
**SECTION 02800
ASPHALT PAVING**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Surface course of compacted mixture of coarse and fine aggregates and asphaltic binder.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for hot-mix asphalt concrete pavement is on a per ton basis. Separate pay items are used for each different required thickness of pavement.
2. Payment for hot-mix asphalt concrete pavement includes payment for associated work performed in accordance with Section 02735 – Tack Coat.
3. Measurement for utility projects: Match actual pavement replaced but no greater than a maximum pavement replacement limits shown on the Drawings.
4. Measurement for utility projects:
 - a. Actual pavement replaced but not beyond the maximum pavement replacement limits shown on the Drawings.
 - b. Include installed hot-mix asphaltic base course material that extends one foot (1 Ft) beyond outside edge of pavement to be replaced, except where proposed pavement section shares common edge with existing pavement section.
5. Payment for speed humps is on linear foot basis and includes milling of existing pavement, tack coat and placement and compaction of asphalt. Measurement of speed hump is along length of twelve foot (12 Ft) wide speed hump, measured transverse to centerline of road. Separate payment is made for thermoplastic markings applied to speed hump.
6. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Standards for Testing and Materials.

1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
 - 1. TxDOT Tex-106-E – Calculating the Plasticity Index of Soils
 - 2. TxDOT Tex-126-E – Molding, Testing and Evaluating Bituminous Black Base Material.
 - 3. TxDOT Tex-200-F – Sieve Analysis of Fine and Course Aggregates.
 - 4. TxDOT Tex-203-F – Sand Equivalent Test.
 - 5. TxDOT Tex-204-F – Design of Bituminous Mixtures.
 - 6. TxDOT Tex-206-F – Compacting Test Specimens of Bituminous Mixtures.
 - 7. TxDOT Tex-207-F – Determining Density of Compacted Bituminous Mixtures.
 - 8. TxDOT Tex-208-F – Test for Stabilometer Value of Bituminous Mixtures.
 - 9. TxDOT Tex-217-F – Determining Deleterious Material and Decantation Test for Coarse Aggregates.
 - 10. TxDOT Tex-227-F – Theoretical Maximum Specific Gravity of Bituminous Mixtures.
 - 11. TxDOT Tex-530-C – Effect of Water on Bituminous Paving Mixtures.
 - 12. TxDOT Tex-531-C – Prediction of Moisture Induced Damage to Bituminous Paving Materials Using Molded Specimens.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit certificates that asphalt materials and aggregates meet requirements of Paragraph 2.1 Materials.
- C. Submit proposed design mix and test data for surface course.
- D. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

PART II: PRODUCTS

2.1 MATERIALS

- A. Coarse Aggregate:
 - 1. Use gravel, crushed stone or combination thereof that is retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic or other injurious matter occurring either free or as coating on aggregate. Use aggregate conforming to ASTM C33 except for gradation. Furnish rock or gravel with Los Angeles abrasion loss not to exceed forty percent (40%) by weight when tested in accordance with ASTM C131.
 - 2. Aggregate by weight shall not contain more than one and one half percent (1.5%) by weight of fine dust, claylike particles or silt when tested in accordance with Tex-217-F, Part II.

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- B. Fine Aggregate: Sand, stone screenings or combination of both passing No. 10 sieve. Use aggregate conforming to ASTM C33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other injurious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than ten (10) when tested by TxDOT Tex-106-E. Sand equivalent shall have a minimum value of forty (40) x when tested by TxDOT Tex-203-F.
- C. Composite Aggregate: Conform to limits when graded in accordance with TxDOT Tex-200-F as specified in TABLE 4.1 – GRADATION OF COMPOSITE AGGREGATE in this Section. Use type specified on the Drawings.
- D. Asphalt Binder: Moisture-free homogeneous material which shall not foam when heated to three hundred forty-seven degrees Fahrenheit (347° F), meeting the requirements specified in TABLE 4.2 – PERFORMANCE GRADED BINDERS in this Section.
- E. Anti-stripping Agent:
 - 1. Evaluate mixture of aggregate, asphalt and additives proposed for use for moisture susceptibility and requirement for anti-stripping agents. To substantiate mix design, produce and test trial mixtures using proposed project materials and equipment prior to placement. Test for susceptibility to moisture and trial mixture may be waived by the Project Manager when similar designs using same material have previously proven satisfactory.
 - 2. Liquid Anti-stripping Agent: Use anti-stripping agent with uniform liquid with no evidence of crystallization, settling or separation of components. Submit sample of antistripping agent proposed for use and manufacturer's product data, including recommended dosage range, handling and storage and application instructions.
- F. Pavement markings for speed humps: Conform to requirements of Section 02860 – Thermoplastic Pavement Markings.

2.2 EQUIPMENT

- A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuous mixtures meeting specifications. With exception of a drum mix plant, plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins and dust collectors.
- B. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:
 - 1. Cold aggregate bins and proportioning device.
 - 2. Dryer.
 - 3. Screens.
 - 4. Aggregate weight box and batching scales.
 - 5. Mixer.

6. Asphalt storage and heating devices.
 7. Asphalt measuring devices.
 8. Truck scales.
- B. Bins: Separate aggregate into a minimum of four (4) bins to produce consistently uniform grading and asphalt content in completed mix. Provide one (1) cold feed bin per stockpile.

2.3 MIXES

- A. Employ certified testing laboratory to prepare design mixes. Test in accordance with TxDOT Tex-126-E or Tex-204-F, Tex-206-F, Tex-208-F, Tex-530-C and Tex-531-C.
- B. Density, Stability and Air Void Requirements as stated in TABLE 4.3 – DENSITY, STABILITY AND AIR VOID REQUIREMENTS in this Section.

PART III: EXECUTION

3.1 EXAMINATION

- A. Verify compacted base course is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Prepare subgrade in accordance with requirements of Section 02700 – Cement-Stabilized Base Course, Section 02705 – Crushed Concrete Base Course or Section 02715 – Hot-Mix Asphaltic Base Course.
- B. Tack Coat: Conform to requirements of Section 02735 – Tack Coat. Where mixture shall adhere to surface on which it is to be placed without use of tack coat, tack coat may be eliminated when approved by the Project Manager.
- C. Thoroughly clean base course surface of loose material by hand brooming or mechanical sweeping prior to application of tack coat or surface course. Prepare subgrade in advance of asphaltic concrete paving operation.
- D. Perform pavement repair and resurfacing as indicated in Section 02845 – Pavement Repair and Resurfacing.
- E. Do not use cutback asphalt.
- G. Milling of pavement for speed humps: Mill pavement (concrete or asphalt) to depth of one inch (1 In) and width between eighteen inches (18 In) and twenty-four inches (24 In) around entire perimeter of proposed hump, as shown in detail for speed hump design.

3.3 PLACEMENT

- A. Do not place asphaltic pavement less than two inches (2 In) thick when surface temperature taken in shade and away from artificial heat is below fifty degrees Fahrenheit (50° F) and falling. Asphalt may be placed when temperature as measured above is above forty degrees Fahrenheit (40° F) and rising.
- B. Haul prepared and heated asphaltic concrete mixture to project in tight

vehicles previously cleaned of foreign material. Mixture temperature shall be between two hundred fifty degrees Fahrenheit (250° F) and three hundred twenty-five degrees Fahrenheit (325° F) when laid.

- C. Spread material into place with approved mechanical spreading and finishing machine of screening or tamping type.
- D. Surface Course Material: Surface course two inches (2 In) or less in thickness may be spread in one (1) lift. Spread lifts in such a manner that, when compacted, finished course shall be smooth, of uniform density and shall be to section, line and grade as shown. Place construction joints on surface courses to coincide with lane lines or as directed by the Project Manager.
- E. Joints: Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back laid material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.
- F. When new asphalt is laid against existing or old asphalt, saw cut existing or old asphalt to full depth to provide straight smooth joint.
- G. In smaller restricted areas where use of paver is impractical spread material by hand. Compact asphalt by mechanical means. Carefully place materials to avoid segregation of mix. Do not broadcast material. Remove lumps that do not break down readily.

3.4 COMPACTION

- A. Construct test strip to identify correct type, number and sequence of rollers necessary to obtain specified in-place density or air-voids when directed by the Project Manager. Prepare test strip at least one thousand feet (1000 Ft) in length, comparable to placement and compaction conditions for Project.
- B. Begin rolling while pavement is still hot and as soon as it shall bear roller without shoving, displacement or hair cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water or petroleum by-products.
- C. Compact surface thoroughly and uniformly, first with power-driven, three (3) wheel or tandem rollers weighing a minimum of eight tons (8 Tn). Obtain subsequent compression by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half (1/2) width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compression can be obtained and rolling marks are eliminated. Complete rolling before mat temperature drops below one hundred eighty-five degrees Fahrenheit (185° F).
- D. Use tandem roller for final rolling. Double coverage with approved pneumatic roller on asphaltic concrete surface is acceptable after flat wheel and tandem rolling has been completed.
- E. Along walls, curbs, headers and similar structures and in locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.
- F. Compact binder course and surface course to a minimum density of

ninety-one percent (91%) of maximum possible density of voidless mixture composed of same materials in like proportions.

3.5 TOLERANCES

- A. Furnish templates for checking surface in finished sections. A maximum deflection of templates, when supported at center, shall not exceed one-eighth inch (1/8 In).
- B. Completed surface, when tested with ten foot (10 Ft) straightedge laid parallel to center line of pavement, shall show no deviation in excess of one-eighth inch (1/8 In) in ten feet (10 Ft). Correct surface not meeting this requirement.
- C. Dimensions of speed humps shall conform to details for speed hump design and speed hump height tolerances.

3.6 QUALITY CONTROL

- A. Testing shall be performed under provisions of Section 02845 – Pavement Repair and Resurfacing.
- B. For in-place depth and density, take a minimum of one (1) core at random locations for each one thousand feet (1000 Ft) of single lane pavement. On a two (2) lane pavement, take samples at random every five hundred feet (500 Ft) from alternating lanes. Take cores for parking lots every five hundred square yards (500 Sy) of base to determine in-place depth and density. If cul-de sac or streets are less than five hundred feet (500 Ft), a minimum of two (2) cores [one (1) per lane] shall be procured. On small projects, take a minimum of two (2) cores for each day's placement. For first days placement and prior to coring, a minimum of five (5) nuclear gauge readings shall be performed at each core location to establish correlation between nuclear gauge (wet density reading) and core (bulk density). This process shall continue for each day's placement until the Project Manager determines that a good basis has been established for the nuclear gauge.
- C. Determine in-place density in accordance with TxDOT Tex-207-F and Tex-227-F from cores or sections. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by the Project Manager. Average densities for each street placed in a single day to determine compliance.
- D. The Contractor may request three (3) additional cores in vicinity of cores indicating nonconforming in-place depths or density at no additional cost to the City. In-place depth and density at these locations shall be average of four (4) cores.
- E. Fill cores and density test sections with new compacted asphaltic concrete.

3.7 NONCONFORMING PAVEMENT

- A. Recompact and retest nonconforming street sections not meeting surface test requirements or having unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute. Retesting shall be at no additional cost to the City.
- B. Remove and replace areas of asphalt surface found deficient in thickness by more than ten percent (10%). Use new asphaltic surface of thickness shown on the Drawings. Remove and replace areas of asphalt surface found deficient in average density.
- C. Replace speed humps which do not conform to requirements of details or which are rejected by the Project Manager.

3.8 PROTECTION

- A. Do not open pavement to traffic until completion of rolling and temperature has cooled to set asphaltic concrete surface or as shown on the Drawings.
- B. Maintain asphalt pavement in good condition until completion of the Work.
- C. Repair defects immediately by replacing asphalt pavement to full depth.

3.9 PAVEMENT MARKINGS FOR SPEED HUMPS

- A. Apply pavement markings to speed humps in conformance with dimensions shown on detail for speed hump design.

PART IV: TABLES

4.1 GRADATION OF COMPOSITE AGGREGATE

GRADATION OF COMPOSITE AGGREGATE		
SIEVE SIZE	PERCENT PASSING	
	Course Surface (TxDOT Type C)	Fine Surface (TxDOT Type D)
7/8"	100	-
5/8"	95 to 100	-
1/2"	-	100
3/8"	70 to 85	85 to 100
#4	43 to 63	50 to 70
#10	30 to 40	32 to 42
#40	10 to 25	11 to 26
#80	3 to 13	4 to 14
#200	1 to 6*	1 to 6*
VMA % Minimum	13	14

* 2 to 8 when Test Method Tes-200-F, Part II (Washed Sieve Analysis) is used.

4.2 PERFORMANCE GRADED BINDERS

PERFORMANCE GRADED BINDER	
CRITERIA/TEST	PERFORMANCE GRADE (PG64-22)
Average 7-day Maximum Pavement Design Temperature, C	< 64
Minimum Pavement Design Temperature, C	> -22
ORIGINAL BINDER	
Flash Point Temperature, T48; Minimum C	230
Viscosity, ASTM D 4402; Maximum, 3Pa*s(3000 cp) Test Temperature, C	135
Dynamic Shear, TP5; G*/sin[], Minimum, 1.00 kPa Test Temperature @ 10 rad/sec., C	64
ROLLING THIN FILM OVEN (T240) OR THIN FILM OVEN (T179) RESIDUE	
Mass Loss, Maximum, %	1.00
Dynamic Shear, TP5; G*/sin[], Minimum, 2.20 kPa Test Temperature @ 10 rad/sec., C	64
PRESSURE AGING VESSEL RESIDUE (PP1)	
PAV Aging Temperature, C	100
Dynamic Shear, TP5; G*/sin[], Minimum, 5000 kPa Test Temperature @ 10/rad/sec., C	25
Physical Hardening	Report
Creep Stiffness, TP1; S. Maximum, 300 Mpa -value, Minimum, 0.300 Test Temperature @ 60 sec., C	-12
Direct Tension, TP3; Failure Strain, Minimum, 1.0% Test Temperature @ 1.0 mm/min., C	-12

4.3 DENSITY, STABILITY AND AIR VOID REQUIREMENTS

PERCENT DENSITY		PERCENT OPTIMUM	HVEEM Stability Percent Not Less Than
Mi	M		
94	97	96	35

END OF SECTION

**SECTION 02805
CONCRETE PAVING**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Portland cement concrete paving.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for concrete paving is on a square yard basis. Separate pay items are used for each different required thickness of pavement.
2. Payment for concrete paving, high early strength, is on a square yard basis.
3. Measurement for utility projects: Match actual pavement replaced but no greater than a maximum pavement replacement limits shown on the Drawings.
4. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Standards for Testing and Materials.

1. ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A185 – Standard Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
3. ASTM A615 – Standard Specification for Deformed and Plain Billet – Steel Bars for Concrete Reinforcement.
4. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
5. ASTM C33 – Standard Specifications for Concrete Aggregates.
6. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
7. ASTM C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
8. ASTM C42 – Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
9. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
10. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

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11. ASTM C136 – Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
12. ASTM C138 – Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
13. ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete.
14. ASTM C150 – Standard Specification for Portland Cement.
15. ASTM C174 – Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.
16. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
17. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
18. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
19. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

B. CFTS – City of Friendswood Technical Specifications.

C. TxDOT – Texas Department of Transportation.

1. TxDOT Tex-203-F – Sand Equivalent Test.
2. TxDOT Tex-406-A – Material Finer than 75 Fm (No. 200) Sieve In Mineral Aggregates (Decantation Test for Cement Aggregates).

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit proposed mix design and test data for each type and strength of concrete in the Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.
- C. Submit for approval manufacturer's description and characteristics for mixing equipment, and for traveling form paver when proposed for use.
- D. Submit manufacturer's certificates giving properties of reinforcing steel. Include certificate of compliance with ASTM A82. Provide specimens for testing when required by the Project Manager.

1.5 HANDLING AND STORAGE

- A. Do not mix different classes of aggregate without written permission of the Project Manager.
- B. Class of aggregate being used may be changed before or during the Work with written permission of The Project Manager. When new class of aggregate is being used, it shall comply with this Technical Specification and shall be verified by the Project Manager.
- C. Reject segregated aggregate. Before using aggregate whose particles

are separated by size, mix them uniformly to grading requirements.

- D. Reject aggregates mixed with dirt, weeds or foreign matter.
- E. Do not dump or store aggregate in roadbed.

1.6 DEFINITIONS

- A. Batch – materials proportioned for concrete according to the APPROVED mix design and adjusted for moisture in aggregates. Batch targets shall be based on mixed design parameters, adjusted for moisture and stay within tolerance the Specifications for proportioning in accordance with ASTM C685.
- B. Cracks – any split, rip or tear that penetrates the surface of the finished concrete. Cracking or “spider cracks” shall not be considered under this Section. The following are types of cracking with clear definitions and remedies which shall be followed:
 - 1. Longitudinal Crack – cracks that mostly follow the centerline of the roadway. In a case where the line runs diagonal to the centerline, it shall be determined by using the rise/run method whether or not the crack is parallel to the centerline of the road way. Any crack that has a run greater than the rise (perpendicular to the centerline) shall be considered a longitudinal crack. If said crack proceeds beyond a construction or expansion joint, this shall be considered the same crack. All concrete that has longitudinal cracks shall be replaced with no exceptions, and new maintenance bond given to cover one year (1 Yr) from date of replacement of concrete.
 - 2. Shrinkage Crack – cracks that are less than six hundredths inch (0.06 In) in width and no more than one-half inch (1/2 In) in depth shall be considered shrinkage cracks. No corrective action shall be required, but the length, width (at widest point) and depth (at widest point) shall be documented. At the one year (1 Yr) maintenance walkthrough, if any of these three (3) measurements have increased by ten percent (10%) or new shrinkage cracks have appeared in the same paving panel, corrective action shall be taken as approved by the Director of Engineering. An extended maintenance bond may be required.
 - 3. Stress Crack – cracks that are more than six hundredths inch (0.06 In) but less than one-tenth inch (0.1 In) in width and of varying depths shall be considered stress cracks. These types of cracks are caused by tensile stress on concrete. Length, width and depth stress cracks shall be documented as described in 1.7.B.2 in this Section. Corrective action shall be taken as approved by the Director of Engineering. An extended maintenance bond may be required.
 - 4. Structural Crack – cracks greater than one-tenth inch (0.1 In) in width, no matter what depth shall be considered structural cracks. These types of cracks are caused by severe tensile

stress on concrete and concrete failure. All concrete with structural cracks shall be replaced with no exceptions, and new maintenance bond given to cover one (1 Yr) year from date of replacement of concrete.

- C. Joints:
 - 1. Control joint – shall either be a tooled or saw cut joint that shall control cracking of concrete paving. Control joints shall be spaced not greater than fifteen foot (15 Ft) intervals between expansion joints unless approved by the Project Manager.
 - 2. Construction joint – shall end a placement of concrete at the end of or at the centerline of a paving section. All construction joints shall use keyways to facilitate tie in to adjacent concrete placement.
 - 3. Expansion joint – shall end a paving panel or connect to existing pavement. Expansion joint shall use cedar wood material with a one inch (1 In) zip strip to allow for installation of sealant material. Dowels shall be imbedded as specified in the City of Friendswood Standard Detail Sheets. Expansion joints shall be placed not more than sixty feet (60 Ft) apart unless otherwise approved by the Project Manager.
- D. Paving Panel – defined as concrete paving from one (1) expansion/construction joint to the next expansion/construction joint in length and edge of paving/construction joint to the next edge of paving/construction joint. There shall be no full width monolithic paving or paving from edge of pavement to edge of pavement, if the placement width exceeds fifteen feet (15 Ft), allowed at anytime.

PART II: PRODUCTS

2.1 MATERIALS

- A. Portland Cement:
 - 1. Sample and test cement to verify compliance with Standards of ASTM C150, Type I or Type III.
 - 2. Bulk cement which meets referenced standards may be used when method of handling is approved by the Project Manager. When using bulk cement, provide satisfactory weighing devices.
 - 3. Fly ash which meets standards of ASTM C618 may be used as mineral fill when method of handling is approved by the Project Manager.
- B. Water: Conform to requirements for water in ASTM C94.
- C. Coarse Aggregate: Crushed stone, gravel or combination thereof, which is clean, hard and durable, conforms to requirements of ASTM C33 and has abrasion loss not more than forty-five percent (45%) by weight when subjected to Los Angeles Abrasion Test (ASTM C131).
 - 1. Maximum percentage by weight of deleterious substances shall not exceed values specified in TABLE 4.1 – DELETERIOUS

- SUBSTANCES in this Section.
2. Conform coarse aggregate (size 1-1/2 inch to No. 4 sieve) to requirements of ASTM C33. Use gradation within limits specified in TABLE 4.2 – COARSE AGGREGATE SIEVE ANALYSIS REQUIREMENTS when graded in accordance with ASTM C136.
- D. Fine Aggregate: Sand, manufactured sand or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Conform fine aggregate for concrete to requirements of ASTM C33. Use gradation within TABLE 4.3 – FINE AGGREGATE SIEVE ANALYSIS REQUIREMENTS in this Section, limits when graded in accordance with ASTM C136.
1. When subjected to color test for organic impurities (ASTM C40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than eighty (80), unless higher value is shown on the Drawings.
- E. Mineral Filler: **FLY ASH CAN ONLY BE USED WHEN DESIGN MIX HAS BEEN SUBMITTED AND APPROVED BY THE DIRECTOR OF ENGINEERING.** Type “C” or Type “F” fly ash of acceptable quality and meeting requirements of ASTM C618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, store and inspect in accordance with ASTM C618. Do not use fly ash in amounts in excess of twenty-five percent (25%) by weight of cementitious material in mix design. Cement content may be reduced when strength requirements can be met. Note: When fly ash is used, the term "cement" is defined as cement plus fly ash.
- F. Air Entraining Agent: Furnish air entraining agent conforming to requirements of ASTM C260.
- G. Water Reducer: Water reducing admixture conforming to requirements of ASTM C494 may be used when required to improve workability of concrete. Amount and type of admixture is subject to approval by the Project Manager.
- H. Reinforcing Steel:
1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A615, Grade 60. Store reinforcing steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil or other injurious materials.
 2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.
 3. Provide wire fabric conforming to ASTM A82. Use fabric in which longitudinal and transverse wires have been electrically welded at points of intersection. Welds shall have sufficient strength to not be broken during handling or placing. Conform welding and fabrication of fabric sheets to ASTM A185.

- 4. Reinforcing Steel shall conform with Section 03200 – Reinforcing Steel.

2.2 EQUIPMENT

- A. Conform Equipment to requirements of ASTM C94.

2.3 MIXING

- A. Compressive strength shall be as specified using test specimens prepared in accordance with ASTM C31 and tested in accordance with ASTM C39. Determine and measure batch quantity of each ingredient, including water for batch designs and all concrete produced for the Work. Mix shall conform to these Technical Specifications and other requirements indicated on the Drawings.

- B. Mix design to produce concrete which shall have compressive strength of two thousand seven hundred pounds per square inch (2700 psi) at seven days (7 D) and three thousand pounds per square inch (3000 psi) at twenty-eight days (28 D). Slump of concrete shall be at least three inches (3 In) but no more than five inches (5 In), when tested in accordance with ASTM C143.

- 1. Concrete pavement, including curb, curb and gutter and saw-tooth curb, shall contain at least five (5) sacks [ninety-four pounds (94 Lbs) per sack] of cement per cubic yard, with not more than six and one-half gallons (6-1/2 Gals) of water, net, per sack of cement (water-cement ratio maximum 0.57). Determine cement content in accordance with ASTM C138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.

- 2. Coarse dry aggregate shall not exceed eighty-five percent (85%) of loose volume of concrete.

- 3. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in the Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be four percent (4%) plus or minus one and one-half percent ($\pm 1-1/2\%$). Determine air content by testing in accordance with ASTM C231.

- 4. Use retardant when temperature exceeds ninety degrees Fahrenheit (90° F). Proportion as recommended by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent.

- C. Use high early strength concrete pavement to limits shown on the Drawings. Design to meet following:

- 1. Concrete Mix: Compressive strength greater than or equal to three thousand pounds per square inch (3000 psi) at seventy-two hours (72 Hrs).

2. Cement: Minimum of seven (7) sacks of cement per cubic yard of concrete.
3. Water-Cement Ratio maximum of 0.45. Slump of concrete shall a maximum of five inches (5 In), when tested in accordance with ASTM C143.
4. Other requirements for proportioning, mixing, execution, testing, etc., shall be in accordance with this Section.

PART III: EXECUTION

3.1 EXAMINATION

- A. Verify compacted base is ready to support imposed loads and meets compaction requirements.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.
- B. Remove subgrade that shall not support loaded form. Replace and compact subgrade to required density.
- C. After one inch (1 In) or more of consecutive rain, retest subgrade for compaction and moisture. Replace or, scarify and compact, to achieve required density.

3.3 EQUIPMENT

- A. Alternate equipment and methods, other than those required by this Section, may be used provided equal or better results shall be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order.
- B. Subgrade Planer and Template:
 1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on the Drawings. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it shall remain on form and have strength and rigidity that, under tests made by changing support from wheels to center, planer shall not develop deflection of more than one-eighth inch (1/8 In). Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.
 2. Provide template for checking contour of subgrade. Template shall be long enough to rest upon side forms and have strength

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and rigidity that, when supported at center, maximum deflection shall not exceed one-eighth inch (1/8 In). Fit template with accurately adjustable rods projecting downward at one foot (1 Ft) intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.

- C. Machine Finisher: Provide power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two (2) screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires when it operates on concrete pavement.
- D. Hand Finishing:
 - 1. Provide mechanical strike and tamping template two feet (2 Ft) longer than width of pavement to be finished. Shape template to pavement section.
 - 2. Provide two (2) bridges to ride on forms and span pavement for finishing expansion and control joints. Provide floats and necessary edging and finishing tools.
- E. Burlap Drag or transverse broom for Finishing Slab: Furnish four (4) plies of ten ounce (10 Oz) burlap material fastened to bridge to form continuous strip of burlap full width of pavement. Maintain contact of three foot (3 Ft) width of burlap material with pavement surface. Keep burlap drags clean and free of encrusted mortar.
- F. Vibrators: Furnish mechanically-operated, synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.
- G. Traveling Form Paver: Approved traveling form paver may be used in lieu of construction methods employing forms, consolidating, finishing and floating equipment. Meet requirements of this specification for subgrade, pavement tolerances, pavement depth, alignments, consolidation, finishing and workmanship. When traveling form paver does not provide concrete paving that meets compaction, finish and tolerance requirements of this Technical Specification, immediately discontinue its use and use conventional methods.
 - 1. Equip traveling paver with longitudinal transangular finishing float adjustable to crown and grade. Use float long enough to extend across pavement to side forms or edge of slab.
 - 2. Ensure that continuous deposit of concrete can be made at paver to minimize starting and stopping. Use conventional means of paving locations inaccessible to traveling paver or having horizontal or vertical curvature that traveling paver cannot negotiate.
 - 3. Where the Drawings require tie bars for adjacent paving, securely tie and support bars to prevent displacement. Tie bars may be installed with approved mechanical bar inserter mounted

on traveling-form paver. Replace pavement in which tie bars assume final position other than that shown on the Drawings.

3.4 FORMS

- A. Side Forms: Use metal forms of approved shape and section. Preferred depth of form is equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement shall be permitted, provided difference between form depth and edge thickness is not greater than one inch (1 In), and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. Forms shall be approved by the Project Manager. Length of form sections shall be not less than ten feet (10 Ft) and each section shall provide for staking in position with not less than three (3) pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of two hundred foot (200 Ft) radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they shall withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than eight inches (8 In) for form eight inches (8 In) or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than ten feet (10 Ft) in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.
- B. Form Setting:
1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than one-eighth inch (1/8 In) in ten feet (10 Ft) of length. Do not remove forms for at least eight hours (8 Hrs) after completion of finishing operations. Provide supply of forms that shall be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by the Project Manager.
 2. Adjacent slabs may be used instead of forms, provided that concrete is well protected from possible damage by finishing equipment. Do not use adjacent slabs for forms until concrete has aged at least seven days (7 D).

3.5 REINFORCING STEEL AND JOINT ASSEMBLIES

- A. Place reinforcing steel and joint assemblies and position securely as indicated on the Drawings. Wire reinforcing bars securely together at ends and splices, remaining mat shall be fifty percent (50%) tied at intersections. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Secure reinforcing steel to chairs.
- B. Position pavement joint assemblies at required locations and elevations and rigidly secure in position. Install dowel bars in joint assemblies, each parallel to pavement surface and to center line of pavement, as shown.
- C. Cut header boards, joint filler, and other material used for forming joints to receive each dowel bar.
- D. Secure in required position to prevent displacement during placing and finishing of concrete.
- E. Drill dowels into existing pavement, secure with approved epoxy, and provide paving headers as required to provide rigid pavement sections.
- F. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on the Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than one-twelfth (1/12) of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than one-quarter inch (1/4 In).

3.6 FIBROUS REINFORCING

- A. Do not use fibrous reinforcing to replace structural, load-bearing or moment-reinforcing steel.

3.7 PLACEMENT

- A. Place concrete when air temperature taken in shade and away from artificial heat is above thirty-five degrees Fahrenheit (35° F) and rising. Do not place concrete when air temperature is below forty degrees Fahrenheit (40° F) and falling.
- B. Place concrete within ninety minutes (90 Min) after initial water had been added. Remove and dispose of concrete not placed within this period.
- C. Concrete slump during placement shall be three inches (3 In) to five inches (5 In), except when using traveling-form paver which require slump shall be a maximum of three inches (3 In).
- D. Deposit concrete continuously in successive batches. Distribute concrete in manner that shall require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At placement interruption of more than thirty minutes (30 Min), place transverse construction joint at stopping point. Remove and replace sections less than ten feet (10 Ft) long.
- E. Take special care in placing and spading concrete against forms and at

longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement shall be cause for rejection of pavement sections.

3.8 COMPACTION

- A. Consolidate concrete using mechanical vibrators as specified herein. Extend vibratory unit across pavement, not quite touching side forms. Space individual vibrators at close enough intervals to vibrate and consolidate entire width of pavement uniformly. Mount mechanical vibrators to avoid contact with forms, reinforcement, transverse or longitudinal joints.
- B. Furnish enough hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not covered by mechanically controlled vibrators.

3.9 FINISHING

- A. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.
 - 1. Hand finish with mechanical strike and tamping template in same width as pavement to be finished. Shape template to pavement section shown on the Drawings. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make a minimum of two (2) trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.
- B. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.
- C. After completion of straightedge operation, make first (1st) pass of burlap drag or transverse broom as soon as construction operations permit and before water sheen has disappeared from surface. Follow with as many passes as required to produce desired texture depth. Permit no unnecessary delays between passes. Keep drag wet, clean and free from encrusted mortar during use.

3.10 JOINTS AND JOINT SEALING

- A. Conform to requirements of Section 02840 – Concrete Pavement Joints.

3.11 CONCRETE CURING

- A. Conform to requirements of Section 02835 – Concrete Pavement Curing.

3.12 TOLERANCES

- A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place ten foot (10 Ft) straightedge parallel to center of roadway to bridge depressions and touch high spots. Do not permit deviation measured from face of straight edge to surface of pavement to exceed one-sixteenth inch (1/16 In) per one foot (1 Ft) from nearest point of contact. Maximum deviation with ten foot (10 Ft) straightedge shall not exceed one-eighth inch (1/8 In). Grind spots in excess of required tolerances to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

3.13 FIELD QUALITY CONTROL

- A. Perform testing under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures
- B. Compressive Strength Test Specimens: Make four (4) test specimens for compressive strength test in accordance with ASTM C31 for each one hundred cubic yards (100 Cy) or less of pavement that is placed in one (1) day. Test two (2) specimens at seven days (7 D), or at number of hours as directed by the Project Manager for high early strength concrete. Test remaining two (2) specimens at twenty-eight days (28 D). Test specimens in accordance with ASTM C39. Minimum compressive strength shall be at least two thousand seven hundred pounds per square inch (2700 psi) for first two (2) specimens tested at seven days (7 D) and three thousand pounds per square inch (3000 psi) for the second two (2) specimens tested at twenty-eight days (28 D).
- C. When compressive test indicates failure, make yield test in accordance with ASTM C138 for cement content per cubic yard of concrete. When cement content is found to be less than that specified per cubic yard, increase batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. Minimum of one (1) – four inch (4 In) core shall be taken at random locations per one thousand square yards (1000 Sy) of pavement to measure in-place depth. Measure depth in accordance with ASTM C174. Each core may be tested for twenty-eight day (28 D) compressive strength according to methods of ASTM C42. Twenty-eight (28) day compressive strength of each core tested shall be a minimum of three thousand pounds per square inch (3000 psi).
- E. Request, at option of the Project Manager, three (3) additional cores in vicinity of cores indicating the nonconforming in-place depths at no cost to the City. In-place depth at these locations shall be average depth of four (4) cores.
- F. Fill cores and density test sections with new concrete paving or non shrink grout.
- G. Alternative testing for depth may be performed using string line and

random testing of locations for depth before concrete is placed.

3.14 NONCONFORMING PAVEMENT

- A. Remove and replace areas of pavement found deficient in thickness by more than ten percent (10%) or that fail compressive strength tests, with concrete of thickness and strength shown on the Drawings.
- B. When measurement of any core is less than specified thickness by more than ten percent (10%), actual thickness of pavement in this area shall be determined by taking additional cores at ten foot (10 Ft) intervals parallel to centerline in each direction from deficient core until, in each direction, core is taken which is not deficient by more than ten percent (10%). Exploratory cores for deficient thickness shall not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine length of pavement in unit that is to be removed and replaced. Replace nonconforming pavement sections at no additional cost to the City.

3.15 PAVEMENT MARKINGS

- A. Restore pavement markings to match those existing in accordance with the City of Friendswood Technical Specifications and Standard Details and the Project Manager's requirements.

3.16 PROTECTION

- A. Barricade pavement section to prevent use until concrete has attained a minimum design strength. Cure barricade pavement section for a minimum of seventy-two hours (72 Hrs) before use. Do not open pavement to light construction traffic until concrete is at least ten days (10 D) old. No heavy loads shall be placed on concrete before twenty-eight day (28 D) breaks have passed. Pavement may be open to traffic earlier provided the Contractor pays for testing and additional specimens once the seven day (7 D) specified strength is obtained. Pavement may be opened when high early strength concrete is used and meets the specified seventy-two hour (72 Hr) strength.
- B. High early strength concrete may be used to provide access at driveways, street intersections, esplanades and other locations approved by the Project Manager.
- C. On those sections of pavement to be opened to traffic, seal joints, clean pavement, and place earth against pavement edges before permitting use by traffic. Opening of pavement to traffic shall not relieve responsibility for the Work.
- D. Maintain concrete paving in good condition until completion of the Work.
- E. Repair defects by replacing concrete to full depth.

PART IV: TABLES

4.1 DELETERIOUS SUBSTANCES

ITEM	PERCENT BY WEIGHT OF TOTAL SAMPLE MAXIMUM
Clay lumps and friable particles	3.0
Material finer than No. 200 sieve:	
Concrete subject to abrasion	3.0*
All other concrete	5.0*
Coal and lignite:	
Where surface appearance of concrete is of Importance	0.5
All other concrete	1.0

* In case of manufactured sand, when material finer than No. 200 sieve consists of dust of fracture, essentially free of clay or shale, then these limits may be increased to five percent (5%) and seven percent (7%) respectively.

4.2 COARSE AGGREGATE SIEVE ANALYSIS REQUIREMENTS

SIEVE DESIGNATION (SQUARE OPENINGS)	PERCENTAGE BY WEIGHT
Retained on 1 ¾" sieve	0%
Retained on 1 ½" sieve	0% to 5%
Retained on ¾" sieve	30% to 65%
Retained on ⅜" sieve	70% to 90%
Retained on No. 4 sieve	95% to 100%
Loss by Decantation Test:	
*Method Tex-406-A	1.0 maximum

* In case of aggregates made primarily from crushing of stone, when material finer than No. 200 sieve is dust fracture essentially free from clay or shale as established by Part III of TxDOT Tex-406-A, percent may be increased to one and one-half percent (1.5%).

4.3 FINE AGGREGATE SIEVE ANALYSIS REQUIREMENTS

SIEVE DESIGNATION (SQUARE OPENINGS)	PERCENTAGE BY WEIGHT
Retained on 3/8" sieve	0%
Retained on No. 4 sieve	0% to 5%
Retained on No. 8 sieve	0% to 20%
Retained on No. 16 sieve	15% to 50%
Retained on No. 30 sieve	35% to 75%
Retained on No. 50 sieve	65% to 90%
Retained on No. 100 sieve	90% to 100%
Retained on No. 200 sieve	97% to 100%

END OF SECTION

**SECTION 02810
CONCRETE MEDIANS AND DIRECTIONAL ISLANDS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Portland cement concrete medians and directional islands.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for concrete medians and directional islands is on a square yard basis measured along length and from back of curbs for width.
2. Refer to Section 01270 – Measurement and Payment for 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. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02805 – Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for welded wire fabric of Section 02805 – Concrete Paving.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02840 – Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint filler of Section 02840 – Concrete Pavement Joints.
- E. Subgrade Materials: Conform to subgrade material requirements of Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade.

PART III: EXECUTION

3.1 SUBGRADE

- A. Prepare subgrade in accordance with applicable portions of sections on excavation and fill and embankment. Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade.

3.2 PLACEMENT OF CONCRETE

- A. Place and finish concrete in accordance with applicable portions of Section 02805 – Concrete Paving.

3.3 JOINTS

- A. Install joints in accordance with Section 02840 – Concrete Pavement Joints.

3.4 CONCRETE CURING

- A. Cure concrete in accordance with Section 02835 – Concrete Pavement Curing.

3.5 PROTECTION

- A. Maintain new placed concrete medians and directional islands in good condition until completion of the Work.
- B. Replace damaged concrete medians and directional islands to comply with this Section.

END OF SECTION

**SECTION 02815
HEADERS, CURB, CURB AND GUTTER**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Reinforced concrete curb, reinforced monolithic concrete curb and gutter, and mountable curb.
- B. Paving headers and railroad headers poured monolithically with concrete base or pavement.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for curbs, curbs and gutter and esplanade curbs is on a linear foot basis measured along face of curb.
 - 2. Payment for three foot (3 Ft) concrete valley gutter is on a linear foot basis.
 - 3. Payment for mountable concrete curbs is on a square foot basis.
 - 4. Payment for concrete paving headers and concrete railroad headers is on a linear foot basis.
 - 5. Payment for headers is on linear foot basis measured between lips of gutters adjacent to concrete base or measured between backs of curbs adjacent to concrete pavement.
 - 6. Refer to Section 01270 – Measurement and Payment for 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 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit details of proposed form work for approval.

1.4 REFERENCES

- A. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02805 – Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for welded wire fabric of Section 02805 – Concrete Paving.
- C. Grout: Nonmetallic, nonshrink grout containing no chloride producing

- agents conforming to requirements specified in TABLE 4.1 – NONSHRINK GROUT REQUIREMENTS, in PART IV of this Section.
- D. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02840 – Concrete Pavement Joints.
 - E. Expansion Joint Filler: Conform to material requirements for expansion joint filler of Section 02840 – Concrete Pavement Joints.
 - F. Mortar: Mortar finish composed of one (1) part Portland cement and one and one-half (1-1/2) parts of fine aggregate. Use only when approved by the Project Manager.

PART III: EXECUTION

3.1 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of sections on excavation and fill, embankment and subgrade and roadbed.

3.2 PLACEMENT

- A. Guideline: Set to follow top line of curb. Attach indicator to provide constant comparison between top of curb and guideline. Ensure flow lines of gutters on monolithic curb and gutters conform to slopes indicated on the Drawings.
- B. Forms: Brace to maintain position during pour. Use metal templates cut to section shown on the Drawings.
- C. Reinforcement: Secure in position so that steel shall remain in place throughout placement. Reinforcing steel shall remain at approximate center of base or pavement as indicated on the Drawings.
- D. Joints: Place in accordance with Section 02840 – Concrete Pavement Joints. Place dummy groove joints at driveways to match concrete pavement joints at right angles to curb lines. Cut dummy grooves one-quarter inch (1/4 In) deep using approved edging tool.
- E. Place concrete in forms to required depth. Consolidate thoroughly. Do not permit rock pockets in form. Entirely cover top surfaces with mortar.
- F. Verify headers are to the depth and the rebar is in place according to the City of Friendswood Standard Details.

3.3 MANUAL FINISHING

- A. For monolithic curb and gutters, remove front curb forms, after concrete is in place. Form exposed portions of curb and of curb and gutter, using mule which conforms to curb shape, as shown on the Drawings.
- B. Thin coat of mortar may be worked into exposed face of curb or curb and gutter using mule and two (2) handled wooden “darby” at least three feet (3 Ft) long.
- C. Before applying final finish move ten foot (10 Ft) straightedge across curb or across gutter and up curb to back form of curb. Repeat until curb and gutter are true to grade and section. Lap straightedge over previous

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finish operation by five feet (5 Ft).

- D. Steel trowel finish surfaces to smooth, even finish. Make face of finished curb true and straight.
- E. Edge outer edge of gutter with one-quarter inch (1/4 In) edger. Finish edges with tool having one-quarter inch (1/4 In) radius.
- F. Finish visible surfaces and edges of finished curb or curb and gutter free from blemishes, form marks and tool marks. Finished curb or curb and gutter shall have uniform color, shape and appearance.

3.4 MECHANICAL FINISHING

- A. Mechanical curb or curb and gutter forming and finishing machines may be used instead of, or in conjunction with, previously described methods, when approved by the Project Manager. Use of mechanical methods shall provide specified curb or curb gutter design and finish.

3.5 CURING

- A. Immediately after finishing operations, cure exposed surfaces of curb or curb and gutter in accordance with Section 02835 – Concrete Pavement Curing.

3.6 TOLERANCES

- A. Top surfaces of curb or curb and gutter shall have uniform width and shall be free from humps, sags or other irregularities. Surfaces of curb top, curb face and gutter shall not vary more than one-eighth inch (1/8 In) from edge of straightedge laid along them, except at grade changes.

3.7 PROTECTION

- A. Maintain newly placed headers, curbs and curbs and gutters in good condition until completion of the Work.
- B. Replace damaged headers, curbs and curbs and gutters to comply with this Section.

PART IV: TABLES

4.1 NONSHRINK GROUT REQUIREMENTS

Compressive Strength:	
At 7 days	3500 psi
At 28 days	8000 psi
Initial Set Time	45 minutes
Final Set Time	1.5 hours

END OF SECTION

**SECTION 02820
CONCRETE SIDEWALKS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Reinforced concrete sidewalks.
- B. Wheelchair ramps.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for concrete sidewalks is on a square foot basis.
 - 2. No separate payment shall be made for work outside these limits or in areas where sidewalks or wheelchair ramps have been removed or replaced for the Contractor's convenience.
 - 3. Payment for wheelchair ramps of each type specified is on a per ramp basis.
 - 4. Removal and replacement of existing sidewalks, curb or curb and gutter and saw-cutting is paid on a unit cost basis for each item.
 - 5. Sodding shall be paid one foot (1 Ft) on each side of sidewalk unless otherwise noted.
 - 6. Coloring of wheelchair ramps is included in cost of ramp.
 - 7. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Society for Testing and Materials.
 - 1. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in Field.
 - 2. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 3. ASTM C42 – Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 4. ASTM C138 – Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
 - 5. ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 6. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
 - 7. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

(12,400 ft-lbf/ft³ (600 kN-m/m³).

- B. CFTS – City of Friendswood Technical Specifications.
- C. TASABA – Texas Accessibility Standards of Architectural Barriers Act, of the Texas Civil Statues.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit certified testing results and certificates of compliance.

PART II: PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02805 – Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements of Section 02805 – Concrete Paving for reinforcing steel. Use No. 3 (3/8 In) reinforcing bars.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02840 – Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02840 – Concrete Pavement Joints.
- E. Forms: Use straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk or wheelchair ramp thickness. The use of two inch by four inch (2 In x 4 In) lumber as forms shall not be allowed.
- F. Sand Bed: Conform to material requirements for bank run sand of Section 02140 – Utility Backfill Materials.
- G. Sodding: Conform to material requirements for sodding of Section 02915 – Sodding.
- H. Coloring for wheelchair ramps: Conform to material requirements for colored concrete of Section 02825 – Colored Concrete for Wheelchair Ramps.

PART III: EXECUTION

3.1 REPLACEMENT

- A. Replace sidewalks which are removed or damaged during construction with thickness and width equivalent to one (1) removed or damaged, unless otherwise shown on the Drawings. Finish surface (exposed aggregate, stamped concrete, etc.) to match existing sidewalk.
- B. Provide wheelchair ramps or existing, replaced or new sidewalks when sidewalk intersects curb at street or driveway.

3.2 PREPARATION

- A. Identify and protect utilities which are to remain.

- B. Protect living trees, other plant growth and features designated to remain.
- C. Conduct clearing and grubbing operations in accordance with Section 02100 – Clearing and Grubbing.
- D. Excavate subgrade six inches (6 In) beyond outside lines of sidewalk or wheelchair ramp. Shape to line, grade and cross section. For soils with plasticity index above forty percent (40%), stabilize soil with lime in accordance with Section 02720 – Lime-Stabilized Base Subgrade. Compact subgrade to minimum of ninety percent (90%) maximum dry density at optimum moisture content plus or minus three percent ($\pm 3\%$), as determined by ASTM D698.
- E. Immediately after subgrade is prepared, cover with compacted sand bed to depth as shown on the Drawings. Lay concrete when sand is moist but not saturated.

3.3 PLACEMENT

- A. Setting Forms: Straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. Use of two inch by four inch (2 In x 4 In) wood studs as forms shall not be allowed. Securely stake forms to line and grade. Maintain position during concrete placement.
- B. Reinforcement:
 - 1. Install reinforcing bars in conformance of Section 03200 – Reinforcing Steel.
 - 2. Install reinforcing steel as shown on the drawings. Lay longitudinal bars in sidewalks or wheelchair continuously, except through expansion joints.
 - 3. Use sufficient number of chairs to support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.
 - 4. Drill dowels into existing paving, sidewalk and driveways, secure with epoxy and provide headers as required.
 - 5. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on the Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than one and one-half (1-1/2) of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than one-quarter inch (1/4 In).
- C. Expansion Joints: Install expansion joints with load transfer units in accordance with Section 02840 – Concrete Pavement Joints.
- D. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp or other acceptable method. Bring mortar to surface.
- E. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush,

and impress or hand-groove required pattern into wheelchair ramp.

- F. Apply coating to wheelchair ramp with contrasting color in accordance with Section 02825 – Colored Concrete for Wheelchair Ramps.
- G. Unless otherwise indicated on the Drawings, install construction sidewalk joints one-eighth inch (1/8 In) deep, at intervals not exceeding five feet (5 Ft). Use joint tool equal in width to edging tool.
- H. Finish edges with tool having one-quarter inch (1/4 In) radius.
- I. After concrete has set sufficiently, refill space along sides of sidewalk to one inch (1 In) from top of walk with suitable fill material. Tamp until firm and solid, place sod as applicable. Dispose of excess material in accordance with Section 01580 – Waste Material Disposal. Repair driveways and parking lots damaged by sidewalk excavation in accordance with Section 02845 – Pavement Repair and Resurfacing.

3.4 CURING

- A. Conform to requirements of Section 02835 – Concrete Pavement Curing.

3.5 FIELD QUALITY CONTROL

- A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
- B. Compressive Strength Test Specimens: Four (4) test specimens for compressive strength test shall be made in accordance with ASTM C31 for each thirty cubic yards (30 Cy) or less of sidewalk that is placed in one day (1 D). Two (2) specimens shall be tested at seven days (7 D). Remaining two (2) specimens shall be tested at twenty-eight days (28 D). Specimens shall be tested in accordance with ASTM C39. Minimum compressive strength: two thousand seven hundred pounds per square inch (2700 psi) at seven days (7 D) for first two (2) specimens and three thousand pounds per square inch (3000 psi) at twenty-eight days (28 D) for the second two (2) specimens.
- C. Yield test for cement content per cubic yard of concrete shall be made in accordance with ASTM C138. When cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. If the Contractor places concrete without notifying the laboratory, the City shall have the concrete tested by means of core test as specified in ASTM C42. When concrete does not meet this specification, cost of test, shall be deducted from the Contractor's payment.
- E. Sampling of fresh concrete shall be in accordance with ASTM C172.
- F. Take slump tests when cylinders are made and when concrete slump appears excessive.
- G. Concrete shall be acceptable when average of two (2) twenty-eight (28) day compression tests is equal to or greater than minimum twenty-eight day (28 D) strength specified.
- H. If either of two (2) tests on field samples is less than average of two (2) tests by more than ten percent (10%), that entire test shall be considered

suspect and not indicative of concrete strength. Core samples shall be required from in-place concrete in question.

- I. If twenty-eight day (28 D) laboratory test indicates that concrete of low strength has been placed, test concrete in question by taking cores as directed and approved by the Project Manager. Take and test at least three (3) representative cores as specified in ASTM C42 and deduct cost from payment due.

3.6 NONCONFORMING CONCRETE

- A. Remove and replace areas that fail compressive strength tests, or thickness of concrete shown on the Drawings.
- B. Replace non-conforming sections at no additional cost to the City.

3.7 PROTECTION

- A. Maintain newly-placed concrete in good condition until completion of the Work.
- B. Replace damaged areas.

END OF SECTION

**SECTION 02825
COLORED CONCRETE FOR WHEELCHAIR RAMPS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Colored concrete for Wheelchair ramps.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

- 1. No separate payment shall be made for coloring agent under this Section. Include payment in unit price bid for wheelchair ramps.
- 2. Refer to Section 01270 – Measurement and Payment for 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 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit product data for proposed coloring agent.

1.4 REFERENCES

- A. ADA – Americans with Disabilities Act.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TABA – Texas Architectural Barriers Act.

PART II: PRODUCTS

2.1 MATERIALS

- A. Coloring Agent: Provide dry-shake color hardener consisting of quartz-silica mixture of finely-graded, non-metallic aggregates, plasticizer and cement binder for producing color as shown on the Drawings.
- B. Color shall be Black.
- C. Concrete: Conform to material and proportion requirements of Section 02805 – Concrete Paving.

PART III: EXECUTION

3.1 WHEELCHAIR RAMPS

- A. Install wheelchair ramps in accordance with requirements of Part III of Section 02820 – Concrete Sidewalks with addition of procedure for application of coloring agent as required by Paragraph 3.2, Coloring Agent.

3.2 COLORING AGENT

- A. Apply coloring agent on newly finished concrete surface as soon as job conditions permit, but in no event later than two hours (2 Hrs) after concrete is placed, at rate recommended by manufacturer or as approved by the Project Manager.
- B. Apply color hardener uniformly to surface by dry-shake method when no excess moisture shows at surface of concrete, but while concrete is still plastic throughout. Do not sprinkle or otherwise add water to surface during application or finishing. Necessary moisture for color hardener shall come from the concrete as that color hardener develops the proper bond and produces adequate density for color-hardened surface.
- C. First (1st) shake shall consume two-thirds (2/3) of material. Withhold one-third (1/3) for second (2nd) shake and final touch-up. After first (1st) shake, float surface thoroughly by mechanical or hand methods. Do not trowel surface between first (1st) and second (2nd) shakes.
- D. Apply second (2nd) shake evenly, then float and trowel surface. Retain small quantity of material from second (2nd) shake for touching up non-uniform or weak-toned areas. Minimize hard troweling and use consistent finishing practices to ensure uniformity of color.

END OF SECTION

**SECTION 02830
CONCRETE DRIVEWAYS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Portland cement concrete driveways.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for concrete driveways is on square foot basis, including excavation and stabilize subgrade.
2. No separate payment shall be made for work in areas where driveway has been removed or replaced for the Contractor's convenience.
3. Refer to Section 01270 – Measurement and Payment for 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 REFERENCENCES

- A. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02805 – Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for reinforcing steel of Sections 02805 – Concrete Paving and 03200 – Reinforcing Steel.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02840 – Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02840 – Concrete Pavement Joints.
- E. Subgrade Materials: Conform to subgrade material requirements of Section 02720 – Lime-Stabilized base Subgrade or Section 02725 – Portland Cement-Stabilized Base Subgrade.

PART III: EXECUTION

3.1 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade.

3.2 REINFORCING STEEL

- A. Reinforcing steel shall comply with Section 03200 – Reinforcing Steel. Steel shall be raised off the ground using chairs. Minimum size of reinforcing bars shall be #3 (3/8 In) reinforcing bars at sixteen inch (16 In) centers with a minimum of eighteen inches (18 In) overlap.
- B. No concrete shall be placed until after reinforcing bars and forms have been inspected and approved by the Project Manager.

3.2 PLACEMENT

- A. Place and finish concrete in accordance with applicable portions of Section 02805 – Concrete Paving.

3.3 JOINTS

- A. Install joints in concrete driveway in accordance with Section 02840 – Concrete Pavement Joints.

3.4 CONCRETE CURING

- A. Cure concrete driveway in accordance with Section 02835 – Concrete Pavement Curing.

3.5 PROTECTION

- A. Conform to applicable requirements of Section 02835 – Concrete Pavement Curing.

END OF SECTION

**SECTION 02835
CONCRETE PAVEMENT CURING**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Curing of Portland cement concrete paving.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment shall be made for concrete curing under this Section. Include payment in unit price for Concrete Paving, Concrete Sidewalks, Concrete Driveways, Mountable Curbs, Curbs and Curb and Gutters.
2. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Society for Testing and Materials.

1. ASTM C156 – Standard Test Method for Water Retention by Concrete Curing Materials.
2. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete.
3. ASTM C309 – Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

B. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit manufacturer's product data for cover materials and liquid membrane-forming compounds.

PART II: PRODUCTS

2.1 COVER MATERIALS FOR CURING

A. Conform curing materials to one of the following:

1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C171.
2. Waterproofed Paper: Paper conforming to requirements of ASTM C171.
3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than three-

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quarters pound (3/4 Lb) of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than six ounces per square yard (6 Oz/Sy). Stitch mats so that mat shall contact surface of pavement at all points when saturated with water.

2.2 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Conform liquid membrane-forming compounds to ASTM C309. Membrane shall restrict loss of water to not more than 0.55 kg/m² in seventy-two hours (72 Hrs) using test method ASTM C156.

PART III: EXECUTION

3.1 CURING REQUIREMENT

- A. Cure concrete pavement by protecting against loss of moisture for period of at least seventy-two hours (72 Hrs) immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphalt concrete.
- B. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

3.2 POLYETHYLENE FILM CURING

- A. Immediately after finishing surface and after concrete has taken its initial set, apply water in form of fine spray. Cover entire surface and all edges of pavement slab with polyethylene film so film shall remain in direct contact with surface and edges during specified curing period.
- B. Cover entire surface and both edges of pavement slab. Overlap joints in film sheets a minimum of twelve inches (12 In). Immediately repair tears or holes occurring during curing period by placing acceptable moisture-proof patches or replacing film sheets.

3.3 WATERPROOFED PAPER CURING

- A. Immediately after finishing surface and after concrete has taken its initial set, apply water in form of fine spray. Cover entire surface and all edges of pavement slab with waterproofed paper so paper shall remain in direct contact with surface and edges during specified curing period.
- B. Prepare waterproofed paper to form blankets of sufficient width to cover entire surface and all edges of pavement slab. Blankets shall not be more than sixty feet (60 Ft) in length. Overlap joints in blankets caused by joining paper sheets by at least five inches (5 In) and securely seal with asphalt cement having melting point of approximately one hundred eighty degrees Fahrenheit (180° F). Place blankets with overlaps of at least twelve inches (12 In). Immediately repair tears or holes appearing in paper during curing period by cementing patches over defects or replacing blankets.

3.4 COTTON MAT CURING

- A. Immediately after finishing surface and after concrete has taken its initial set, completely cover entire surface and edges of pavement slab with cotton mats, thoroughly saturated before application, maintaining contact with surface and edges of pavement equally at all points.
- B. Keep mats on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water shall drip freely from them.

3.5 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Immediately after free surface moisture and after concrete has dispersed, apply liquid membrane-forming compound in accordance with manufacturer's instructions.
- B. Moisten concrete by water fogging prior to application of film, paper or mat when surface has become dry.
- C. Seal concrete surface with single coat at rate of coverage recommended by manufacturer or as directed by the Project Manager, but not less than one gallon (1 Gal) per two hundred square feet (200 Sf) of surface area.
- D. Concrete surface shall be completely and evenly covered. Any portion that has streaking, splattering or spurting shall be redone at no additional cost to the City.

3.6 TESTING MEMBRANE

- A. Treated areas shall be visually inspected for areas of lighter color of dry concrete as compared to dump concrete. Test suspected areas by placing few drops of water a on surface. Membrane passes test when water stands in rounded beads or small pools which can be blown along surface of concrete without wetting surface.
- B. Reapply membrane compound immediately at no cost to the City when membrane fails test noted above.

END OF SECTION

**SECTION 02840
CONCRETE PAVEMENT JOINTS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Joints for concrete paving, concrete sidewalks, concrete driveways, mountable curbs, curbs and curb and gutters.
- B. Saw-cutting existing concrete or asphalt pavements for new joints.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for street pavement expansion joints, with or without load transfer, is on a linear foot basis.
 - 2. No separate payment shall be made for horizontal dowels. Include payment in the unit price for Concrete Paving, Concrete Driveways, Concrete Sidewalks or Curb and Gutter.
 - 3. No separate payment shall be made for formed or sawed street pavement contraction joints and longitudinal weakened plane joints. Include payment in the unit price for Concrete Paving.
 - 4. No separate payment shall be made for joints for Mountable Curbs, Curb, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks and Concrete Driveways. Include payment in the unit price for Mountable Curbs, Curbs, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks and Concrete Driveways.
 - 5. Payment shall be made for Preformed Expansion Joints on a linear foot basis only when field conditions require that sidewalk be moved adjacent to existing concrete structure (i.e., street, back of curb, etc.).
 - 6. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Society for Testing and Materials.
 - 1. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 2. ASTM D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - 3. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 4. ASTM D3405 – Standard Specification for Joint Sealants, Hot-

Applied, for Concrete and Asphalt Pavements.

- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
 - 1. TxDOT Tex-525-C – Tests for Asphalt and Concrete Joint Sealers.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit product data for joint sealing compound and proposed sealing equipment for approval.
- C. Submit samples of dowel caps, metal supports and deformed metal strip for approval. Submit manufacturer's recommendation for placing sealant(s).

PART II: PRODUCTS

2.1 BOARD EXPANSION JOINT MATERIAL

- A. Filler board of selected stock: Use wood of density and type as follows:
 - 1. Clear, all-heart cypress weighing no more than forty pounds per cubic foot (40 Lbs/Cf), after being oven dried to constant weight.
 - 2. Clear, all-heart redwood weighing no more than thirty pounds per cubic foot (30 Lbs/Cf), after being oven dried to constant weight.

2.2 PREFORMED EXPANSION JOINT MATERIAL

- A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D994 and ASTM D1751.

2.3 JOINT SEALING COMPOUND

- A. Joint sealants shall conform to one (1) of the sealant classes described in this Section.
- B. Hot-poured rubber-asphalt compound to conform to ASTM D3405.
- C. Two (2) component Synthetic Polymer.
 - 1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
 - 2. Cure sufficiently at average temperature of seventy-seven degrees Fahrenheit (77° F) plus or minus two degrees Fahrenheit ($\pm 2^\circ$ F) so as not to pick up under wheels of traffic in a maximum of three hours (3 Hrs).
 - 3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as specified in TABLE 4.1 – COLD EXTRUDED AND COLD POURABLE (SELF LEVELING) SPECIFICATIONS in this Section.
 - 4. Provide cold-extruded type for vertical or sloping joints.
 - 5. Provide self-leveling type for horizontal joints.

- D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required shall be compatible with the sealant; no reaction shall occur between rod and sealant. When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet requirements as specified in TABLE 4.2 – SELF-LEVELING, LOW MODULUS OR POLYURETHANE SEALEANT SPECIFICATIONS in this Section.

2.4 LOAD TRANSMISSION DEVICES

- A. Smooth, steel dowel bars conforming to ASTM A615, Grade 60. When indicated on the Drawings, encase one (1) end of dowel bar in approved cap having inside diameter one-sixteenth inch (1/16 In) greater than diameter of dowel bar.
- B. Deformed steel tie bars conforming to ASTM A615, Grade 60.

2.5 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY

- A. Employ supports of approved shape and size that shall secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by the Project Manager.

PART III: EXECUTION

3.1 PLACEMENT

- A. When new Work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.
- B. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement a minimum of two inches (2 In) deep to provide straight, smooth joint surface without chipping, spalling or cracks.
- C. All new concrete joints shall be placed as shown in the City of Friendswood Standard Details.

3.2 CONSTRUCTION JOINTS

- A. Place transverse construction joint wherever concrete placement must be stopped for more than thirty minutes (30 Min). Place longitudinal construction joints at interior edges of pavement lanes using #6 (3/4 In) deformed tie bars, thirty inches (30 In) long and spaced sixteen inches (16 In) on centers and use keyways.

3.3 EXPANSION JOINTS

- A. Place three-quarters inch (3/4 In) wide expansion joints at radius points of curb returns for cross street intersections or as located in adjacent pavement but no further than sixty feet (60 Ft) apart. Use no boards shorter than six feet (6 Ft). When pavement is twenty-four feet (24 Ft) or narrower, use not more than two (2) lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross-section of concrete slab. Use load transmission devices of type and size shown on the Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

3.4 CONTRACTION JOINTS

- A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on the Drawings.
- B. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove a minimum of one-quarter inch (1/4 In) wide. Maintain depth of one-quarter (1/4) of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one (1) pass. Complete sawing within twenty-four hours (24 Hrs) of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.
- C. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at work site during sawing operations. Maintain sawing equipment on job during concrete placement.

3.5 LONGITUDINAL WEAKENED PLANE JOINTS

- A. Place longitudinal weakened plane joints at spaces indicated on the Drawings. If more than fifteen feet (15 Ft) in width is poured, longitudinal joint must be saw cut. Seal sawed or tooled groove with joint sealing compound.

3.6 EXPANSION AND CONTRACTION JOINTS FOR MOUNTABLE CURB, CURB, CURB AND GUTTER

- A. Place three-quarters inch (3/4 In) wide preformed expansion joints through mountable curb, curb, curb and gutters at locations of expansion and contraction joints in adjacent pavement, at end of radius returns, at street intersections, at driveways, at curb inlets and any other location directed by the Project Manager. Maximum spacing between joints shall be fifteen feet (15 Ft) for contraction joints and sixty feet (60 Ft) for expansion joints.

- 3.7 EXPANSION AND CONTRACTION JOINTS FOR CONCRETE SIDEWALKS
- A. Provide three-quarters inch (3/4 In) wide expansion joints conforming to ASTM A1751 across sidewalk at intervals no greater than sixty feet (60 Ft) and along sidewalks at back of curbs, at intersections with driveways, steps and walls. Provide expansion joint material conforming to ASTM D994 for small radius curves and around fire hydrants and utility poles. Extend expansion joint material full depth of slab. Saw-cut or tool contraction joints into sidewalk at intervals not exceeding five feet (5 Ft).
- 3.8 EXPANSION JOINTS FOR CONCRETE DRIVEWAYS
- A. Provide three-quarters inch (3/4 In) wide expansion joints conforming to ASTM D1751 across driveway at street pavement, at right-of-way line, at existing concrete driveways and intersections with sidewalks and other structures or as shown on the Drawings. Extend expansion joint material full depth of slab. Contraction joints are not normally required, unless shown on the Drawings or as directed by the Project Manager.
- 3.9 JOINT SEALING
- A. Seal joints only when surface and joints are dry, ambient temperature is above fifty degrees Fahrenheit (50° F) and less than eighty-five degrees Fahrenheit (85° F) and weather is not foggy or rainy.
 - B. Use joint-sealing equipment in like new working condition throughout joint sealing operation and be approved by the Project Manager. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.
 - C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, contraction joints and cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.
 - D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that upon completion, surface of sealer within joint shall be one-quarter inch (1/4 In) above level of adjacent surface or at elevation as directed by the Project Manager.
- 3.10 PROTECTION
- A. Maintain newly-placed joints in good condition until completion of the Work.
 - B. Replace damaged joints material with new material as required by this Section.

PART IV: TABLES

4.1 COLD EXTRUDED AND COLD POURABLE (SELF LEVELING) SPECIFICATIONS.

COLD EXTRUDED AND COLD POURABLE (SELF-LEVELING) SPECIFICATIONS	
PROPERTY	REQUIREMENT
Penetration, 25° C (77° F), 150g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29° C (-20° F), 3 cycles:	
Dry Concrete Block	Pass
Steel blocks (Primed, if recommended by manufacturer)*	Pass
Flow at 70° C (158° F)	None
Water content % by mass, maximum	5.0
Resilience:	
Original sample, % minimum (cured)	50
Oven-aged at 70° C (158° F), % minimum	50
Cold Extruded material only – Cold Flow (10 minutes)	None

After bond extension test, there shall be no evidence of cracking, separation or other opening that is over one-eighth inch (1/8 in.) deep in sealer or between sealer and test blocks.

* Steel blocks shall be used when armor joints are specified.

4.2 SELF-LEVELING, LOW MODULUS OR POLYURETHANE SEALEANT SPECIFICATIONS

SELF-LEVELING, LOW MODULUS SILICONE OR POLYURETHANE SPECIFICATIONS	
PROPERTY	REQUIREMENT
Tack Free Time, 25° ± 1° C (77° ± 2° F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum
Tensile Strength and 24 Hour Extension Test:	
Initial, 10-day cure 25° ± 1° C (77° ± 2° F), kPa (psi)	21 to 69 (3 to 10)
After Water Immersion, kPa (psi)	21 to 69 (3 to 10)
After Heat Aging, kPa (psi)	21 to 69 (3 to 10)
After Cycling -29° C (-20° F), 50%, 3 cycles, kPa (psi)	21 to 69 (3 to 10)
24 Hour Extension	Pass (All Specimens)

After twenty-four hours (24 Hrs), there shall be no evidence of cracking, separation or other opening that is over one eighth inch(1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

END OF SECTION

**SECTION 02845
PAVEMENT REPAIR AND RESURFACING**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Repairing and resurfacing streets, highways, driveways, sidewalks and other pavements that have been cut, broken or otherwise damaged during construction.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. No separate payment shall be made for pavement repair and resurfacing under this Section. 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. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 MATERIALS

- A. Subgrade:
 - 1. Provide backfill material as required by Sections 02110 – Borrow, 02115 – Embankment, 02120 – Excavation and Backfill for Structures, 02125 – Excavation and Backfill for Utilities, 02130 – Extra Unit Price Work for Excavation and Backfill, and 02135 – Excavation for Roadway.
 - 2. Provide material for stabilization as required by applicable portions of Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade.
- B. Base: Provide base material as required by applicable portions of Section 02700 – Cement-Stabilized Base Course Section 02705 – Crushed Concrete Base Course and Section 02715 – Hot-Mix Asphaltic Base Course.

- C. Pavement: Provide paving materials as required by applicable portions of Section 02800 – Asphaltic Concrete Pavement, Section 02805- Concrete Paving, Section 02830 – Concrete Driveways and Section 02815 – Headers, Curb, Curb and Gutter and Section 02820 – Concrete Sidewalks.

PART III: EXECUTION

3.1 PREPARATION

- A. Notify the Project Manager prior to commencement of excavation in pavement for which an Excavation in Public Right-of-Way permit has been obtained. Follow directions contained in the permit.
- B. Conform to requirement of Section 02105 – Removing Existing Pavements and Structures, for removals.
- C. Saw cut pavement two feet (2 Ft) wider than width of trench needed to install utilities unless otherwise indicated on the Drawings.
- D. When removing pavement to existing deformed metal strip (i.e. dummy joint), saw cut pavement a minimum of two inches (2 In) deep on opposite side of deformed metal strip. Place saw joint far enough behind deformed metal strip to obtain continuously straight joint. Remove damaged portion of deformed metal strip as required to provide proper joint. Saw cut and remove metal strip before placement of new concrete pavement.
- E. Protect edges of existing pavement to prevent damage during removals, utility placement, backfill and paving operations. For concrete pavement, protect undisturbed subgrade that is to remain to support replacement slab.
- F. Dowel-in to existing pavement where no reinforcement is found or is broken due to construction activities. Unless otherwise directed by the Project Manager, provide No. 6 (3/4 In) reinforcing bars twenty-four inches (24 In) long, drilled and embedded twelve inches (12 In) into center of existing slab with 'PO-ROC' epoxy grout or approved equal. Space dowels to match new pavement reinforcement spacing.
- G. Provide transitional paving, additional base depth and undercutting of existing pavement as required to tie proposed pavement to existing pavement when unable to dowel new pavement into existing pavement.
- H. Temporarily fill hole with base material or bridge with three-quarter inch (3/4 In) steel plates until ready to place concrete.

3.2 INSTALLATION

- A. Parking Areas, Service Drives, Driveways and Sidewalks: Replace with material equal to or better than existing or as indicated on the Drawings. Conform to applicable requirements of sections referenced in Paragraph 2.1, Materials.
- B. Street Pavements and Curbs, Curbs and Gutters: Replace subgrade, base and surface course with like materials or as indicated on the

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Drawings and the City of Friendswood Standard Details and Technical Specifications. Curbs and curbs and gutters shall match existing. Conform to requirements of sections referenced in Paragraph 2.1, Materials.

- C. For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on the Drawings and the City of Friendswood Standard Details and Technical Specifications. Place types and spacing of joints to match existing joints or as indicated on the Drawings.
- D. Where existing pavement consists of concrete pavement with asphaltic surfacing, resurface with a minimum of two inch (2 In) depth asphaltic pavement.
- E. Repair TxDOT highway and county crossings in accordance with TxDOT permit or county requirements as appropriate, and within one week (1 Wk) after utility work is complete or pavement removal in cases of pavement repair only.

3.3 WASTE MATERIAL DISPOSAL

- A. Dispose of waste material in accordance with requirements of Section 01580 – Waste Material Disposal.

3.4 PROTECTION

- A. Maintain pavement in good condition until completion of the Work.
- B. Replace pavement damaged by the Contractor's operations at no cost to the City.

END OF SECTION

**SECTION 02850
BLAST CLEANING OF PAVEMENT**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Removal of existing pavement markings.
- B. Preparation of pavement surfaces for new pavement markings.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for blast cleaning of roadway lanes is on a linear foot basis for each width, measured in place.
 - 2. Payment for blast cleaning of symbols and legends is on a per legend or symbol basis, for each type of group of symbols or legends.
 - 3. Payment for removal of raised pavement markings, all types, is on a lump sum basis.
 - 4. Refer to Section 01270 - Measurement and Payment for 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 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit description and characteristics of proposed blasting medium and equipment for approval.

1.4 REFERENCES

- A. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 MATERIALS

- A. Blasting Media: Quality commercial product capable of producing specified surface cleanliness without deposition of deleterious materials on cleaned pavement surface. Do not use high silica content sand particles as blasting agent that may result in high levels of free crystalline silica dust.

2.2 EQUIPMENT

- A. Equipment shall be power-driven and of sufficient capacity to remove pavement markings. Equipment shall utilize moisture and oil traps of sufficient capacity to remove contaminants from air and prevent deposition of moisture, oil or other contaminants on pavement surface.

PART III: EXECUTION

3.1 REMOVAL OF EXISTING MARKINGS

- A. Remove pavement markings in a sequence that shall prevent driver confusion or where indicated on the Drawings. Included are areas where it shall be necessary for drivers to cross existing markings which they would not normally cross. Completely remove or obliterate markings. Do not damage pavement surface.

3.2 CLEANING FOR PLACEMENT OF MARKERS

- A. Remove old pavement markings, loose material and other contaminants deleterious to adhesion of new pavement markings to be placed. On Portland cement concrete pavement, minimize over-blasting to prevent damage to pavement surface. Small particles of tightly adhering existing pavement markings may remain, as approved by the Project Manager, if complete removal shall result in pavement surface damage.
- B. Follow manufacturer's written instructions for proper cleaning of pavement surfaces to receive pavement marking.

END OF SECTION

**SECTION 02855
RAISED PAVEMENT MARKERS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Raised reflective pavement markers and jiggle bars.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for Type I raised reflective pavement markers with one (1) reflective face is per each marker installed.
2. Payment for Type I raised reflective pavement markers with two (2) reflective faces is per each marker installed.
3. Payment for Type I raised pavement markers with no reflective face is per each marker installed.
4. Payment for Type II raised reflective pavement markers with one (1) reflective face is per each marker installed.
5. Payment for Type II raised reflective pavement markers with two (2) reflective faces is per each marker installed.
6. Payment for Type "W" jiggle bars is on a unit price basis per each jiggle bar.
7. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Society for Testing and Materials.

1. ASTM D2444 – Standard Test Method for Determination of Impact Resistance of Thermoplastic Pipe and Fittings by means of a Tup (Falling Weight).
2. ASTM E808 – Standard Practice for Describing Retroreflection.
3. ASTM E809 – Standard Practice for Measuring Photometric Characteristics of Retroreflectors.

B. CFTS – City of Friendswood Technical Specifications.

C. Federal Specification L-P-380C – Plastic Molding Material Methacrylate.

D. TxDOT – Texas Department of Transportation.

1. TxDOT Material Specification DMS-4100 – Jiggle BarTile.
2. TxDOT Material Specification DMS-6130 – Bituminous Adhesive for Pavement Markers.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.

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- B. Submit manufacturer's product data concerning following materials for approval:
 - 1. Types I, II and III, W and Y markers.
 - 2. Primers, solvents and adhesives.
 - 3. Installation instructions.
- C. Submit certificate by manufacturer that each marker and adhesive conforms to requirements in this Section.
- D. Submit details of manufacturer's replacement policy for each type and class of marker.

1.5 DELIVERY AND STORAGE

- A. Deliver markers in cartons of one hundred (100) units and epoxy adhesive in one gallon (1 Gal) pails. Ship like materials in like-sized containers to facilitate storage.
- B. Store material in cool, dry conditions until application.

PART II: PRODUCTS

2.1 MARKERS

- A. Raised Reflective Pavement Markers: Shallow frustum of pyramid shaped markers with tempered glass prismatic reflective elements. Bodies shall be plastic shells with resin/sand fillings or single-piece injection-molded bodies of impact resistant polymers. Plastic shells shall be Methyl Methacrylate conforming to Federal Specification L-P-380C, Type I, Class 3 and shall have a minimum wall thickness of sixty-five hundredths of an inch (0.65 In).
- B. Marker configuration shall be as specified in Table 4.1 – RAISED PAVEMENT MARKER CONFIGURATION FOR TYPES I, II AND III.
- C. Optical performance for Type I or II Raised Pavement Markers shall be as specified in Table 4.2 – RAISED PAVEMENT MARKER OPTICAL PERFORMANCE FOR TYPES I AND II.
- D. Optical performance for Type III Raised Pavement Markers shall be as specified in Table 4.3 – RAISED PAVEMENT MARKER OPTICAL PERFORMANCE FOR TYPES III.
- E. Testing Procedure: Locate randomly selected test marker with center of reflecting face five feet (5 Ft) from uniformly bright light source with effective diameter of two-tenths of an inch (0.2 In). Use photocell width of five hundredths of an inch (0.05 In) for Type I markers and photocell with annular ring of thirty-seven hundredths of an inch by forty-six hundredths of an inch (0.37 In x 0.46 In) for Type II markers; shield to eliminate stray light. Distance from light source to photocell center of twenty-one hundredths of an inch (0.21 In). Modify source receiver dimensions and distance between source and receiver proportionally to test distance change for test distances other than five feet (5 Ft). Lots containing more than four percent (4%) reflecting face failures shall be rejected according to ASTM E808 and ASTM E809.

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- F. Physical requirements shall be in accordance with following test procedures:
1. Type I and Type III Markers: Select three (3) random markers per lot. Center marker over open end of vertically positioned one inch (1 In) long hollow metal cylinder with three inch (3 In) inside diameter and twenty-five hundredths of an inch (0.25 In) wall thickness. Apply load slowly to top of marker through one inch (1 In) diameter by one inch (1 In) high metal plug centered on marker. Breakage or appreciable deformation of test sample at a load less than two thousand pounds (2000 Lbs) shall be cause for lot rejection.
 2. Type II Markers: Select twenty (20) random markers per lot. Condition markers in convection oven at one hundred thirty degrees Fahrenheit (130° F) for one hour (1 Hr). At elevated temperature, impact reflective face by dropping ninety gram (90 g) dart, fitted with twenty-five hundredth of an inch (0.25 In) radius spherical head, six inches (6 In) perpendicularly onto center of reflective surface. Cracks in impact surface area shall be generally concentric in appearance. Small radial cracks less than twenty-five hundredth of an inch (0.25 In) in length shall be allowed. Lot shall be acceptable when eighteen (18) test samples meet testing requirements. The failure of four (4) test samples shall cause lot rejection. Retest additional twenty (20) markers when three (3) samples from the first (1st) group fail. The failure of one (1) lens of re-sample group shall cause lot rejection.
- G. Impact Resistance: Test in accordance with ASTM D2444 Tup A.
- H. Jiggle Bar Tile, Class A, shall conform to TxDOT Material Specifications D-9-4100 and includes Types I-A, I-C, II-A-A, W and Y.
1. Type I-A shall contain approach face that reflects amber light. Body, other than reflective face, shall be yellow.
 2. Type I-C shall contain approach face that reflects white light. Body, other than reflective face, shall be white, silver-white or light gray.
 3. Type II-A-A shall contain two (2) reflective faces (approach and trailing) each of which shall reflect amber light. Body, other than reflective faces, shall be yellow.
 4. Type W shall have white body and no reflective faces.
 5. Type Y shall have yellow body and no reflective faces.
 6. Adhesive:
 - a. Bituminous adhesive conforming to TxDOT material Specification D-9-6130 shall be used for Class A type markers on bituminous pavements.
 - b. Epoxy adhesive for Class A type markers on Portland cement concrete pavements.

- c. Adhesives for installation of jiggle bar shall be as recommended by manufacturer.

2.2 ADHESIVE

- A. Obtain two (2) component epoxy adhesive from reflective pavement marker manufacturer which conforms to manufacturer's requirements for installation for Class A, B, C and D markers on Portland cement concrete pavements.
- B. Provide bituminous adhesive per TxDOT Material Specification D-9-6130 and which conforms to manufacturer's requirements for installation for Class A, B, C and D markers on bituminous pavements.

PART III: EXECUTION

3.1 PREPARATION

- A. Accurately locate and install approved markers to conform to classes and colors indicated on the Drawings.
- B. Clean and repair surfaces to receive markings. Remove loose material, dust and contaminants such as oil, curing membrane or polished aggregates.
- C. Blast clean surfaces indicated on the Drawings or where directed by the Project Manager in accordance with requirements of Section 02850 – Blast Cleaning of Pavement. Do not clean Portland cement concrete pavements by grinding. Mechanical wire brushing may be used to remove curing membranes.

3.2 INSTALLATION

- A. Prepare pavement surfaces and install markers in accordance with marker and adhesive manufacturer's recommendations.
- B. Test pavement surface for moisture content prior to application of markings. Place approximate two square foot (2 Sf) sheet of clear plastic or tar paper on road surface and hold in place for twenty minutes (20 Min). Immediately inspect sheet for build up of condensed moisture. When sufficient moisture has condensed to cause water to drip from sheet, do not apply markings. Repeat test as necessary until sufficient moisture has evaporated from pavement to allow placement.
- C. Observe manufacturer's recommended pavement and ambient air temperature requirements for application. When manufacturer has no temperature recommendations, do not install markings when pavement surface temperature is below sixty degrees Fahrenheit (60° F) or above one hundred twenty degrees Fahrenheit (120° F).
- D. Position reflective face of markers so that direction of reflection of one (1) face is directly opposite to direction of reflection of other face and parallel to centerlines of street.
- E. Prepare surfaces to which markers are to be attached by adhesive by a method to ensure that surface is free of dirt, curing compound, grease,

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oil, moisture, loose or unsound pavement markings and other materials which would adversely affect adhesive bond.

- F. Establish guides to mark lateral location of pavement markings as shown on drawings. Guides placed on roadway for alignment purposes shall not establish permanent marking on roadway.
- G. Place pavement markings in alignment with guides. Deviation rate in alignment shall not exceed one inch (1 In) per two hundred feet (200 Ft) of roadway. A maximum deviation shall not exceed two inches (2 In) nor shall deviation be abrupt. Remove and replace markings that are out of alignment or proper sequence.
- H. Apply adhesive in sufficient quantity to ensure adhesion and as recommended by manufacturer for installation.
- I. Markers shall be free of rust, scale, dirt, oil, grease, moisture or contaminants which might adversely affect adhesive bond.
- J. Adhesive or other materials that impair functional reflectivity shall not be acceptable.
- K. Place markers immediately after adhesive is applied and set into adhesive. Pavement markers shall not be in contact with pavement surface but shall be seated on continuous layer of adhesive. One hundred percent (100%) of bonding area of marker shall be in contact with adhesive.
- L. For Bituminous adhesive use, pavement and pavement marker temperature shall be at least forty degrees Fahrenheit (40° F). Do not heat Bituminous adhesive to temperature greater than four hundred degrees Fahrenheit (400° F). Agitate Bituminous adhesive immediately to ensure even heat distribution.
- M. Prime pavement surface and apply markings as recommended by manufacturer.

3.3 CLEANING

- A. Keep project site free of unnecessary traffic hazards at all times.
- B. Clean area upon completion of the Work and remove rubbish from the work site.

3.4 WARRANTY

- A. Warrant material and labor for period of twelve months (12 Mos) from date of installation of markings.

PART IV: TABLES

4.1 RAISED PAVEMENT MARKER CONFIGURATION FOR TYPES I, II AND III.

RAISED PAVEMENT MARKER CONFIGURATION			
MARKER	NOMINAL DIMENSIONS	REFLECTING FACE SLOPE	REFLECTING FACE SURFACE AREA
Type I	4" x 4" x 0.75 high	30°	3.25 sq. in.
	3" x 5" x 0.70 high	30°	4.00 sq. in.
Type II	2" x 4" x 0.40 high	30°	1.87 sq. in.
Type III	3" x 5" x 0.70 high	30°	4.00 sq. in.

4.2 RAISED PAVEMENT MARKER OPTICAL PERFORMANCE FOR TYPES I AND II.

TYPE I AND II RAISED PAVEMENT OPTICAL PERFORMANCE			
SPECIFIC INTENSITY, SI, MIN.	WHITE	YELLOW	RED
Entrance Angle = 0°	15.0	9.0	3.5
Entrance Angle = 20°	6.0	3.6	1.2

4.3 RAISED PAVEMENT MARKER OPTICAL PERFORMANCE FOR TYPES III.

TYPE III RAISED PAVEMENT OPTICAL PERFORMANCE			
SPECIFIC INTENSITY, SI, MIN.	WHITE	YELLOW	RED
Entrance Angle = 0°	15.0	9.0	3.5
Entrance Angle = 20°	6.0	3.6	1.2

END OF SECTION

**SECTION 02860
THERMOPLASTIC PAVEMENT MARKINGS**

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. This item includes white or yellow thermoplastic pavement markings for crosswalks, stop lines, lane lines, edge lines and other types of traffic controls.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for thermoplastic pavement markings is on a linear foot basis for the width of markings.
2. Payment for words and symbols is per each word or symbol.
3. Unit price bid for each shall be item full compensation for furnishing and placing all materials and for all manipulations, including blast cleaning, surface sealing and priming, labor, tools, equipment and incidentals necessary to complete the Work in accordance with drawings and Technical Specifications.
5. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

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

1.3 REFERENCES

A. ASTM – American Standards for Testing and Materials.

1. ASTM E28 – Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus.
2. ASTM G152 – Standard Practice for Operating Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
3. ASTM G153 – Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.

B. CFTS – City of Friendswood Technical Specifications.

C. TxDOT – Texas Department of Transportation.

1. TxDOT Tex-822-B – Determining Refraction Index of Glass Beads.
2. TxDOT Tex-826-B – Water Absorption Test of Beads.
3. TxDOT Tex-839-B – Determining Color in Reflective Material.
4. TxDOT Tex-851-B – Evaluating the Abrasion Resistance of Pavement Marking Material.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.

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- B. Product Data: Submit Manufacturer's literature indicating product specifications and instructions for handling, installation and curing. Include performance test data sheets for each product.
- C. Submit material supplier's certification of compliance with the Technical Specifications.
- D. Submit proposed methods, equipment and sequence of operation for layout, surface preparation and installation.
- E. Chemical Analysis: Submit infrared analysis of Type B resins for each manufacturer used.

PART II: PRODUCTS

2.1 MATERIAL REQUIREMENTS

- A. General Requirements: Especially compound Type B thermoplastic pavement marking material for use on either asphaltic or Portland cement concrete surfaces. Clearly mark each container to indicate color, weight, type of material and lot or batch number (consider lot or batch as each individual mix or blend that produces finished product ready for use). Package material in either suitable corrugated containers or thermal degradable plastic bags to avoid sticking during shipment or storage.
- B. Thermoplastic markings shall not be slippery when wet, and shall not exhibit tacky, exposed surface. Cold ductility of material shall permit normal road surface expansion and contraction without chipping or cracking. Markings shall retain their original color, dimensions and placement under normal traffic conditions at road surface temperatures of one hundred fifty-eight degrees Fahrenheit (158° F) and below.
- C. Prime and filler pigments shall pass U.S. Standard sieve No. 230 (0.0024 inch opening) when washed free of resins by solvent washing and meet following specific requirements for each pigment.
 - 1. Prime Pigments: White pigment shall be Rutile Titanium Dioxide. Yellow pigment shall be a heat-resistant, double-encapsulated medium chrome yellow or other approved heat-resistant pigment.
 - 2. Filler Pigment: Filler pigment shall be calcium carbonate, with a purity of ninety-five percent (95%).
- D. Binder
 - 1. Type B – Alkyd: Use binder consisting of mixture of resins, at least one (1) of which is solid at room temperature and high boiling point plasticizers. At least one-third (1/3) of binder compositions shall be a maleic-modified glyceryl ester 012 Rosin and shall be no less than eight percent (8%) by weight of entire material formulation.
- E. Glass Traffic Beads: The total silica used in formulation shall be in the form of glass traffic beads meeting the following requirements:
 - 1. Manufacture: Use glass traffic beads having the following

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- characteristics:
 - a. Manufactured from glass;
 - b. Spherical in shape;
 - c. Free of sharp angular particles;
 - d. Free of particles showing milkiness, surface scoring or surface scratching;
 - e. Water white in color.
- 2. Contaminants: Use glass traffic beads having the following characteristics:
 - a. Containing less than one-quarter of one percent (0.25%) moisture by weight;
 - b. Free of trash, dirt, etc;
 - c. Showing no evidence of objectionable static electricity when flowing through traffic-bead dispenser.
- 3. Gradation:
 - a. Sieve Analysis: Glass traffic beads shall meet gradation requirements specified in TABLE 4.1 – GLASS TRAFFIC BEADS SIEVE ANALYSIS, in this Section.
 - b. Irregular Particles: Glass traffic beads, retained on screen used to determine gradation requirements, shall contain not more than thirty percent (30%) (by weight) of irregular particles.
- 4. Index of Refraction: Glass traffic beads, when tested by TxDOT Tex-822-B, using liquid immersion method at seventy-seven degrees Fahrenheit (77° F) shall show index of refraction within range of 1.50 to 1.53.
- 5. Wetting: Use glass traffic beads capable of being readily wet with water when tested in accordance with TxDOT Tex-826-B.
- 6. Stability: Use glass traffic beads showing no tendency toward decomposition, surface etching, change in retro-reflective characteristics or change in color after:
 - a. One hour (1 Hr) exposure to concentrated hydrochloric acid at seventy-seven degrees Fahrenheit (77° F);
 - b. Twenty-four hour (24 Hr) exposure to weak alkali;
 - c. One hundred hours (100 Hrs) of Weather-O-Meter exposure, in accordance with ASTM G152 and ASTM G153.

2.2 FINISHED PRODUCT REQUIREMENTS

- A. Physical Characteristics: Finished thermoplastic pavement markings material shall be free-flowing granular material, unless otherwise shown on the Drawings. Material shall remain in free flowing state in storage at temperatures of one hundred degrees Fahrenheit (100° F) or less. Materials shall be readily sprayed through nozzles commonly used on thermoplastic spray equipment at temperatures between four hundred one degree Fahrenheit (401° F) to four hundred twenty-five degrees

- Fahrenheit (425° F).
- B. Toxicity: At temperatures up to and including four hundred forty-six degrees Fahrenheit (446° F), materials shall not give off fumes which are toxic and otherwise injurious to persons, animals or property.
 - C. Material shall not break down or deteriorate when held at four hundred one degrees Fahrenheit (401° F) for four hours (4 Hrs).
 - D. Temperature versus viscosity characteristics of material in plastic state shall remain constant throughout up to four reheatings at four hundred one degrees Fahrenheit (401° F) and from batch to batch.
 - E. Material shall not be adversely altered by contact with sodium chloride, calcium chloride or other similar chemicals on or used on, roadway surface; by contact with oil content of pavement materials or by contact from oil dropping from traffic.
 - F. Softening Point: After heating thermoplastic materials for two hours (2 Hrs) at four hundred degrees Fahrenheit (400° F) Type B Alkyd material shall have softening point greater than 194 degrees Fahrenheit when tested in accordance with ASTM E28-58T – Ball and Ring Method.
 - G. Color: CIE chromaticity coordinates of materials, when determined in accordance with TxDOT Tex-839-B, shall fall within area having following corner points and shall meet luminosity requirements specified in TABLE 4.2 – CIE CHROMATICITY COORDINATE CORNER POINTS LUMINISITY REQUIREMENTS, in this Section. Material shall meet above specified color requirements, before and after seventy hours (70 Hrs) of exposure in Weather-O-Meter (Atlas, Sunshine Type) fitted with [eighteen minutes (18 Min) sunshine and rain to one hundred two minutes (102 Min) of sunshine] cyclic gear. Prepare panels for testing with material as supplied.
 - H. Abrasion: Thermoplastic pavement marking materials shall have loss between four grams (4 g) and twelve grams (12 g) when tested for abrasion in accordance with TxDOT Tex-851-B. Test according to steps one (1) through eight (8) of procedure utilizing test parameters specified in TABLE 4.3 – ABRASION TEST FOR THERMOPLASTIC PAVEMENT MARKING MATERIALS, in this Section.
 - I. Uniformity: Manufacture material so that, when sampled in accordance with TxDOT Manual of Testing Procedures, a one hundred gram (100 g) sample shall be representative of the batch or lot of material.
 - J. When applied one-eighth inch (1/8 In) thick, setting time shall not exceed characteristic straight-line curve lower limit which is four minutes (4 Min) at fifty-nine degrees Fahrenheit (59° F) road surface temperatures and upper limit of which is ten (10) minutes at ninety degrees Fahrenheit (90° F) road surface temperature. Both temperatures are to be measured at a maximum relative humidity of ninety percent (90%).

2.3 FORMULAE

- A. Type B – Alkyd Thermoplastic Marking shall be as specified in TABLE 4.4 – TYPE B ALKYD THERMOPLASTIC MARKING FORMULA, in this Section.

PART III: EXECUTION

3.1 GENERAL

- A. Spray apply pavement marking or extrude hot material to pavement surface unless application method is specified on the Drawings.
- B. Provide continuous mixing and agitation of material. Provide clean, square, marking ends. Do not use pans, aprons or similar appliances which die overruns.
- C. Provide thermometer capable of measuring temperature of pavement marking material.
- D. Use automatic bead dispenser attached to pavement marking equipment in manner that beads are dispensed uniformly and almost instantly upon marking as marking is being applied to road surface. Rate of application shall be sufficient to achieve retro-reflective characteristics specified. Provide automatic cut-off control for bead dispenser, synchronized with cut-off of pavement marking application process.
- E. Place markings in accordance with approved traffic control plan so that minimal interruption to traffic flow is achieved, or so that driver confusion is minimized. Protect newly-installed pavement markings from damage by traffic.
- F. Apply pavement markings onto clean, dry pavement having road surface temperature above sixty degrees Fahrenheit (60° F). When pavement marking application is by spray and operations cease for five minutes (5 Min) or more, flush spray head by spraying pavement marking material into pan or similar container until material is proper temperature for application.
- G. Use markings that are completely reflectorized internally and externally.
- H. Use crew experienced in the Work of installing pavement markings and supply all equipment and materials necessary for placement of pavement markings.
- I. Apply material within temperature limits recommended by manufacturer.
- J. Prior to placement of thermoplastic material, properly prepare pavement with primer.

3.2 LAYOUT

- A. Place pavement markings in proper alignment with guidelines established on roadway. Do not deviate from alignment established greater than two inches (2 In). Do not deviate in alignment of marking being placed greater than one inch (1 In) per two hundred feet (200 Ft) of marking and do not deviate abruptly.
- B. Place additional markings required to achieve alignment specified

throughout both straight and horizontally curved sections of roadway. Additional markings placed on roadway for alignment purposes shall be temporary in nature and shall not be established as permanent marking on roadway. Materials used for alignment markings and equipment used to place markings shall be approved by the Project Manager.

3.3 SURFACE PREPARATION

- A. Clean pavement by sandblasting and prepare in accordance with recommendations of thermoplastic material manufacturer and to satisfaction of the Project Manager prior to placement of markings. Surface scarification can be used with prior approval of the Project Manager.
- B. Use cleaning methods approved by the Project Manager that completely remove contaminants, loose materials and conditions deleterious to proper adhesion. Do not clean Portland cement concrete surfaces by grinding.
- C. Further prepare Portland cement concrete surfaces after cleaning by completely sealing with epoxy or methyl methacrylate sealer as recommended by thermoplastic material manufacturer. Place sealer sufficiently in advance of thermoplastic to allow release of all solvents.
- D. Prime asphaltic surfaces with sealer as recommended by thermoplastic material manufacturer and based on surface conditions. Include adhesive or adhesion promoter when asphaltic surfaces exhibit polished aggregate.

3.4 INSTALLATION

- A. Install in widths of four inches (4 In), six inches (6 In), eight inches (8 In) or twelve inches (12 In) or shape as otherwise shown on the Drawings. Tolerances in width shall not exceed one-eighth inch (1/8 In). Tolerance shall not exceed one-quarter inch (1/4 In) in case of undulation in pavement.
- B. Material shall not prohibit adhesion of other thermoplastic markings if, at some future time, new markings are placed over or across existing materials.
- C. Maintain uniform thickness of each pavement marking. The minimum thickness of markings, as measured above plane formed by pavement surface, shall not be less than one-eighth inch (1/8 In), one hundred twenty-five mils (125 mils), unless shown otherwise on the Drawings. The maximum thickness shall be three-sixteenths inch (3/16 In). Supply device approved by the Project Manager to measure thickness of applied extruded markings.

3.5 TESTING

- A. Maintain uniform cross section, density, quality and thickness for markings. Markings shall be uniform throughout their thickness. Use applied markings that are ninety-five percent (95%) free of holes and voids and free of blisters for a minimum of sixty days (60 D) after application.

PART IV: TABLES

4.1 GLASS TRAFFIC BEADS SIEVE ANALYSIS

OPENINGS U.S. STANDARD SIEVES	PERCENT PASSING
No. 20	95 – 100
No.30	80 – 95
No. 50	15 – 35
No. 100	0 – 4

4.2 CIE CHROMATICITY COORDINATE CORNER POINTS LUMINISITY REQUIREMENTS

	POINT 1	POINT 2	POINT 3	POINT 4	
Color	X Y	X Y	X Y	X Y	Luminosity
White {tc \ 12" White}	0.290 – 0.315	0.310 – 0.295	0.350 – 0.340	0.330 – 0.360	Minimum 65

4.3 ABRASION TEST FOR THERMOPLASTIC PAVEMENT MARKING MATERIALS

THERMOPLASTIC MARKINGS TEST PARAMETERS	
TEST PARAMETERS	VALUE
Test Distance	5 Inches
Blast Pressure	40 psi
Sample Angle	10° and 122 gram blast media
Blast Media	1200 grams

4.4 TYPE B – ALKYD THERMOPLASTIC MARKING FORMULA

MATERIAL	POUNDS
Binder	18 – 23
Titanium Dioxide	12 – 15
Calcium Carbonate	20 – 42
Glass Traffic Beads	30 – 45
TOTAL	100

END OF SECTION

SECTION 02865 TRAFFIC SIGNS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

- A. Requirements for furnishing and installing signs for traffic control.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for traffic signage is on a per each basis per sign type.
 - 2. Refer to Section 01270 – Measurement and Payment for 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. ASTM – American Society for Testing and Materials.
 - 1. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - 3. ASTM B209 – Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - 4. ASTM B449 – Standard Specification for Chromates on Aluminum.
 - 5. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 6. ASTM D4956 – Standard Specification for Retroreflective Sheeting for Traffic Control.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
 - 1. Department of Materials Specification DMS-7110 Aluminum Sign Blanks.
 - 2. Department of Materials Specification DMS-8300 Sign Face Materials.
 - 3. Standard Specifications for Construction of Highways, Streets and Bridges Item 636 – Aluminum Signs (Type A).
 - 4. Texas Manual on Uniform Traffic Control Devices (TMUTCD), Latest Edition.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit manufacturer's product data concerning following materials for approval:

1. Sign Blanks.
 2. Facing materials.
 3. Mounting hardware and poles.
- C. Submit manufacturer's certification that all signage meets requirements in this Technical Specification.

PART II: PRODUCTS

2.1 ALUMINUM SIGN BLANKS

- A. Aluminum sheet or coil sign blanks shall meet all requirements of TxDOT Standards Specification Item 636, TxDOT DMS-7110 Aluminum Sign Blanks and ASTM B209, Alloys 6061-T-6 or 5052-H38.
- B. Sign blanks made from sheet or coil shall be free of buckles, warps, dents, cockles, burrs and other defects and must be a plane surface. Sign blank thickness shall be eight-hundredths inch (0.08 In) in thickness.
- C. Treat all sign blanks fabricated from sheet and coil with a chromate chemical process resulting in a coating meeting the requirements of ASTM B449, Class 2. The coating shall be light colored, tight and free from powdery residues.
- D. Manufacturer shall furnish mill test reports for aluminum sheet or coil which reflect the chemical and physical properties of the aluminum.

2.2 SIGN MOUNTING HARDWARE AND ADHESIVES

- A. All material for sign posts and mounting hardware shall be galvanized Steel and be in compliance with ASTM A307, ASTM A153 and ASTM B695.
- B. Sign posts shall be two and three-eighths inches (2-3/8 In) in outside diameter galvanized steel.
- C. Sign Post mounting shall be "Pos-Lok" or equal system consisting of sixteen inch (16 In) sleeve and removable wedge.
- D. Pipe and post clamp castings and miscellaneous fasteners shall be verified by manufacturer's certifications stating that the material meets all applicable requirements.

2.3 FACE MATERIALS

- A. All materials are to be certified by lot or shipment that material supplied meets requirements listed in these Specifications. Material shall also comply with ASTM D4956 and TxDOT DMS 8300.
- B. Sign face materials shall be processed, applied and stored according to the manufacturer's recommendations. Sign face materials shall perform for a minimum of ten years (10 Yrs).
- C. The Project Manager shall reject any sign and or face material for the following reasons:
 1. Cracks discernible with the unaided eye from the drivers position

- while in an outside lane at a distance of fifty feet (50 Ft) or greater from the sign.
2. Peeling in excess of one-quarter inch (1/4 In).
 3. Shrinkage in excess of one-eighth inch (1/8 In) total per forty-eight inches (48 In) of sheeting width.
 4. Fading or loss of color to the extent that color fails to meet the requirements of ASTM D4956 or TxDOT DMS 8300.
 5. In non-construction zone – loss of reflectivity to a level eighty percent (80%) of the minimum values as specified in ASTM D4956.
 6. In construction zone – loss of reflectivity to a level sixty percent (60%) of the minimum values as specified in ASTM D4956.
 7. Face consists of pressure-activated material of either diamond or prismatic vinyl.

2.4 STREET NAME SIGNS

- A. Street name signs shall conform to the applicable City of Friendswood Standard Details, and to TxDOT Specifications where applicable.

PART III: EXECUTION

3.1 INSTLLATION

- A. All signs and their installation shall be accordance with the latest edition of the TMUTCD Texas Manual on Construction Traffic Control Devices (TMUTCD).
- B. All signs shall be installed at the locations shown on the Drawings or as directed by the Project Manager.
- C. Sign Posts shall be set a minimum of three feet (3 Ft) in depth in a twelve inch (12 In) diameter hole filled with concrete as specified in Section 03300 – Structural Concrete.
- D. All installation and materials shall conform to all applicable requirements specified in Section 01430 – Project Signage.

END OF SECTION

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

02870-1

- 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