttings, waste water and waste grout; clean up of the areas upon completion of the work and all other such operations as are incidental to the drilling and grouting. The work contemplated consists of constructing a grout curtain [area grouting, the approximate locations, limits, and details of which are indicated.

Materials Delivery, Storage, and Handling

Cement:

A sufficient quantity of cement shall be stored at or near the site of the work to insure that grouting-operations will not be delayed by shortage of cement. In the event the cement is found to contain lumps or foreign matter of a nature and in amounts which, in the opinion of the Engineer, may be deleterious to the grouting operations, screening through a standard 100 mesh screen may be required. No payment will be made for such screening.

Project / Site Conditions

The program shown and described is based on currently available information. Conditions encountered during construction may require additions or deletions. The grouting program shall not be modified or curtailed as construction expediency. It is a required part of design and shall not become secondary to any time or scheduling restrictions. Grouting mixes, pressures, injection rate and the sequence in which the holes are drilled and grouted will be determined in the field and shall be as directed.

III - Products

Grouting Material:

Grout shall be composed of water and cement, admixtures, and fillers. The grout mixes will be designed by the Engineer and will be varied to meet the characteristics of each hole as determined by conditions encountered. The various materials to be furnished by the Contractor shall conform to the specifications listed in paragraphs below.

Water:

The water used in the grout shall be furnished by the Contractor. It shall be fresh, clean and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

Cement:

Portland cement used in grout shall conform to the requirements of ASTM C 150, Type I or II. The Contractor shall submit to the contracting Officer of the source of cement, brand name and type.

Fly Ash shall conform to ASTM C-618 grade c or grade f. Alternate sources of fly ash may be submitted and will be considered.

The microfine cement material furnished shall be selected from one or more of the following:

A blend of approximately 50 percent microfine Portland cement and 50 percent microfine slag, with 98 percent of the particles less than 10 microns and 50 percent of the particles less than 4 microns.

100 percent microfine Portland cement, with 90 percent of the particles less than 10 microns and 50 percent of the particles less than 3 microns.

A mixture of microfine slag, with 98 percent of the particles less than 7 microns and 50 percent of the particles less than 3 microns and microfine Portland cement, with 90 percent of the particles less than 10 microns and 50 percent of the particles less than 3 microns. The mixture shall be at least 25 percent microfine Portland cement, as determined by the Contracting Officer.

Admixture:

Admixtures may be added to the grout immediately before or during its mixing and will consist of accelerators, retarders, water reducers, and fluidifiers.

Sand:

Sand for grout shall be clean and consist of hard, tough, durable, un-coated particles meeting the requirements and gradation of masonry sand ASTM C-33.

Pipe and Pipe Fittings:

Pipe and fittings required for constructing grout, drainage and exploratory holes shall be furnished, cut, threaded, and fabricated by the Contractor.

Pipe:

Pipe will be PVC of the diameter and in the location indicated. The pipe shall conform to ASTM.

IV - Execution

Equipment:

General:

All drilling and grouting equipment used shall be of a type, capacity and mechanical condition suitable for performing the work, as determined by the Engineer. The power and equipment and the layout thereof shall meet all applicable requirements of local, State, and Federal regulations and codes, both safety and otherwise.

Drilling Equipment:

Standard drilling equipment of the rotary type shall be used to perform the drilling as specified in paragraphs GROUT HOLE DRILLING. Water or Air shall be used for removing cuttings from the hole during drilling operations. Supplies shall include all bits, drill rods, tools, casing, piping, pumps water, and power to accomplish the required drilling. All drilling rigs and pumps will be equipped with pressure gages.

Grouting Equipment:

The grout plant shall be capable of supplying, mixing, stirring and pumping the grout and additives, to the satisfaction of the Engineer. The plant shall have a minimum capacity of (30) gpm (____) cfm of grout injected at a pressure not greater than (100) psi. It shall be maintained at all times and any grout hole that lost or damaged due to mechanical failure of equipment or inadequacy of grout supply shall be replaced by another hole, drilled by the Contractor at his expense. The amount of grouting equipment shall be as necessary to perform the work specified herein. The type to be furnished shall include the following.

- A progressive cavity pump capable of generating pressures up to (100) psi and pumping a maximum of (30) gpm () cfm. In no case will the pump be separated by more than (200) feet of grout line from the header of a hole being grouted.
- A colloidal or paddle type grout mixer having a minimum drum capacity of approximately (10) cubic feet with a mix batch of (6) cubic feet. Mixing time shall be approximately (60) seconds per batch.
- A mechanically agitated sump having a minimum capacity (10) of cubic feet.
- A circulating grout header with control valves and a pressure gage with protector as shown on the plans. Control valves shall be connected to the return line and header. The header shall be joined directly to the riser pipe at the hole by means of a quick connector union.
- A water meter graduated in cubic feet and tenths having a direct reading totalizer.
- Such valves, packers, pressure gages, pressure hose, supply lines, and small tools as may be necessary to provide a continuous supply of grout at accurately controlled pressures as specified. The inside diameter of the pressure hose and grout supply line shall be not less than (1) inches. An accurately calibrated, high precision pressure gage shall be used to check the accuracy of all gages used in the grouting. Gages shall be checked at least every 24 hours, or more frequently if the Engineer so determines. When defects are found, grouting operations will be stopped until calibration of gages has been obtained.

Grout:

All holes for grouting, shall be drilled at the locations, in the direction, angle, and to the depths indicated or as directed by the Engineer. A maximum tolerance for deviation in angle and direction shall be (30) The first series of holes to be drilled and grouted shall be at (10) - foot intervals and hereinafter are referred to as primary holes . The location of secondary and succeeding series (intermediate) holes shall be determined by the split spacing method as defined in paragraph SPLIT SPACING. The number of grout holes shall be increased, progressively, by the split spacing method as defined in paragraph SPLIT SPACING. The number grout holes shall be increased progressively, by the split spacing method as deemed necessary by the Engineer until the amount of grout used -indicates that the foundation is tight. Each hole drilled shall be protected from becoming clogged or-obstructed by means of a cap or other suitable device on the collar and any hole that becomes clogged or obstructed due to fault of the contractor before completion of operations shall be cleaned out in a manner satisfactory to the Engineer or another hole provided by and at the expense of the Contractor.

Grout Hole Drilling:

Grout holes shall be drilled with standard rotary drilling equipment. No core recovery will be required and the type bit used shall be optional with the Contractor. The hole shall be of sufficient diameter to allow use of an expansion plug or packer with an effective inside diameter of not less than 1 inch. The minimum diameter of hole shall be 2 inches at the point of maximum penetration. No grout hole will be drilled at an angle greater than (30)degrees measured from the vertical nor to a depth greater than (40)feet measured from the collar of the hole. It is determined that holes to depths greater than indicated are necessary, drilling to such greater depth will be ordered in writing, and the drilling to depths in excess of (40) feet will be paid for at a negotiated unit price.

Drilling will be done in accordance with the applicable grouting method hereinafter described. Whenever as much as (50) percent of the drill water is lost or the cumulative total of successive water losses is estimated to amount to (50) percent loss, or artesian flow is encountered, the drilling operations shall be stopped, the hole washed, pressure tested and grouted before drilling operations are resumed in such hole. The grout so injected remaining in a partially completed hole shall be removed therefrom by washing or other methods before it has set sufficiently to require redrilling. Redrilling required because of the Contractor's failure to clean out a hole before the grout has set shall be performed at the Contractor's expense. Except that where the grout has been allowed to set by direction of the Engineer, the redrilling will be paid for at the contract price for drilling the grout hole. Upon completion of drilling of any

hole and prior to pressure testing, all drill cuttings and slurry shall be removed by applying water to the bottom of the hole through open end rods and returning the wash water through the hole to the surfaces until the return water is clear. No separate payment will be made for this washing.

Definitions and Procedures for Drilling and Grouting:

General:

The drilling and grouting shall be accomplished in single or multiple lines as shown. Zones, using the split spacing shall do the drilling and the grouting.

Split Spacing:

Split spacing is the procedure of locating an additional grout hole midway between two previously drilled and grouted holes.

Primary Holes:

Primary holes for foundation grouting shall be drilled to their full depth. The depths will be governed by the foundation conditions.

The holes thus drilled shall be washed and pressure tested, and then grouted.

Successive Holes:

After the primary holes have been completed in any section as specified above, the second and succeeding series of holes, as determined by the "split spacing method," shall be drilled and grouted as directed.

As the drilling and grouting work progresses, it may develop that conditions are such that all or parts of the foundation already grouted require additional grouting. In such event, the equipment shall be returned and additional holes for grouting shall be drilled and grouted as directed and no allowance above contract unit prices will be made for drilling and grouting such holes or for the expense of any movement of equipment necessary to the performance of such work.

Grouting Pressures:

Grouting pressures to be used in the work will vary with conditions encountered in the respective holes and pressures used shall be as directed. It is anticipated that pressures will range from (0) psi to (5) psi but in no event will pressures in excess of (5) psi be required or allowed.

Grouting:

All pressure grouting operations shall be performed in the presence of the Engineer, and shall be in accordance with the following general procedures.

Grout Mixes:

Mixes shall be in the proportions directed by the Engineer who will, from time to time, direct changes to suit the conditions found to exist in the particular grout hole.

- Cement Grout shall consist of cement, and water.
- Mortar Grout shall consist of cement, sand, and water.

Grout Injection:

In general, if pressure tests indicate a tight hole, grouting shall be started with a thin mix. If an open hole condition exists, as determined by loss of drill water or inability to build up pressure during washing operations, then grouting shall be started with a thicker mix and with a grout pump operating as nearly as practicable at constant speed at all times; the ratio will be decreased, if necessary, until the required pressure has been reached. If this procedure does not produce the desired pressure, mortar grout shall be used and the mix varied as necessary to produce the desired results.

When the pressure tends to rise too high, the water/cement ratio shall be increased and/or the mix of mortar, grout changed or discontinued as may be required to produce the desired results. If necessary to relieve premature stoppage, periodic applications of water under pressure shall be made. Under no conditions shall the pressure or rate of pumping be increased suddenly as either may produce a water-hammer effect, which may promote stoppage.

The grouting of any hole shall not be considered complete until that hole takes grout at the rate of one cubic foot of grout or less in ten minutes measured over at least a five minute period at the pressure required for that portion of the hole being grouted.

Should grout leaks develop, the Contractor shall caulk such leaks when and as directed, the cost thereof being included in the contract price for unit price pay item "Placing Grout", in accordance with MEASUREMENT AND PAYMENT.

If, due to size and continuity of fracture, it is found impossible to reach the required pressure after pumping a reasonable volume of grout at the minimum workable water/cement ratio or mortar grout materials ratio the speed of the pumping shall be reduced or pumping shall be stopped temporarily and intermittent grouting shall be performed, allowing sufficient time between grout injections for the grout to stiffen. Following such reduction in pumping speed, if the desired result is not obtained, grouting in the hole shall be discontinued when directed. In such event, the hole shall be cleaned, the grout allowed to set, and additional drilling and grouting shall then be done in this hole or in the adjacent areas as directed, until the desired resistance is built up.

Grout that cannot be placed, for any reason, within two hours after mixing shall be wasted. If such grout is mixed at the direction of the Engineer or with his knowledge and consent, such wasted grout, except as specified in MEASUREMENT AND PAYMENT, shall be paid for at the contract unit prices for the materials contained therein.

Backfilling of Holes:

Holes shall be backfilled with grout proportioned as directed by the Engineer and generally having a water/cement ratio less than 1.0. The backfilling shall be accomplished by injection of grout through a tremie pipe or hose inserted to full depth of hole. When grout vents at the surface, the tremie shall be gradually withdrawn, maintaining grout in pipe or hose until completely removed. Holes containing freshly injected grout shall not be backfilled until the injected grout has set, grout will be paid for at the contract unit price for the Portland cement therein.

Equipment Arrangement and Operation:

The arrangement of the grouting equipment shall be such as to provide a continuous circulation of grout throughout the system and to permit accurate pressure control by operation of a valve on the grout return line, regardless of how small the grout take may be. The equipment and lines shall be prevented from becoming fouled by the constant circulation of grout and by the periodic flushing out of the system with water. Flushing shall be done with the grout intake valve closed, the water supply valve open, and the pump running at full speed.

Records:

The Engineer will keep records of all grouting operations, such as a log of the grout holes, results of washing and pressure testing operations, time of each change of grouting operation, pressure, rate of pumping, amount of cement for each change in water/cement ratio, and other data deemed by him to be necessary. The Contractor shall furnish all necessary assistance and cooperation to this end.