

**SECTION 02870
CONCRETE SLAB RAISING**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Hydraulic pressure jacking of concrete slabs to correct slab profile. Jacking is accomplished by drilling injection holes and pumping a cement/fly ash slurry or polyurethane (foam) under the slab.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment shall be made for boring, drilling, pumping of cementitious grout slurry or polyurethane formulation filler and shall be incidental to this Specification. Measurement shall be per Square Yard or portion thereof, as measured between Construction Joints. Payment shall be in accordance with Measurement and Payment for work as required in appropriate sections.
2. Refer to Section 01270 – Measurement and Payment for other unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. M-295 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
2. T-26 – Standard Method of Test for Quality Water to Be Used in Concrete.

B. ACI – American Concrete Institute

1. 304.6R – Guide for Use of Volumetric-Measuring and Continuous-Mixing Concrete Equipment.

C. ASTM – American Society for Testing and Materials.

1. C-94 – Standard Specification for Ready-Mixed Concrete.
2. C-150 – Standard Specification for Portland Cement.
3. C-685 – Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
4. C-939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
5. C-942 – Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
6. D-1621 – Standard Test Method for Compressive Properties of

- Rigid Cellular Plastics.
- 7. D-1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- C. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit for approval, materials proposed for use. Submittal shall include mill certification for cement, physical and chemical analysis for fly ash, tests if the grout slurry by an independent testing laboratory that conforms to Section 01470 – Testing Laboratory Services.
 - 1. Tests shall show one (1), three (3) and seven (7) day strengths, flow cone times, shrinkage, and expansion observed, and time of initial set. The seven (7) day strength shall be at least six hundred pounds per square inch (600 psi) as measured in accordance with ASTM C-942.

PART II: PRODUCTS

2.1 CEMENT SLURRY MATERIALS

- A. Fluidity of the grout when measured by a flow cone in accordance with ASTM C-939 shall have a time efflux between sixteen (16) and thirty-six (36) seconds. During initial injection at each hole an efflux time between nine (9) and fifteen (15) seconds will be permitted. The use of material with an efflux time between nine (9) and fifteen (15) seconds shall be discontinued prior to movement of the slab. The Contractor shall be required to perform this test prior to placing any material.
- B. Portland Cement: Portland Cement shall be Type 1A conforming to ASTM C-150 – Standard Specification for Portland Cement.
- C. Fly Ash: Class C fly ash conforming to AASHTO M-295 shall be used in grout for pavement jacking, undersealing or when specified. Fly Ash shall be from approved base loaded electric generating plants using a single coal source. Plants using a limestone injection process for controlling air pollutants are not acceptable. Fly ash from start up and shut down of plant shall not be used. The total of silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3) shall be at least sixty-six percent (66%) by dry weight of the total fly ash composition. The silicon dioxide (SiO_2) shall be at least forty percent (40%) by dry weight of the total fly ash composition.

- D. Water: Clean, free from harmful amounts of oils, acids, alkalis, organic or other deleterious substances, and meeting requirements of ASTM C-94. Water from municipal supplies approved by State agencies will not require testing, but water from other sources shall be tested before use in concrete.
 - 1. Tests shall be made in accordance with AASHTO T-26. One gallon (1 Gal) shall be taken to qualified testing laboratory for testing.
- E. Mix Design: Cement Slurry Mix Design shall conform to the following TABLE 4.1 – CEMENT SLURRY MIXTURE. There will be **NO** deviation from the approved mix design.

2.2 POLYURETHANE FORMULATION

- A. Jacking Foam: Water blown formulation of high-density polyurethane. The high density, closed cell polyurethane shall be hydrophobic and shall exhibit the following physical characteristics as specified in TABLE 4.2 – HIGH-DENSITY POLYURETHANE FOAM.
- B. The polyurethane formulation shall have a free rise density of three (3.0) to three and two-tenths (3.2) pounds per cubic foot (lbs/cf), with a minimum compressive strength of forty pounds per square inch (40 psi). The material shall be resistant to oils, gasoline and most solvents.
- C. The high-density polyurethane formulation shall reach ninety percent (90%) of full compressive strength within fifteen (15) minutes from injection.

2.3 EQUIPMENT

- A. For Cement Slurry:
 - 1. The grout plant shall consist of a positive displacement cement injection pump and a high speed colloidal mixing machine. The colloidal mixing machine shall operate between eight hundred revolutions per minute (800 rpm) and two thousand revolutions per minute (2,000 rpm), creating a high shearing action and subsequent pressure release to make a homogeneous mixture.
 - 2. Mixing equipment shall be self-contained continuous mixer, with calibrated mixing and delivery systems, carrying all water, cement, aggregate for slurry mixes and foam for polyurethane mixes needed on the job site. The continuous mixer shall meet or exceed the Standards of Calibration set forth by the Volumetric Mixer Manufacture Bureau (VMMB), a member of the National Ready Mix Concrete Association (NRMCA), and conforming to ASTM C-685 and ACI 304.6R.
 - 3. All materials pumped shall be a minimum of five hundred pounds per square inch (500 psi) to a maximum of one thousand pounds per square inch (1,000 psi).
- B. For Polyurethane Formulation:
 - 1. The pumping unit for polyurethane formulation shall be a truck-

mounted pumping unit capable of injecting high-density polyurethane formulation between the concrete slab and the subgrade and be capable of controlling the rate of rise of the slab. The pumping unit shall be equipped with a metering device to measure quantity of material pumped.

- C. Drilling shall be accomplished using an air compressor and rock drills, or other devices capable of drilling the injection holes completely through the concrete slab.
- D. A laser leveling unit shall be used to ensure that the concrete slab is raised to an even plane and to the required elevation.

PART III: EXECUTION

3.1 PREPARATION

- A. Notify the Project Manager prior to commencement of any activities. Project Manager will verify the areas to be raised and the pattern for the drilling of the injection holes.
- B. Slab jacking shall not be performed when the slab surface temperatures are below forty degrees Fahrenheit (40° F), or if the subgrade or base course is frozen. Slab jacking shall not be performed when the subgrade or base course contains an abnormal amount of moisture from recent rainfall, as evidenced by standing water on the slab, or in the joints, or cracks.
- C. All materials for jacking operations shall be on site and mobile and not stored in the road or work area, unless approved by the Project Manager.
- D. The Contractor shall not start any new location unless it can be completed in the same day.
- E. The Contractor shall take all necessary precautions to prevent jacking material from entering areas such as pipes, culverts or any other area that is not designated for slab raising. If jacking material enters these areas the Contractor shall remove it to the satisfaction of the City.

3.2 DRILLING HOLES

- A. When jacking slurry is specified, holes should be between one and one half inch (1-1/2 in) and two inches (2 in) in diameter, drilled vertically and round, to a depth sufficient to penetrate any stabilized base and into the subgrade material. Holes may be washed to create a small cavity, allowing initial spread of grout. Holes shall be drilled in a manner that prevents breakout at the bottom of the slab. The downward force of the drill shall not exceed two hundred pounds (200 lbs).
- B. When polyurethane formulation is specified, holes shall be five-eighths inch (5/8 in) in diameter, drilled vertically, and round to a depth sufficient to penetrate any stabilized base and in the subgrade material. Holes shall be drilled in a manner that prevents breakout of the slab.

3.3 CEMENT SLURRY JACKING

- A. String lines shall be established and blocked up from pavement high points to monitor movement.
- B. An expanding rubber packer or other approved device connected to the discharge from the plant shall be lowered into the hole. The discharge end of the packer shall not extend below the lower surface of the concrete slab.
- C. The Contractor shall pump in a pattern and in the amount to raise the slab to within two-hundredths foot (0.02 ft) of specified grade. Grade tolerances are applicable to both transverse and longitudinal grades. After the pavement has been raised to the desired elevation, all holes shall be injected to ensure complete filling of voids.
- D. Continuous pressure of up to two hundred pounds per square inch (200 psi) will be permitted. Pressures up to three hundred pounds per square inch (300 psi) will be allowed only for short periods. If the slab is bonded to the subgrade, brief pressure rises up to six hundred pounds per square inch (600 psi) ten seconds (10 sec) or less.
- E. Mixed material shall not be held in the mixer or injection sump pump for more than one hour (1 HR) after mixing. Any material held longer than one hour (1 HR) shall be wasted and shall not be paid for. Additional water shall not be added after the initial mixing of the grout.
- F. Excessive loss of the slurry through cracks, joints, other drilled holes, or from back pressure in the hose will not be tolerated and shall not be paid for.
- G. If the Project Manager determines that continued slurry injection at a specific location is no longer feasible due to major voids, the Project Manager may direct the Contractor to cease slurry injection at that location.
- H. Upon completion of jacking, holes shall be patched in conformity with the grout specifications in this Section.

3.4 POLYURETHANE FORMULATION JACKING

- A. The high-density polyurethane formulation is to be injected under the slab. The amount of rise shall be controlled using the pumping unit and by regulating the rate of injection.
- B. The Contractor shall inject in a pattern and in the amount required to raise the pavement to within two-hundredths foot (0.02 ft) of the specified grade. Grade tolerances are applicable to both transverse and longitudinal grades. A tight string line and/or laser level shall be used to monitor and verify elevations. After the slab has been raised to the desired elevation, all holes shall be injected to ensure complete filling of voids.
- C. Excessive loss through cracks, joints, other drilled holes, or from back pressure in the hose will not be tolerated and shall not be paid for.
- D. If the Project Manager determines that continued slurry injection at a specific location is no longer feasible due to major voids, the Project

Manager may direct the Contractor to cease slurry injection at that location.

- E. Upon completion of jacking, the upper two inches (2 in) of the drilled holes shall be patched in conformity with the grout specifications in this Section. The foam material shall; be removed from the injection hole appropriately to ensure a good bond between the grout and the in-place concrete.

3.5 DAMAGE

- A. Radial Cracks: The slab shall not be raised more than one-quarter inch (1/4 in) while pumping in any one (1) hole at any one (1) time. Cracks emanating radially from the grout injection holes shall be presumed to have been caused by improper injection techniques by the Contractor and shall be repaired at no cost to the City.
- B. Transverse Cracks: If cracks develop between adjacent injection holes, the Contractor shall repair the cracks at no cost to the City.
- C. Slab Raised above Tolerance: Slabs raised above tolerance, shall be brought to grade by grinding. If over jacking is greater than one-tenth foot (0.10 ft), satisfactory removal, and replacement shall be required at no additional cost to the City.
- D. Corrective actions for cracks shall be as those listed in Section 02805 – Concrete Paving.

3.6 GROUT

- A. Holes that have been used for injections sites will be grouted utilizing a mixture of Portland Cement Type I and Mason Sand in a two (2) to one (1) proportion. All grout shall be non-shrinkable and conform to Section 03105 – Grout.
- B. For cement slurry mixture the hole can be grouted as soon as the cement slurry has set. If the operations make it unfeasible to grout immediately after the slab has been raised, then the holes shall be cleaned using a wire brush or sand blasting the full depth of the slab to remove the excess of slurry, then grouted.
- C. For polyurethane formulations the foam shall be removed from the top two inches (2 in) of the injection hole and filed with grout.

PART IV: TABLES

4.1 – CEMENT SLURRY MIXTURE

<u>MATERIAL</u>	<u>PERCENT PASSING</u>	<u>PERCENT OF MIXTURE</u>
Lime/Fly Ash Mixture passing #50 Sieve	100%	27%
Sand Passing #4 Sieve	100%	15%
Ground clay passing #4 Sieve	100%	50%
Portland Cement, Type 1A, 3-1/2 bag mix (approx.)	N/A	8%
NOTE: Should Fly Ash and/or Lime not be readily available, increase the amount of Sand by 27%.		

4.2 – HIGH-DENSITY POLYURETHANE FOAM

Density, LB/CF (ASTM D-1622)	Compressive Strength (ASTM D-1621)
3.0	40 psi
3.5	50 psi
4.0	60 psi
6.0	110 psi

END OF SECTION