HOUSTON SHIP CHANNEL (HSC), TEXAS
EXPANSION CHANNEL IMPROVEMENT PROJECT (ECIP)
PROJECT 11: PACKAGE #7 SEGMENT 3 - BARBOURS CUT
CHANNEL MORGANS POINT BULKHEAD

SOLICITATION NO.: W912HY-XX-X-XXXX
CONTRACT NO.: XXXXXX XX-X-XXXX
ISSUE DATE: AUGUST 2020
VOLUME # 1 OF 1
GENERAL REQUIREMENTS
1. CONTRACTOR SHALL NOT COMMENCE ANY CONSTRUCTION WORK UNLESS PERMITS FOR THIS PROJECT HAVE BEEN ACQUIRED.
2. DESIGN AND CONSTRUCTION WORK SHALL COMPLY WITH ALL APPLICABLE STATE AND LOCAL CODES AND STANDARDS, THE PROJECT SPECIFICATIONS AND PROJECT DRAWINGS. CONTRACTOR SHALL PROVIDE CONSTRUCTION DRAWINGS TO THE OWNER FOR REVIEW AND APPROVAL PRIOR TO COMMENCEMENT OF CONSTRUCTION WORK.
3. CONTRACTOR SHALL FURNISH TO THE OWNER ALL CONSTRUCTION DRAWINGS OF WORK TO BE PERFORMED UNDER THIS CONTRACT.
4. CONTRACTOR SHALL SUBMIT STORMWATER POLLUTION PREVENTION PLAN (SWPPP) TO THE APPROPRIATE REGULATORY AGENCY PRIOR TO ANY CONSTRUCTION.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PERMIT APPLICATIONS, ENGINEERING FEASIBILITY STUDIES, AND ENVIRONMENTAL PERMITTING ACTIVITIES.

SOIL BORINGS
2. BORING LOGS ARE SHOWN ON SHEETS B-001 AND B-002 ARE FROM GEOGRAPHICAL AUGER, HOLE, OR CONTRACTOR'S REMEMBRANCE. CONTRACTOR IS REQUESTED TO CONFORM TO CONTRACT DRAWING IMPROVEMENT PROJECT REPORT NO. H-2018/11/22-1 DATED 03/06/2019.
3. SOIL INVESTIGATION DATA IS PROVIDED FOR THE INFORMATION AND CONVENIENCE OF THE CONTRACTOR. THE INFORMATION PROVIDED IN THIS PROJECT IS FOR THE USE OF THE CONTRACTOR AS SHOWN, UNLESS NOTED OTHERWISE. THE APPRPROXIMATE LOCATION, EXTENT, SCOPE AND MANUFACTURER'S SPECIFICATIONS OF SOILS SHOWN, SUBJECT TO SHOP DRAWING APPROVAL.
4. SOIL INVESTIGATION REPORTS ARE NOT A PART OF THE CONTRACT DOCUMENTS.
5. FOR GRAFOGRAPHIC LOCATIONS OF ALL BORINGS, REFER TO SHEET C-001.

DEMOLITION AND SALVAGE
1. THE CONTRACTOR SHALL REMOVE ALL EXISTING ABOVE SURFACE AND BURIED STRUCTURES. PRIOR TO THE TIME CONCRETE IS PLACED AGAINST IT.
2. THE DRAWINGS OR WITH PRIOR APPROVAL FROM ENGINEER.
3. CONTRACTOR MAY INITIALLY USE VIBRATORY EQUIPMENT TO DRIVE SHEET PILING TO THE FINISHED STEEL SURFACE. ALL DAMAGED COATING SHALL BE REPAIRED.
4. WHEN AN IMPACT HAMMER IS USED, SHEET PILES SHALL BE DRIVEN SUCH THAT THE TIP OF THE PILE BEING DRIVEN DOES NOT ADVANCE MORE THAN 4-FT BELOW THAT OF ANY OTHER PILE.

SHOP DRAWINGS
1. THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND ELEVATIONS SHOWN ON THE CONSTRUCTION DRAWINGS PRIOR TO ANY CONSTRUCTION.
2. THE CONTRACTOR SHALL DETERMINE ANY SPLICE LOCATIONS IN ADDITION TO THOSE SHOWN, SUBJECT TO SHOP DRAWING APPROVAL.
3. THE CONTRACTOR SHALL FIELD CHECK AND VERIFY ALL ELEVATIONS, COORDINATES, DIMENSIONS, AND VERTICAL AND HORIZONTAL CONTROL POINTS SHOWN ON THE CONSTRUCTION DRAWINGS PRIOR TO ANY CONSTRUCTION.

CONCRETE
1. BEFORE COMMENCEMENT-CONCRETE PLACEMENT PERFORM FOLLOWING:
   a. SURFACES TO BE CLEANED
   b. REMOVE ALL NON-CRETE MATERIALS
   c. SURFACE TO BE CLEANED AND PULVERIZED
   d. SURFACE TO BE BLOWED TO REMOVE ANY LOOSE MATERIALS
   e. MORTAR ARTIFACTS TO BE REMOVED TO ENSURE CLEAN SURFACE
   f. STEEL WELDING機構 TO BE ENSURED
   g. CONCRETE STRENGTH = 5,000 PSI

REINFORCING STEEL
1. ALL REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A416-06.
2. CLEAR COVER OVER REINFORCING STEEL SHALL BE A MINIMUM OF 3-INCH, UNLESS OTHERWISE NOTED.
3. DIMENSIONS TO REINFORCING STEEL ARE TO CUT DIMENSIONS UNLESS OTHERWISE NOTED.
4. MECHANICAL CONNECTORS MAY BE USED AT CONSTRUCTION JOINTS AND IN LOU..
65% REVIEW

G-003

A

C90-D13-P11-007

3. FILL BENEATH WATER LEVEL SHALL BE PLACED AS BY DUMP AND DOZE METHOD COMPACTED TO 95% STANDARD PROCTOR DENSITY. UNIFORMLY ALONG ENTIRE LENGTH OF BULKHEAD WALL. EACH LAYER SHALL BE AND WASHOUTS IN THE SLOPE HAVE BEEN ELIMINATED AND PROPERLY FILLED.

2. FILL MATERIAL SHALL BE PLACED IN LIFTS NOT TO EXCEED 9" LOOSE DEPTH. IN #200 MAXIMUM LINEAR SHRINKAGE 8.5 MAXIMUM LIQUID LIMIT 45 MAXIMUM

PORTION OF MATERIAL PASSING OF 40 MESH SIEVE SHALL EXHIBIT THE FOLLOWING PROPERTIES:

- MOMENT OF INERTIA (in²·ft) - 797.87 / 152.18
- SECTION MODULUS (in³/ft) - MINIMUM BULKHEAD WALL

THIS TABLE IS A SUMMARY OF THE DESIGN COATING FOR THE PROJECT. THE SPECIFICATION (2 OF 2)

TABLE 3 - COATING SCHEDULE

<table>
<thead>
<tr>
<th>BULKHEAD</th>
<th>BULKHEAD 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTRUCTION</td>
<td>OPERATIONAL</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>OPERATIONAL</td>
</tr>
<tr>
<td>Ps (psi)</td>
<td>300</td>
</tr>
<tr>
<td>TOP OF WALL ELEVATION</td>
<td>+5.0</td>
</tr>
<tr>
<td>LINE</td>
<td>+2.0</td>
</tr>
<tr>
<td>COAT. ELEV.</td>
<td>+2.0</td>
</tr>
<tr>
<td>NOMINAL EXCAVATION ALLOWANCE</td>
<td>+0.0</td>
</tr>
<tr>
<td>125 BONDING WALL</td>
<td>100/34 PAVING</td>
</tr>
<tr>
<td>MINERAL SIO3</td>
<td>30%</td>
</tr>
<tr>
<td>MINERAL SIO3</td>
<td>30%</td>
</tr>
<tr>
<td>NOMINAL MINERAL BULKHEAD WALL</td>
<td>100/34 PAVING</td>
</tr>
<tr>
<td>SECTION MODULUS (ft-lb)</td>
<td>1500</td>
</tr>
<tr>
<td>MINERAL BULKHEAD WALL</td>
<td>100/34 PAVING</td>
</tr>
<tr>
<td>MASSIVE BULKHEAD WALL</td>
<td>100/34 PAVING</td>
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<tr>
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<td>MASSIVE BULKHEAD WALL</td>
<td>100/34 PAVING</td>
</tr>
<tr>
<td>MASSIVE BULKHEAD WALL</td>
<td>100/34 PAVING</td>
</tr>
</tbody>
</table>

NOTE: THIS TABLE IS A SUMMARY OF THE DESIGN COATING FOR THE PROJECT. THE CONTRACTOR SHALL PROVIDE PANT SCHEDULE IN SHOP DRAWINGS.

BULKHEAD FILL

1. BACKFILL AND FILL FOR BULKHEAD SHALL BE A COARSE MATERIAL AND THE POSITION OF MATERIAL PASSING OF 40 MESH (51) SHEAR STRENGTH OF THE FOLLOWING PROPERTIES:

- LIQUID LIMIT 8.5 MAXIMUM
- LINEAR SHRINKAGE 45 MAXIMUM
- DRY DENSITY 3.5 MINIMUM
- MAXIMUM
- LIQUID LIMIT 8.5 MAXIMUM
- DRY DENSITY 3.5 MINIMUM
- MAXIMUM

2. FILL MATERIAL SHALL BE PLACED IN LIFTS NOT TO EXCEED 9" LOOSE DEPTH. IN DUMPING AND PLACING FILL, CONTRACTOR SHALL ENSURE THAT EACH LAYER IS COMPACTED TO A MINIMUM OF 90% STANDARD PROCTOR DENSITY. UNIFORMLY ALONG ENTIRE LENGTH OF BULKHEAD WALL. EACH LAYER SHALL BE COMPACTED TO A MINIMUM OF 90% STANDARD PROCTOR DENSITY.

3. FILL BENEATH WATER LEVEL SHALL BE PLACED AS BY DUMP AND DOZE METHOD INSURING THAT SOIL LIQUID MATERIAL IS DISPLACED IN FRONT OF THE FILL AND NOT TRAPPED IN THE FILL. THICER LAYERS MAY BE USED BELOW THE WATERLINE.
A. CONTRACTOR HAS THE OPTION OF PERFORMING THE CONSTRUCTION PER THE SEQUENCE SHOWN BELOW OR HAS THE OPTION OF PROPOSING AN ALTERNATIVE CONSTRUCTION SEQUENCE THAT IS CONSISTENT WITH THE DESIGN PRESENTED. ALTERNATIVE CONSTRUCTION SEQUENCE SHALL BE SUBMITTED TO THE OWNER FOR APPROVAL PRIOR TO ORDERING OF MATERIALS. FOLLOWING IS THE CONSTRUCTION SEQUENCE FOR THE BULKHEAD.

1. CANTILEVERED WALLS

STEP 1: EXCAVATE 1 FOOT BELOW THE BOTTOM OF CONCRETE CAP ON THE WATER SIDE AS SHOWN. EXCAVATE TO THE SAME ELEVATION ON THE LAND SIDE.

STEP 2: INSTALL THE BULKHEAD PILES.

STEP 3: INSTALL THE BULKHEAD CAP.

STEP 4: BACKFILL BEHIND BULKHEAD WALL TO MEET FINAL GRADE.

STEP 5: DREDGE MATERIAL WATER SIDE OF BULKHEAD WALL.

2. ANCHORED WALLS

STEP 1: EXCAVATE 1 FOOT BELOW THE BOTTOM OF CONCRETE CAP ON THE WATER SIDE AS SHOWN. EXCAVATE TO THE SAME ELEVATION ON THE LAND SIDE.

STEP 2: INSTALL THE BULKHEAD PILES.

STEP 3: INSTALL THE BULKHEAD CAP.

STEP 4: INSTALL RAKER ANCHOR PILES.

STEP 5: PARTIAL BACKFILL BEHIND BULKHEAD WALL TO INSTALL TIE-RODS AND PRE-TENSION TIE-RODS WHERE PRESENT ON PLAN.

STEP 6: CONSTRUCT CONCRETE CAP.

STEP 7: BACKFILL BEHIND BULKHEAD WALL TO MEET FINAL GRADE.

STEP 8: DREDGE MATERIAL WATER SIDE OF BULKHEAD WALL.

B. TEMPORARY CONSTRUCTION FILL IS ALLOWED, BUT NOT REQUIRED, NEAR THE EXISTING SHORELINE AS PER US ARMY CORPS OF ENGINEERS PERMIT NO. SWG-2006-00997. THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN OF CONSTRUCTION METHODS INVOLVING THE PLACEMENT OF FILL MATERIAL TO FIRM THE EXISTING SHORELINE. CONTRACTOR MAY NEED CONFINEMENT IN SOME AREAS TO CONTAIN THE TEMPORARY FILL.

C. CONTRACTOR SHALL SUBMIT DETAILED MATERIAL TESTS AND PLACEMENT METHODS FOR FILL BEHIND THE BULKHEAD WALL AT LEAST ONE WEEK PRIOR TO THE ORDERING OF MATERIALS.

D. SEE SHEET G-005 FOR LOAD LIMITATIONS BEHIND BULKHEAD DURING CONSTRUCTION.

3. BULKHEAD DESIGN CRITERIA

CONSTRUCTION SURCHARGE

CRANE SURCHARGE

CANTILEVERED BULKHEAD BASE OF DESIGN - CONSTRUCTION CONDITION

CANTILEVERED BULKHEAD BASE OF DESIGN - OPERATIONAL CONDITION

ANCHORED BULKHEAD BASE OF DESIGN - OPERATIONAL CONDITION
1. **THIS IS A STANDARD CIVIL SYMBOLOGY SHEET. ALL SYMBOLS ARE NOT NECESSARILY USED ON THIS PROJECT.**

2. **SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.**

**GENERAL NOTES:**

- **Legend**

- **Utility/Civil Line Symbole**

- **Civil Mapping Symbole**

- **Transportation**

- **Hydrography**

- **Geophysics**

- **Soil & Water**

- **Public & Private Utility**

- **Historic & Cultural**

- **Miscellaneous**
NOTES:
1. HORIZONTAL COORDINATE SYSTEM IS NAD 83 TEXAS STATE PLANE SOUTH CENTRAL ZONE.
2. BASE MAPPING IS ESRI WORLD IMAGERY, RETRIEVED FROM GIS TO CAD IN FEBRUARY 2020.
3. CONTRACTOR SHALL CONDUCT PRE-CONSTRUCTION SURVEY CHECKS OF PROJECT MONUMENTATION AND IMMEDIATELY REPORT DISCREPANCIES TO THE CONTRACTING OFFICER.
4. ALL PROJECT ELEVATIONS FOR CHANNEL DREDGING AND DIKE CONSTRUCTION ARE REFERENCED TO MEAN LOWER LOW WATER (MLLW). ELEVATIONS ARE ROUNDED TO THE NEAREST TENTH AND ARE BELOW THE REFERENCE PLANE UNLESS PRECEDED BY A PLUS (+) SIGN.

LEGEND:
- USACE TIDE STAFF
- CONTROL POINT

SURVEY CONTROL PLAN
SCALE: 1" = 10,000'

SURVEY CONTROL PLAN
SCALE: 1" = 10,000'

PORT OF HOUSTON AUTHORITY

HDR Engineering, INC
TBPELS Firm
Registration No. F-754
DESIGN PREPARED BY:

C90-D13-P11-007
V-001
PROJECT 11
PACKAGE #7
SEGMENT 3 - BARBOURS CUT CHANNEL, MORGANS POINT BULKHEAD
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OVERALL CIVIL SITE KEY PLAN

SCALE: 1"=400'

1. REFER TO GENERAL NOTES ON SHEET G-002.
2. CONTROL POINT: PHA3 (5/8" REBAR WITH CAP SET 3" BELOW GRADE)
   NORTHING: 13815119.815
   EASTING: 3239346.324
   ELEVATION: 19.424' (NAVD88)

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EXISTING CONDITIONS SITE PLAN

1. REFER TO GENERAL NOTES ON SHEET G-002.
2. REFER TO SHEET B-001 FOR SOIL BORING LOG INFORMATION.

**GENERAL NOTES**

- PROPOSED TOWER FOUNDATION (BY OTHERS)
- UNDERGROUND WATERLINE (DEPTH TO BE DETERMINED)
- MARINE STRUCTURES (TO BE DETERMINED)
- TO BE DETERMINED
- SOIL BORING LOCATION MARKER
- LOG OF BORING TAG

**EXISTING CONDITIONS SITE PLAN**

- BARBOURS CUT SHIP CHANNEL
- MORGANS POINT
- STORAGE AREA
- PROPOSED TOWER FOUNDATION (BY OTHERS)
- UNDERGROUND WATERLINE (DEPTH TO BE DETERMINED)
- MARINE STRUCTURES (TO BE DETERMINED)
- TO BE DETERMINED
- SOIL BORING LOCATION MARKER
- LOG OF BORING TAG

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65% REVIEW
1. Refer to General Notes on Sheet G-003.

General Notes:

- Marine structures (to be determined)
- Underground waterline to be removed and relocated (by others)
- To be removed and relocated (by others)
- Proposed tower foundation (by others)
- Power poles to be relocated, TYP (by others)
- To be determined

Marine Structures (to be determined)

Underground Waterline to be removed and relocated (by others)

To be removed and relocated (by others)

PROPOSED TOWER FOUNDATION (BY OTHERS)

POWER POLES TO BE RELOCATED, TYP (BY OTHERS)

MARINE STRUCTURES (TO BE DETERMINED)

UNDERGROUND WATERLINE TO BE REMOVED AND RELOCATED (BY OTHERS)

TO BE REMOVED AND RELOCATED (BY OTHERS)

STORAGE AREA

17-15

MORGANS POINT

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HDR Engineering, Inc.

TBPELS Firm

Registration No. F-754

DESIGN PREPARED BY:

C90-D13-P11-007

C-202

PROJECT 11

PACKAGE #7

SEGMENT 3 - BARBOURS CUT CHANNEL, MORGANS POINT BULKHEAD

Enlarged Clearing and Grubbing Plan

65% Review
GENERAL NOTES

1. REFER TO GENERAL NOTES ON SHEET G-003.
2. REFER TO SHEET C-101 FOR WORKING POINT STATION CONTROL LEGEND.

PORT OF HOUSTON AUTHORITY

HOUSTON SHIP CHANNEL (HSC)
EXPANSION CHANNEL IMPROVEMENT PROJECT (ECIP)
PROJECT 11
PACKAGE #7

ENLARGED PROPOSED BULKHEAD PLAN

SEGMEN 3 - BARBOURS CUT CHANNEL, MORGANS POINT BULKHEAD

TOWER FOUNDATION (BY OTHERS)

ENLARGED BULKHEAD PILE PLAN, SEE PLAN A ON SHEET S-101
ENLARGED BULKHEAD CAP PLAN, SEE PLAN A ON SHEET S-102

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ENLARGED BULKHEAD PILE PLAN (AT EL. +4.34')

1. REFER TO GENERAL NOTES ON SHEET G-003.
2. REFER TO SHEET C-101 FOR WORKING POINT STATION/CONTROL LEGEND.
1. REFER TO GENERAL NOTES ON SHEET G-003.

ENLARGED BULKHEAD CAP AND TIE ROD PLAN

ENLARGED BULKHEAD CAP PLAN

MATCH LINE SEE TOP RIGHT

MATCH LINE SEE BOTTOM LEFT

SCALE: 1" = 10'

ENLARGED BULKHEAD CAP AND TIE ROD PLAN

ENLARGED BULKHEAD CAP PLAN

65% REVIEW

65% DRAFT
PORT OF HOUSTON AUTHORITY

HOUSTON SHIP CHANNEL (HSC)
EXPANSION CHANNEL IMPROVEMENT PROJECT (ECIP)

SEGMENT 3 - BARBOURS CUT CHANNEL, MORGANS POINT BULKHEAD

BULKHEAD WALL SECTIONS (1 OF 2)

SCALE: 1" = 10'

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PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

List of Specifications – 65% Submittal

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<td>CONSTRUCTION SURVEYING_ADD</td>
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<tr>
<td>02 22 13</td>
<td>CONSTRUCTION VIBRATION MONITORING_ADD</td>
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<tr>
<td>03 21 00.00</td>
<td>REINFORCING STEEL_ADD</td>
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<td>STRUCTURAL CONCRETE_ADD</td>
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<td>32 11 33.16</td>
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PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS FOR

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

SECTION 01 71 23.16 Add– CONSTRUCTION SURVEYING

PART 1- GENERAL

1.01 SUMMARY

Construction Surveying includes furnishing materials, labor, and equipment for topographic where required under the Contract Documents.

1.02 RELATED SECTIONS

Section 01 22 10.00 Std – Measurement of Quantities
Section 31 24 00 Add – Embankment Construction

1.03 REFERENCES

Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.


1.04 SUBMITTALS

A. Engineer’s approval is required for submittals with an “E” designation; submittals not having an “E” designation are for information only. The following shall be submitted in accordance with Section 01 33 00, “Submittal Procedures”:

1. Name of Registered Professional Land Surveyor (Paragraph 1.05 A)
2. Surveying Plan (Paragraph 1.05 B); E
3. Survey Submittal Log (Paragraph 3.02 D)
4. Upland Placement Area (PA) Dike Surveys (Paragraph 3.07); E
5. Shoreline Protection Surveys (Paragraph 3.09); E

1.05 QUALITY ASSURANCE

A. General: All survey plots submitted to Engineer shall be sealed by a professional land surveyor registered in the State of Texas, experienced in topographic surveying, and familiar and experienced with the USACE’s surveying guidelines in Engineer Manuals (EM) 1110-1-1005 and 1110-2-1003. Prior to commencing Work, Contractor shall provide name and credentials of professional land surveyor (PLS) who will oversee surveys. Use of a PLS who is certified as an American Congress on Surveying and Mapping (ACSM) Hydrographer is strongly encouraged.

B. Surveying Plan: Contractor shall provide description of methods and equipment to be applied for required surveys as well as quality control and quality assurance (QA/QC) procedures to be applied. No other equipment shall be used for surveying without prior notification to
Engineer. Refer to Paragraph 3.08.B for additional QA/QC requirements for multi-beam surveys.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

3.01 GENERAL

Contractor shall provide Initial, Interim, and Final surveys for measurement and acceptance of Work items. Plots showing lines and grades, and quantity computations, shall accompany all payment requisitions. Refer to Table 1 for a general summary of the required surveys.

3.02 SURVEY PLOTS

A. All construction surveys submitted to Engineer shall be in the form of plan-view and cross-section plots and digital data. All surveys shall be referenced to the project datums shown on the Drawings. Plots shall be transmitted digitally in PDF and AutoCAD format. All plots shall legibly and clearly display the following information:

1. Project and Owner names
2. Professional Land Surveyor’s seal, signature, and business affiliation (required on pdf transmittals)
3. Date(s) surveys were performed
4. Location and description of survey control
5. Vertical and horizontal datums
6. Sheet name and number
7. Name of Contractor
8. Drawing scale(s)
9. Submittal title (e.g., “Berm Existing Grade”)
<table>
<thead>
<tr>
<th>Survey</th>
<th>Intended Purpose</th>
<th>Submittal(s) Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dikes at Upland Placement Areas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>To establish baseline conditions at perimeter and interior dikes where dike improvements are required.</td>
<td>Prior to dike improvements (as applicable) and discharge of dredged material.</td>
</tr>
<tr>
<td>Interim</td>
<td>Interim surveys shall be performed to document conformance of completed portions of work for monthly progress payments.</td>
<td>With pay requests.</td>
</tr>
<tr>
<td>Final</td>
<td>To document completed condition of dike improvements and establish final pay volumes.</td>
<td>Upon completion of dike improvements, prior to discharge of dredged material.</td>
</tr>
<tr>
<td><strong>Shoreline Protection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>To verify existing conditions and for review by Engineer in assessing need for any adjustments to specified templates and/or work limits prior to start of shoreline protection construction.</td>
<td>Prior to commencement of shoreline protection construction.</td>
</tr>
<tr>
<td>Interim</td>
<td>Interim surveys shall be performed to document conformance of completed portions of work for monthly progress payments.</td>
<td>With pay requests.</td>
</tr>
<tr>
<td>Final</td>
<td>Final survey shall be performed to document final lines and grades of any portions of shoreline protection not previously accepted through Interim Surveys.</td>
<td>After completion of shoreline protection (req’d prior to final payment).</td>
</tr>
</tbody>
</table>

B. Survey plots shall include the following:

1. Plan sheets clearly documenting locations, limits, and dimensions of completed Work (as applicable) and locations where cross sections were taken.

2. Cross-section sheets providing an overlay of sequential survey transects (as applicable) along with specified templates. A legend shall be provided indicating the date and survey type (e.g., Initial, Interim, Final, etc.) for each transect shown.

3. Cross-sectional areas for each section calculated by comparing the Initial/Interim/Final, as applicable surveys.

C. Digital Data: In addition to plots in pdf format, all survey submittals shall include digital data on labeled CD or DVD. Digital data shall include the following:

1. A submittal log documenting surveys submitted to date with descriptors for survey dates and locations.

2. AutoCAD files in ".dwg format"
3. 3D ASCII “XYZ” files

4. PDF files with signed Registered PLS seal

3.03 SURVEY TRANSECTS

A. **General:** The survey transects specified herein apply to all surveys of dikes and shoreline protection at upland placement areas, performed by Contractor for acceptance and/or submittal with monthly pay requests. Survey shots along each transect shall be taken at all significant grade breaks and at a maximum horizontal spacing of 20 ft.

B. **Placement Areas:** Where dike improvements are specified on the Drawings, survey transects shall consist of cross-sections of the dikes at 100 ft intervals extending 50 ft (min) beyond the proposed inner and outer toe.

C. **Shoreline Protection:** Where shoreline protection is specified on the Drawings, survey transects shall consist of cross-sections of the shoreline protection at 100 ft intervals extending 50 ft (min) beyond the outer toe of the shoreline protection, and 50 ft (min) beyond the inner toe of the dike. For sections of shoreline protection not adjacent to a dike, the cross-sections shall extend 50 ft (min) beyond the limits of the shoreline protection.

3.04 PLACEMENT AREA SURVEYS

A. **Initial Survey(s):** For any PAs for which dike improvements are specified on the Drawings, Contractor shall perform a topographic survey (i.e., cross-sections) along the dikes prior to construction of dike improvements.

B. **Final Survey(s):** For any PAs for which dike improvements are specified on the Drawings, Contractor shall perform a topographic survey (i.e., cross-sections) along the dikes after construction of dike improvements and prior to commencing discharge of dredged material in PA. Monthly surveys shall be performed during dike improvements for progress payments.

3.05 SHORELINE PROTECTION SURVEYS

A. **Initial Survey:** Contractor shall perform a topographic survey (i.e., cross-sections) along the specified shoreline protection alignment prior to construction of shoreline protection.

B. **Interim Survey:** Upon completion of excavation and grading for preparation of shoreline protection subgrade, Contractor shall perform a topographic survey (i.e., cross-sections) along the specified shoreline protection alignment at the following stages:

1. Upon completion of excavation and grading for preparation of shoreline protection subgrade (prior to placement of any fill).
2. Upon completion of excavation and grading for preparation of shoreline protection subgrade (after placement of fill).
3. After placement of bedding stone.
4. After placement of armor stone (prior to backfilling).

C. **Final Survey:** Contractor shall perform a topographic survey (i.e., cross-sections) along the completed shoreline protection.

1. After final backfilling and grading.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. SCOPE:

1. Work under this section includes, but is not limited to, pre-construction condition and topographic surveys, post construction condition and topographic surveys and monitoring of construction-related vibration producing activities completed for this project. Vibration monitoring shall be conducted before, during and after any anticipated vibration producing activities such as, but not limited to:

   a. Demolition
   b. Site preparation and excavation activities
   c. Pile installation
   d. Operation of construction equipment, construction traffic and other activities related to new construction or rehabilitation work for the duration of the activity, and until sufficient information has been collected to prove that project-induced ground-borne vibration levels do not approach or exceed a threshold for annoyance, and cosmetic or structural damage to structures in the study area.

   The Contractor shall provide, install, calibrate, operate, process and report results from the necessary equipment to monitor potential vibrations caused by their construction operations or as directed by the Engineer.

2. Existing structures/features within a pre-determined area of influence which may be susceptible to vibration effects include but are not limited to:

   a. The Fire Boat Dock
   b. Above and below-ground utilities
   c. Historical structures and other hard structures
   d. Construction of new maintenance facility is in master Plan

   The Contractor shall prepare a well-planned and executed, thorough construction vibration management plan. The construction vibration management plan should include at a minimum:
• The qualifications of the staff preparing and executing the plan;
• Identifying reasonable and appropriate vibration impact thresholds for human and building response to vibration;
• Review of geotechnical and other information to assess subsurface conditions and the general propagation characteristics of soils and subsurface conditions in the project area;
• Identifying equipment and activities with potential to cause or contribute to ground-borne vibration levels of concern;
• A determination of the potential area of effect (AOE) through execution of an appropriate screening process;
• An inventory and ranking of buildings and land uses within that AOE based on potential sensitivity to construction-induced ground-borne vibration;
• Windshield survey and site visits to enhance the inventory and ranking;
• A process for contacting stakeholders to discuss potential concerns;
• A determination of where pre- and post-construction site inspections should occur (for photo and video inspections and potential installation of crack gauges and/or vibration monitoring equipment);
• The types of monitoring equipment, feedback systems, and reporting requirements that are appropriate, and;
• Where reasonable and appropriate, for controlled surveys of the target structures that are tied to survey monuments, and a right-of-entry process for obtaining access to private properties for the purposes of managing construction vibration.

B. REQUIRED SERVICE PROVIDERS AND THEIR ROLES

1. Seismologist, or Other Qualified Vibration Specialist

The seismologist or other approved qualified vibration specialist prepares the construction vibration management plan, collects and analyzes data during the pre-construction stage of the project. In conjunction with the Owner and Contractor the seismologist uses that information to:
• Develop the monitoring plans for the existing structures/features
• Evaluate expected levels of construction-related vibrations on the existing structures
• Assess means and methods for reducing potential vibrations of the existing structures.

The data collected shall include baseline ground motions caused by non-construction related vibration sources near the structures identified in the construction vibration management plan.

The seismologist or other approved qualified vibration specialist shall supervise and confirm the monitoring and recording of vibration by the vibration monitoring contractor, and shall also be required to recommend values for maximum peak
particle velocities (PPV) thresholds and geographic limits of zones of influence for the existing structures/features that are identified in the monitoring plan.

The seismologist or other approved qualified vibration specialist shall prepare and submit a final report to the Owner at the completion of construction which clearly documents all pertinent activities and data associated with the activities.

2. Vibration Monitoring Contractor

The vibration monitoring contractor installs monitoring equipment, routinely observes vibrations during construction, keeps records of the activities that create the vibrations, and will regularly update or inform the seismologist or other approved qualified vibration specialist and Contractor of his findings. The constant monitoring should allow pertinent information to be provided to the Contractor so as to limit deleterious construction related vibrations of the structures.

3. Specialty Engineer

The Specialty Engineer performs conditions assessments of the existing structures prior to the Contractor’s mobilization and documents any existing damage to the structures identified in the monitoring plan. The Specialty Engineer shall prepare and submit a report to the Owner of the findings prior to start of construction.

During construction operations, the seismologist or other approved qualified vibration specialist may require the Specialty Engineer to check specific structures identified in the monitoring plan for deformations, cracks and/or settlement in real time based on information provided by the vibration monitoring contractor.

The Specialty Engineer also performs post-condition assessments of the structures identified in the monitoring plan at the completion of all construction-related activities to document any changes to the conditions of the structures.

4. Land Surveyor

The land surveyor establishes the existing topographic, layout, and as-built surveys of existing buildings or site features shown on the monitoring plan prior to the beginning of any construction-related activities. The land surveyor also conducts a final survey at the end of the construction project to document changes to vertical and horizontal locations of these buildings and other features that may be the result of the vibration-related work.

1.2 QUALITY ASSURANCE

A. SUB-CONTRACTOR QUALIFICATIONS:

The Contractor employs qualified service providers to avoid and mitigate the deleterious effects of the contractor’s activities. The minimum qualifications of each, standing on their own merit, shall include a minimum of three projects within the last
five years providing the required services outlined in Section 1.1.B and as generally described below.

1. The Contractor shall employ the services of a qualified seismologist or other approved qualified vibration specialist with verifiable previous experience of a minimum of three projects within the last five years in the installation and use of vibration monitoring equipment, planning, supervising or performing the required vibration-monitoring operations and interpretation & reporting of vibration data.

2. The Contractor shall employ the services of a qualified vibration monitoring firm or individual with verifiable previous experience of a minimum of three projects within the last five years in performing the required vibration-monitoring field operations during construction.

3. The Contractor shall employ the services of a Specialty Engineer who shall be a Registered Professional Civil or Structural Engineer and is a qualified inspector with the competence to observe and inspect materials, installation, and erection of components and connections that require special expertise to ensure compliance with approved construction documents and referenced standards. The Specialty Engineer shall have verifiable previous experience of a minimum of three similar projects (with respect to complexity, project value and construction methodology) within the last five years.

4. The Contractor shall employ the services of a Registered Professional Land Surveyor with verifiable previous experience of a minimum of three projects within the last five years in performing land surveying.

1.3 SUBMITTALS

A. PRE-CONSTRUCTION:

The Contractor shall submit the following:

1. A construction vibration management plan that includes:
2. Qualifications of the seismologist or other approved qualified vibration specialist
3. Qualifications of the vibration-monitoring Contractor
4. Qualifications of the Specialty Engineer
5. Qualifications of the land surveyor
6. A general notice prepared by the seismologist or other approved qualified vibration specialist for at least one (1) public pre-construction consultation with property owners and occupants within the zone of influence advising of the possibility of construction vibrations.
7. A pre-construction report that shall include the following:
   a. Results of the pre-construction condition survey including all records, reports, video, photographs, and recommendations for maximum peak particle velocity (PPV) threshold limits and warning limits in any of the three mutually perpendicular components of particle velocity for all structures/features
surveyed that might be affected by construction-induced vibrations. A threshold limit should be recommended for each structure/feature in the zone of influence. The construction vibration management plan should address human response to vibration and building response to vibration.

b. A vibration-monitoring plan prepared by the seismologist or other qualified vibration specialist which includes, the locations and types of the seismic monitoring sensors and equipment, feedback triggers, and reporting requirements.

c. Pre-construction topographical survey of all structures within the specified zone of influence and along the project limits, as determined by the seismologist or other qualified vibration specialist.

8. The Contractor shall identify and submit for review by the Owner mitigation measures to reduce the effects of construction related vibrations within the zone of influence. The Contractor shall submit for review by the Owner a remedial action plan for the structures/features that are likely to be so affected.

B. DURING CONSTRUCTION:

The Contractor shall submit the following:

1. PPV measurement data of the monitoring activities to the Owner or the Engineer in responsible charge at the end of each work day when vibration inducing activities are conducted.
2. A report summarizing when construction vibration monitoring notifications were sent to site and project managers.
3. Changes in the physical features of the structures that are identified in the monitoring plan throughout the entire project duration and as determined by the seismologist or other qualified vibration specialist.
4. Monthly photographic updates during the entire project duration.
5. A monthly report that documents any deviations from the construction vibration monitoring plan, and explains the reasons for the deviations, and consequences & outcomes of those deviations.

C. POST-CONSTRUCTION:

The Contractor shall submit a vibration monitoring final report that shall include the following:

1. All vibration monitoring data associated with the specific construction activities that were observed in the field, including the warning notification text messages sent by the monitoring systems.
2. Results of the post-construction condition surveys including all records, reports, video, and photographs for items that may have been affected by construction-induced vibrations and narratives on comparative pre-construction condition survey information.
3. Post-construction survey data of critical physical features of all structures potentially impacted by the construction and that were recommended by the seismologist, and written statements of how this data compare to the pre-construction survey data.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

A. PRE-CONSTRUCTION REQUIREMENTS:

1. The contractor shall prepare and submit a construction vibration management plan, prepared by a qualified engineering, acoustical, or related consultant with demonstrated experience managing construction-related ground-borne vibration.

2. The seismologist or other qualified vibration specialist shall determine the predicted and maximum allowable PPV threshold values for the structures/features defined in the vibration monitoring plan based on the analysis of data gathered during the pre-construction condition survey.

3. The seismologist or other qualified vibration specialist shall establish the vibration zone of influence. A vibration zone of influence is defined as the area of land within or adjacent to a construction site, including any buildings or structures, that potentially may be affected by vibrations emanating from a construction activity where the PPV at the location where measured, is equal to or greater than the limiting PPV threshold value as defined in Section 1.3 (6) of this document.

4. Pre-construction Survey
   a. The Contractor, through the seismologist or other qualified vibration specialist shall perform a documented pre-construction condition survey as part of determining vibration or settlement effects on any existing structures/features within the influence zone of the proposed construction activities.
   b. The pre-construction condition survey shall include tape-recorded observations; videotape and still photography and sketches as needed to fully describe the existing condition of each feature potentially affected by any construction induced vibrations, including the interior and exterior of any building structures. Crack gauges may be used to document existing cracks.
   c. The Contractor, through the seismologist or other qualified vibration specialist shall use site-specific information about on-site and sub-surface soils to perform a screening assessment that shall be used to determine the distances from the vibration sources to target features within the influence zones. This pre-construction condition survey shall be completed at least 30-days prior to the start of onsite activities and a pre-condition survey report shall be submitted to the OWNER within 7 days after completion.
d. The Contractor must perform pre-construction surveys of critical physical features of all structures within the specified zones of vibration influence and of any other structures that are located along the project limits at the direction of the seismologist or other approved qualified vibration specialist.

e. A report shall be prepared for each feature identified by the seismologist or other approved qualified vibration specialist. The report shall include all of the recorded observations.

5. Baseline Ground Motions (Existing, Pre-construction ground-borne vibration levels)
   a. The data that is collected shall include baseline ground motions caused by non-construction vibration sources near the structures that are shown in the construction vibration management plan.
   b. Where predicted PPVs are anticipated to exceed the determined threshold, the seismologist or other qualified vibration specialists shall establish protocols for the structures that are expected to receive project-related, construction-induced ground-borne vibration levels in excess of the thresholds shown in the construction vibration management plan.

6. Specifications for Proposed Vibration Monitoring Equipment
   a. Equipment for measuring construction-induced ground-borne vibration shall measure peak particle velocity, be tri-axial 3-channel (3 seismic channels) units capable of digitally storing collected data and sending out warning and stop work notifications via text message. Equipment shall be capable of printing ground motion time histories and summaries of peak motion intensities, frequencies and USBM R18507 PPV-frequency plots. Printed report records must also include date, time of recording, operator name, instrument number and date of last calibration. Other required system features:
      i. Instruments must have certifications of factory- or equivalent calibrations within the past 12 months.
      ii. Instruments shall have a flat frequency response between 2 and 250 Hz for particle velocity
      iii. The digitizing sampling rate for peak particle velocity measurements shall be at least 1,024 samples per second
      iv. Seismographs shall be capable of performing a calibration self-test of velocity transducers and printed event records shall indicate whether or not the sensor test was successful.
      v. Seismographs used for compliance monitoring shall be capable of recording particle velocity from 0.01 to 5.0 in/sec.
      vi. Systems shall be capable of providing printed event reports that include all peak measurements, frequencies and complete waveform plots. At a minimum, the monitors shall employ a two-tiered text messaging notification system so work can be paused or stopped before measured levels reach damage thresholds.
      vii. Seismographs shall have adequate memory to digitally record the entire duration of the construction-induced motion. The minimum event recording time shall be three seconds.
xi. All seismograph software systems shall be capable of saving back-up copies of all event files on USB flash drives or portable hard drives, and copies shall be furnished to the OWNER.

x. The Contractor shall provide the seismograph reporting software to the OWNER with the first submittal of the vibration measurement records.

B. DURING CONSTRUCTION REQUIREMENTS:

1. Vibration Monitoring:
   a. Maintaining ground vibration within the limits imposed under this contract is critical to the success of this project. To assure satisfactory results for data acquisition, the collection of these data must be conducted under the supervision of a qualified vibration specialist or seismologist.
   b. The vibration monitoring contractor and all persons performing monitoring work shall be an independent third party.
   c. Vibrations shall be monitored at appropriate locations throughout the project. Vibration measured in peak particle velocity in inches per second shall be recorded at the monitoring locations. Monitoring locations shall be determined by the seismologist or other approved qualified vibration specialist within the guidelines in (2) below and approved by the OWNER. Each monitoring location shall be a secure, marked and surveyed position and shall remain at the same position. The Contractor may elect at the Contractor's expense to provide additional instrumentation at additional monitoring locations for any purpose.
   d. Vibration monitors shall run continuously during the duration of the project's activities at the site, and readings on each seismograph shall be checked at the intervals recommended by the seismologist or other qualified vibration measurement specialist. If equipment allows, this data may be downloaded and checked remotely. See Section (2) for additional information.
   e. The Contractor shall provide and maintain temporary weather protection and remote power & communication capabilities as necessary for all measurement/monitoring facilities.

2. Vibration Control
   a. The seismologist or other approved qualified vibration specialist shall place at least two (2) seismographs at structures/features of concern (or as recommended and approved by the OWNER) to measure and record ground movements during construction. The seismologist or other approved qualified vibration specialist shall provide qualified personnel capable of setting up instruments at designated locations to accurately record data, deploy the instruments, and operate, gather, and analyze the vibration data. The seismologist or other approved qualified vibration specialist shall use the collected data to control future construction vibration so as not to exceed the limits established in these specifications. The instrumentation shall record three orthogonal components (vertical, radial and transverse) of particle velocity direction. The PPV for compliance purposes is the highest
measurement made in any of the three measured directions. The instrument records shall consist of instrument readings identified by instrument number; the location of instruments; the date, time and location of the measurements; and the peak particle velocity and dominant frequency it occurred in.

b. Construction activities shall be controlled in such a manner that the intensity of ground motion at the nearest existing structures shall be limited to a peak particle velocity as set out in Section 1.3 (6) above or in accordance with Federal, State or local codes and regulations, whichever is more stringent.

3. Immediate Threshold Adherence
a. The OWNER shall be notified immediately when the measured PPV values exceed specified warning levels. When the PPV threshold limit is exceeded one time or warning levels are exceeded more than three times at any type of structure, the Contractor shall submit a revised construction plan to the OWNER that outlines specific measures that will be applied to bring ground motion levels into compliance within specified limits. The Contractor shall submit a printed copy of the monitoring records showing PPV values. A digital copy of the monitoring event records on a CD-ROM disk shall also be submitted.

4. Reporting
a. The Contractor shall provide results of the testing to the Owner at the end of each workday when vibration inducing activities are conducted.

b. The OWNER shall be notified of any movements detected and the Contractor shall immediately take any remedial measures required to prevent damage to the existing structures.

5. Damages:
   a. The Contractor shall make every effort to avoid damage to the existing utilities, appurtenances, structures or features within the zone of influence of any construction-induced vibrations including the use of site access routes.

   b. The Contractor is responsible for all construction related damages caused by, but not limited to, vibration or soil settlement from Project construction operations, cosmetic, or structural damage to buildings. Any damage caused by the Contractor's operations shall be repaired by the Contractor, to the satisfaction of the OWNER, at no additional cost to the Owner.

c. Upon the discovery of any damage, construction operations shall cease until the Contractor has the damage repaired to the satisfaction of the OWNER or has agreed with the OWNER on an acceptable timeline by which the damage shall be satisfactorily repaired, and provides suitable measures to control future disturbance.

C. POST-CONSTRUCTION REQUIREMENTS:
1. Post-Construction Survey
   a. Following the completion of the vibration producing activities, a post-construction condition survey shall be performed for each feature that received a pre-construction condition survey. The pre-construction survey, photographs, video, descriptions and sketches shall be compared to the post-construction condition as described in the post-construction survey to determine if any changes occurred during the construction activities. The same individual or firm that performed the pre-construction survey shall perform the post-construction survey.

2. Vibration Monitoring Report
   a. A report will be prepared for each feature previously identified with a summary that documents any changes from the pre-condition survey and whether any of the changes noted were a direct result of the construction activities. The qualified seismologist or other approved qualified vibration specialist shall attend the post-construction survey to provide input. Changes in the condition of any feature affected by project-related construction-induced ground-borne vibration shall be documented with video, still photographs, and sketches and a detailed narration.

3. Site Restoration
   a. Any areas or items determined to be adversely affected by project-related construction-induced ground-borne vibration by the Contractor’s operations shall be restored to pre-construction conditions or replaced by the Contractor at no additional cost to the OWNER. The costs for any site restoration or replacement of items damaged as a result of the Contractor's work shall be paid for by the contractor.

3.2 PROTECTION OF SITE

A. EXISTING STRUCTURES:

1. When the Plans require excavation, piling or other foundation construction operations in proximity to existing structures, the Contractor shall take precautions to prevent damage to such structures. The requirements described herein apply to all types of structures (within or outside of project limits) that may be adversely affected by construction operations (including phased construction) due to vibrations. The Contractor shall protect utilities as required.

2. When pile driving or excavating for construction, the Contractor is responsible for evaluating the need for, design of, and providing any necessary precautionary materials, items, or activities to protect adjacent structures/features from damage, including, but not limited to, selecting construction methods and procedures that
will prevent damaging caving of the excavation, and monitoring and controlling the vibrations from construction activities, including driving of piles, casings, and sheeting.

3. The Contractor shall survey and monitor structures for settlement in a manner approved by the Owner, recording elevations to 0.001 foot. The Contractor shall employ a qualified Specialty Engineer to inspect and document the condition of structures prior to and after completion of all pile installations, excavations and other related foundation construction activities, and to inspect and monitor the structures within the following influence zones as a minimum:
   a. As shown on the monitoring plans
   b. As determined in Section 3.1- 4(c) above.

4. The Contractor shall obtain the OWNER’S approval of the number and location of monitoring points and shall record survey elevations:
   a. Before beginning construction
   b. Daily during the driving of any casings, piling, or sheeting
   c. Weekly for two weeks after stopping pile driving
   d. During excavation
   e. Or as directed by the Engineer
5. The contractor shall notify the OWNER of any movements detected and immediately take any remedial measures required to prevent damage to the existing structures.

6. The OWNER will make the necessary arrangements to provide right of way entry to the existing structures.

B. CONCRETE:

1. The seismologist or other approved qualified vibration specialist shall provide vibration limits to ensure that concrete whose age is less than 7 days is not subjected to vibrations from pile driving and/or installation sources located within 100 feet from the nearest outside edge of said concrete to the vibration source.

C. MISCELLANEOUS:

1. Upon detecting settlement or heave or vibration levels near threshold values, or damage to the structure, immediately stop the source of vibrations or disturbance, backfill any open excavations, and contact the OWNER for instructions.
2. When shown in the Contract Documents or when authorized by the Engineer, the Contractor shall install the piling to the depth required to minimize the effects of vibrations or ground heave on adjacent structures by approved methods other than driving (preformed holes, predrilling, jetting, etc.).
3. When shown on the Plans or as directed by the Engineer, the Contractor shall install a piezometer near the property line and near any structure that may be affected by lowering of the ground water when dewatering is required. The Contractor shall monitor the piezometer and record the ground water elevation
level daily, and notify the Engineer of any ground water lowering near the structure of 12 inches or more.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; the furnishing and placing of reinforcing steel of the type, size, and quality designated for use in structures, pavements and appurtenances thereof, as described and specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities
SECTION 03 31 00.00 Add – Structural Concrete

1.3 REFERENCES

A. ASTM International Publications, latest editions:

ASTM A-82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A-185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A-496 Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A-497 Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A-615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A-706 Standard Specification for Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A-775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A-884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A-934 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM D-3963 Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars
B. American Concrete Institute (ACI) Publications, latest editions:
   ACI-315 Details and Detailing of Concrete Reinforcement
   ACI-318 Building Code Requirements for Structural Concrete
C. American Welding Society (AWS), latest editions:
   AWS D1.4 Recommended Practices for Welding Reinforcing Steel
D. Concrete Reinforcing Steel Institute (CRSI), latest editions: Manual of Standard Practice
   Placing Reinforcing Bars

1.4 SUBMITTALS
A. Shop Drawings: Submit shop drawings for all reinforcing steel and related accessories. Shop drawings shall show layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars, mechanical connections, proposed welding locations and details, and shall be prepared in accordance with ACI 315.
B. Product Data: Submit product data sheets for dowels, dowel baskets, sleeves, supports, spacers, mechanical couplers, tapered thread dowels and inserts, dowel bar substitution or rebar splice systems, and any other reinforcement hardware or accessories to be incorporated into the work. Submit epoxy coating product data and repair procedures.
C. Mill Certificates: Submit authentic, legible mill certificates for all reinforcement bars, signed by producer.
D. Samples: Provide samples of reinforcement bars in the quantity and length requested by Construction Manager.
E. Welding: Prior to welding any reinforcing steel, the Contractor shall submit for approval, the specification and chemical composition of the reinforcements to be welded, the filler metal to be used, proposed preheating and cooling procedures, and welder qualifications.

1.5 HANDLING AND STORAGE
A. Store steel reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure that reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Wire-brush excessive rust and mill scale prior to placement. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.
B. Reinforcing steel delivered to the job site shall be tagged so as to identify the heat from which the bars were rolled. Material not so identified may be rejected.

PART 2 PRODUCTS
2.1 MATERIALS
A. Reinforcement:
   1. Reinforcing Steel: Unless otherwise specified in this Section or on the Drawings, all bar reinforcement shall be manufactured from billet steel bars conforming to the requirements of Standard Specification for Deformed Billet-Steel Bars for Concrete Reinforcement (ASTM A-615), Grade 60. Plain bars and dowels shall conform to ASTM A-675, Grade 60. Carbon content shall be limited to 0.60 percent maximum.
Reinforcing steel to be welded shall conform to ASTM A-706.

Spiral reinforcement for columns shall be plain cold-drawn wire conforming to ASTM A-82.

Welded wire fabric reinforcing shall conform to ASTM A-185 for plain wire and ASTM A-497 for deformed wire. Where not shown otherwise, fabric reinforcement shall be 6 x 6 - W 1.4 x W 1.4.

Reinforcing steel delivered to the job site shall be tagged so as to identify the heat from which the bars were rolled. Material not so identified may be rejected.

2. Deformed Bar Anchors: Deformed Bar Anchors shall conform to ASTM A-496 with minimum yield strength of 75,000 psi. Standard ASTM A-615 Grade 60 or Grade 60 reinforcing bars may not be substituted for deformed bar anchors.

3. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge. Provide only plastic coated or stainless steel tie wire in exposed concrete structures and all architectural concrete.

B. Mechanical Couplers: Mechanical couplers may be sleeve-filler, sleeve-threaded, sleeve-swaged, or sleeve-wedged. Sleeve-wedge type couplers will not be permitted on coated reinforcing.

C. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations.

1. Slabs-on-Grade: Use supports with sand plates.

2. Exposed to View Concrete: Provide supports with legs, which are plastic protected (CRSI Class 1) or stainless steel protected (CRSI Class 2).

PART 3 EXECUTION

3.1 SPLICES

A. Bars shall not be spliced at points of maximum stress, i.e., bottom bars at mid-span or top bars over supports. Splices shall be permitted only at the locations shown on the plan drawings or approved shop drawings, or as permitted by the Construction Manager.

B. Lap splices shall conform to ACI 318 and the drawings. Tension splices not at points of maximum stress shall be Class B.

C. Where welding of reinforcing steel is required this work shall be performed by experienced, certified welders in accordance with Recommended Practices for Welding Reinforcing Steel, AWS Designation D1.4. Do not weld reinforcing without prior written approval from the Chief Construction Manager.

D. Splices in slabs shall be well distributed. Bars shall be rigidly clamped or wired together at all splices.

E. Unless otherwise shown on the Drawings, all the reinforcement in outer face of all corners of grade beams and spandrels shall be returned around corners or shall be provided with at least one No. 5 bent splice bar top and bottom. At ends of beams where they intersect cross beams or walls, at least No. 5 horizontal dowels shall be provided in the top and in the bottom. At corners of walls, all horizontal bars in the outer face shall be returned at corners, or bent dowels
of equal size shall be provided. At the end of a wall where it intersects a cross wall, all horizontal bars shall be bent to lap with steel in the cross wall. Splices of such dowels or of bars bent around corners shall be Class B.

F. Unless otherwise shown on the drawings, lap welded wire fabric a minimum of two cross wires plus two inches.

3.2 FABRICATION

All details of fabrication not otherwise specified or shown on the Drawings shall be in accordance with latest edition of "Manual of Standard Practice for Detailing Reinforced Concrete Structures: of the American Concrete Institute (ACI 315).

Do not heat reinforcement for bending. Do not flame-cut reinforcement.

3.3 PLACING

A. Metal reinforcement at the time concrete is placed shall be free from all loose rust and scale, and oil or grease, dirt, concrete, or any other coating that will impair bond.

B. Metal reinforcement shall be placed accurately and adequately secured in position in the forms by metal chairs or spacers. The clear distance between bars, except in columns, shall be the greatest of (a) the nominal diameter of the larger of two adjacent bars, (b) 1-1/3 times the maximum size of coarse aggregate in the concrete, or (c) one inch. Where reinforcement in beams is placed in two layers, the clear distance between layers shall be one inch, and the bars in the upper layers shall be directly above those in the bottom layer. The clear distance between bars shall apply to the clear distance between contact splices or bars.

C. Reinforcing steel in concrete columns and walls shall be held at the required distance from face of forms by approved spacers.

D. All reinforcing bars shall be tied together in the form. Two-way mats of steel shall be tied at alternate intersections both ways, except that in floor and pavement slabs that bear on ground or on flexible base, all bars shall be wired at every intersection.

E. In the plane of the steel parallel to the nearest surface of concrete, bars must not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars must not vary from plan placement by more than ¼ inch.

F. Scheduled reinforcing steel shall not be tack welded for any reason.

G. Reinforcement must be approved by the Construction Manager prior to concrete placement. Placement of concrete without prior approval of reinforcement by the Construction Manager may be rejected.

3.4 BAR SUPPORTS

A. Reinforcement in bottom of structural slabs and beams shall be supported on approved plastic, galvanized, or plastic tipped metal chairs. Plastic or plastic tipped chairs shall be used for soffits exposed to view. Use high chairs and bar raisers to support top bars of slabs and beams. All raisers in each line shall be continuous from side to side of the slab and shall be securely tied, with splices lapped 6 inches. Tie raiser bars to high chairs and tie top of each reinforcing bar to each raiser bar that it crosses.
B. Reinforcement in columns and walls that are formed shall be spaced at the correct distance from face of walls by approved plastic or galvanized metal spacers of approved design.

C. Galvanized wire for spacers and chairs shall not be smaller than No. 6 gage. Lines of low chairs shall be spaced at four-foot centers maximum and each bottom bar shall be tied to each row of chairs that it crosses.

D. Reinforcement in drilled shafts, pipe piles, spread footings, floor and pavement slabs poured on ground, and on surfaces of walls and beams poured against earth, may be supported and spaced from sides either by plastic or galvanized metal supports and spacers of approved design or by concrete blocks. Blocks for supporting horizontal steel shall be 3" wide by 6" long and of such thickness as to support bars at the required elevation above bottom and below top of concrete. Blocks for spacing vertical steel from sides of columns and walls shall be 3" x 3" and of such thickness as will result in the cover of concrete over reinforcing steel shown on the Plans. Blocks shall have No. 16 gage wire ties embedded in the face. Concrete roller spacers may be used in drilled shafts.

E. Space blocks 3 feet on centers each way and tie each block to principal reinforcement.

F. Contractor shall provide spacers between layers of bars in beams, and, where continuous top steel in beams is not required by the Drawings, shall provide ties of sufficient size to hold vertical stirrups in position. The Contractor shall provide any other accessories or tie bars necessary to hold the reinforcement rigidly in correct position during placement.

3.5 DOWEL BARS

Furnish and place dowel bars at all floor slab and pavement—expansion, contraction, and construction joints, for roadway curbs, and at other locations, as detailed and specified on the Drawings or as prescribed elsewhere in the specifications.
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

SECTION 03 31 00.00 Add - STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; the furnishing of all labor, material, tools, equipment, and the performance of all operations required to complete all normal weight structural concrete work for wharves, beams, columns, structural slabs, drilled shafts, foundations and other structures as described and specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std - Measurement of Quantities
SECTION 03 21 00.00 Std - Reinforcing Steel

1.3 REFERENCES

A. ASTM International Publications, latest editions:

ASTM C-31  Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C-33  Standard Specification for Concrete Aggregates
ASTM C-42  Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C-39  Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C-143  Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C-172  Standard Practice for Sampling Freshly Mixed Concrete
ASTM C-150  Standard Specification for Portland Cement
ASTM C-138  Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C-94  Standard Specification for Ready-Mixed Concrete
ASTM C-231  Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C-260  Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C-295 Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C-618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C-1077 Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C-1152 Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete
ASTM C-1218 Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C-1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C-309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D-1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM C-171 Standard Specification for Sheet Materials for Curing Concrete
ASTM C-567 Determining Density of Structural Lightweight Concrete
ASTM D-1752 Standard Specification for preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D-6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

B. American Concrete Institute (ACI) Publications, latest editions:
   ACI 301 Specifications for Structural Concrete
   ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
   ACI 305R Hot Weather Concreting
   ACI 318 Building Code Requirements for Structural Concrete Commentary
   ACI 347 Guide to Formwork for Concrete

C. Texas Department of Transportation (TXDOT) Publications, latest Editions:
   TXDOT 420 Concrete Structures
   TXDOT 421 Hydraulic Cement Concrete

D. Encyclopedia of Industrial Chemical Analysis – Volume 15

E. U.S. Army Corps of Engineers (COE) Standards and Specifications:
   CRD-C 61 Test Method for Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water

1.4 SUBMITTALS
A. Laboratory Test Reports: submit laboratory test reports for concrete materials and mix design test in accordance with ASTM C 33, ASTM C 157, ASTM C 1152, ASTM C1218, ASTM C 1260, and ASTM C 295.

TECHNICAL SPECIFICATION
Date: August 2020
Page 2

STRUCTURAL CONCRETE
B. Material Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by the submittal reviewer. Materials certificates shall be signed by the manufacturer and CONTRACTOR, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

C. Test Data submitted for review shall be current to within one (1) years of submission unless otherwise reviewed and accepted by the submittal reviewer.

D. Contractor shall submit Mill Certificates for bulk cement.

E. Design Mixes:
   1. At least 60 days prior to concrete placement, submit test data on proposed design mixes for each type of concrete in the Work, including each class, and variations in type, source or quantity of material. Include type, brand and amount of cementitious materials; type, brand and amount of each admixture; slump; air content; aggregate sources, gradations, specific gravity and absorption; total water (including moisture in aggregate); water/cement ratio; compressive strength test results for 7 and 28 days; and results of tests in accordance with ASTM C 33, ASTM C 157, ASTM C 1152, ASTM C1218, ASTM C 1260, and ASTM C 295.
   2. Testing of aggregates, including sieve analysis, shall be performed by a certified independent testing laboratory. Tests shall have been performed no earlier than 3 months before Notice to Proceed.
   3. Provide standard deviation data for plant producing concrete. Data shall include copies of laboratory test results and standard deviation calculated in accordance with ACI 301-16, Item 4.2.3. Laboratory tests shall have been performed within past 12 months. When standard deviation data is not available, comply with ACI 301, Table 4.2.3.1.
   4. Review and acceptance of mix design does not relieve Contractor of responsibility to provide concrete of quality and strength required by this Section.

F. Admixtures: Submit manufacturer's technical information, including following:
   1. Air-Entraining Admixture: Give requirements to control air content under all conditions, including temperature variations and presence of other admixtures.
   2. Chemical Admixtures: Give requirements for quantities and types to be used under various temperatures and job conditions to produce uniform, workable concrete mix. Submit evidence of compatibility with other admixtures and cementitious materials proposed for use in design mix.

G. High-range Water Reducer (Superplasticizer): When proposed for use, submit manufacturer's technical information and instructions for use of superplasticizer. When superplasticizer is to be added at ready-mix plant, submit contingency plans for adding additional superplasticizer at job site when required due to delay in placing concrete. Identify portions of Work on which superplasticizer is proposed for use.

H. Hot and Cold Weather Concreting: Submit, when applicable, proposed plans for hot and cold weather concreting. Review and acceptance of proposed procedure will not relieve Contractor of responsibility for quality of finished product.

I. Project Record Drawings: Accurately record actual locations of embedded utilities and components which are concealed from view.

J. Shop Drawings include pour schedule, pour sequence and construction joints.

K. MSDS for products

L. Quality Control Plan: The Contractor shall develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan shall include standard forms and checklists to be completed by Contractor's QC Manager
for the concrete supplier, the reinforcing steel supplier, and installer and shall address aspects of the mix design, materials, and workmanship that may affect the ultimate performance of the structure. The Contractor shall provide direct oversight for the concrete qualification program. The QC plan shall include, as a minimum, developing, submitting for review by Port Authority, and use of standard forms to:

1. Record and check off the pre-placement preparatory work.

2. Form to be completed by Contractor's QC Manager prior to notification of the Port Authority for inspection.

3. Record items that include the concrete batch tickets and a brief description of work (times, dates, equipment used, crews on site, batch, quantities, etc.) performed during the placement. These forms shall be submitted every month during the course of concrete work.

4. Record shop drawing review.

M. Quality Control Personnel: The contractor shall submit for approval an organizational chart defining the quality control hierarchy, the responsibilities of the various positions, including the names and qualifications of the individuals in those positions. Submit American Concrete Institute certification for the following:

1. CQC personnel responsible for inspection of concrete operations.

2. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

3. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager Certification at the Plant Manager level.

N. Laboratory Qualification: The contractor shall submit for approval by Port Authority documentation indicating laboratory qualifications as specified herein. The laboratories performing the tests shall be accredited in accordance with ASTM C1077. The accreditation shall be current and shall include the required test methods, as specified.

1.5 HANDLING AND STORAGE

A. Cement shall be stored in weather-tight buildings, bins, or silos which will exclude moisture and contaminants.

B. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates. To ensure that this condition is met, any test for determining conformance to requirements for cleanliness and grading shall be performed on samples secured from the aggregates at the point of batching. Frozen or partially frozen aggregates shall not be used.

C. Natural or manufactured sand shall be allowed to drain until it has reached a relatively uniform moisture content before it is used.

D. Admixtures shall be stored in such a manner as to avoid contamination, evaporation, or damage. For those used in the form of suspensions or non-stable solutions, agitating equipment shall be provided to assure thorough distribution of the ingredients. Liquid admixtures shall be protected from freezing and from temperature changes which would adversely affect their characteristics.
PART 2  PRODUCTS

2.1  MATERIALS

A. Portland Cement: Portland cement shall conform to the requirements of ASTM C 150, for Type II cement.

B. Fly Ash for Reactive Aggregates: ASTM C 618, Type F only (8 percent maximum CaO), have maximum of 1.5 percent available alkali, and 3 percent loss on ignition.

C. Fly Ash for Non-Reactive Aggregates: ASTM C 618 Type F only, have maximum of 1.5 percent available alkali, a 3 percent loss on ignition, and Calcium Oxide (CaO) variation in percentage points from the average of the last 10 samples (or less provided 10 have not been tested) shall not exceed plus or minus 4.0 percent.

D. Normal Weight Aggregates: ASTM C 33, including Appendix IX, and as herein specified. Only materials free from chlorides and other deleterious coatings or substances shall be used. Aggregate shall be considered non-reactive if both of the following conditions are met:

   1. The quantities to be retained on each sieve may be adjusted only where available aggregates are elongated or slivered and cause interference with mix mobility, or available aggregate gradations do not comply with the 18-8 requirement explained below. The combined aggregates in the mixture (coarse, intermediate, and fine) shall be well graded with no more than 18 percent nor less than 8 percent of the combined aggregate retained on any individual sieve. The No. 50 sieve may have less than 8 percent retained; sieves finer than No. 50 shall have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained. Use intermediate sizes for blending where necessary, to provide a well graded combined aggregate. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136.

   2. Expansion as measured by ASTM C 1260 is not greater than 0.08 percent at 16 days.

   3. Mineral content, as determined by ASTM C 295, is not greater than the following, based on the total aggregate sample:
      a. Optically strained, microfractured, or microcrystalline quartz, 5.0 percent.
      b. Chert or chalcedony, 3.0 percent.
      c. Tridymite or cristobalite, 1.0 percent.
      d. Opal, 0.5 percent.
      e. Natural volcanic glass, 3.0 percent.
      f. All aggregates not meeting Conditions (2) and (3) above shall be considered potentially reactive.

E. Water: Mixing water for concrete shall be fresh, clean and potable.

F. Admixtures:

   1. Air Entrainment: An approved brand of air entraining agent conforming to ASTM C 260 shall be used with all concrete. It shall be introduced in the mixture at the mixer in such quantities as to provide not more than five percent nor less than three percent entrained air as determined by tests performed in accordance with ASTM C 138. Entrained air in concrete floor slabs shall not exceed 4.5 percent.

   2. Water-Reducing, Retarding and Accelerating Admixtures:
      a. Water-reducing, retarding and accelerating admixtures shall conform to the requirements of ASTM C 494. Acceptable manufacturers are:
         i. W. R. Grace and Co.
         ii. BASF
         iii. Sika Chemical Co.
         iv. Fox Industries, Inc.
      b. Products of other manufacturers may be submitted for approval. No admixture containing calcium chloride as a functional ingredient may be used at any time.
c. The manufacturer shall submit a statement of conformance to ASTM C 494, including test results. In addition, the manufacturer shall state, in writing, the chloride content of the admixture and whether or not chloride has been added during its manufacture.

3. Provide anti-washout or viscosity modifying admixtures for underwater concrete placement. Provide certification that the admixture is compatible with the cementitious materials and other chemical admixtures in the proposed concrete mixture. The anti-washout or viscosity modifying admixture shall have a proven record of performance with a minimum of five similar projects. Test per COE CRD-C 61 to determine cumulative mass loss shall be performed once for each 350 cubic yards of underwater concrete and results submitted to Port Authority for approval prior to continued use.

4. Corrosion inhibitor shall be 30 percent water solution of calcium nitrite. Allow for the free water in the admixture within the total water in concrete mixture. Accelerating and set adjusted versions are acceptable, however, the concrete set time effects and mixture workability shall be considered.

G. CMU grout materials shall be as specified on the Drawings.

2.2 FORM MATERIALS

A. Form materials shall be of wood, metal, fiberglass, or other approved material. Wherever rubbed surfaces are indicated on the Drawings or hereinafter specified, the forms shall be lined, plywood, or approved metal forms. Forms shall conform to the following requirements:

1. Unlined Wood Forms: Lumber used in forms for exposed surfaces shall be dressed to a uniform thickness, and shall be free from loose knots, splits, or other defects. Undressed lumber may be used for unexposed surfaces. Joints in forms shall be horizontal or vertical.

2. Lined Forms: Lining material shall be moisture resistant concrete-form plywood, form grade hardboard, metal, plastic, or other approved material.

3. Universal Standard Plywood Form Panels: Panels shall be designed to produce and maintain shape, lines and dimensions of the concrete as called for on the Drawings.

4. Metal Forms: Metal forms shall be an approved type that will produce surfaces equal to those produced by specified wood forms. Headers, bridging, appurtenances, or special metal forms in accordance with requirements peculiar to the design of the forms shall be provided and installed where required.

5. Plywood Forms: Plywood shall be moisture resistant concrete-form plywood at least 9/16-inch in thickness, and not less than 5-ply.

2.3 CLASSIFICATION

A. The Drawings and/or the Technical Specifications for each item of work indicate the class of concrete to be used for each element of the work. Each class of concrete shall meet the requirements tabulated below:

<table>
<thead>
<tr>
<th>Class</th>
<th>Minimum Compressive Strength at 28 Days</th>
<th>Minimum Compressive Strength at 7 Days</th>
<th>Gradation of Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>5000</td>
<td>4000</td>
<td>1&quot; to No. 4</td>
</tr>
</tbody>
</table>

2.4 PROPORTIONING OF CONCRETE

A. The concrete shall be composed of Portland cement, coarse aggregate fly ash, fine aggregate, approved admixtures and water. Marine applications shall contain fly ash as specified below. Concrete shall meet all requirements herein for strength, cementitious material content, water-cement ratio, slump, etc. Concrete shall have adequate workability and proper consistency to
be worked readily into the forms and around reinforcement under the conditions of placement to be employed without excessive segregation or bleeding.

B. Mix Designs Containing Only Non-Reactive Aggregate: Fly ash shall be 20-30 percent of cement content by weight. Refer to paragraph 2.1 C of this section for fly ash details.

C. Mix Designs Containing Potentially Reactive Aggregate: Mix design shall contain fly ash in the range of 20-30 percent of cement content by weight. The mix design shall be considered effective to prevent deleterious alkali-silica reactivity if the expansion as measured by ASTM C 1260 is not greater than 0.08 percent at 16 days. Any mix design containing potentially reactive aggregate not meeting this requirement will be rejected. Refer to paragraph 2.1 B of this section for fly ash details.

D. Mix Designs for Marine applications shall meet the requirements listed in the table below:

<table>
<thead>
<tr>
<th>Test Requirements</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial acid-soluble chloride content in cast-in-place and precast concrete per ASTM C1152/C1152M, percent/cement</td>
<td>0.10</td>
</tr>
<tr>
<td>Initial acid-soluble chloride content in prestressed concrete determined following ASTM C1152/C1152M, percent/cement</td>
<td>0.06</td>
</tr>
<tr>
<td>Water Soluble Chloride Ion Content in cast-in-place and precast concrete per ASTM C1218/C1218M, percent/cement</td>
<td>0.08</td>
</tr>
<tr>
<td>Water Soluble Chloride Ion Content in prestressed concrete per ASTM C1218/C1218M, percent/cement</td>
<td>0.06</td>
</tr>
</tbody>
</table>

E. Underwater concrete: When the concrete is intended for placement under water using the tremie technique, the concrete shall be proportioned to be cohesive and flow with minimal segregation. Viscosity modifying admixtures are permitted for underwater concrete. Proportioning guidance in ACI 304R shall be considered. Concrete mixtures shall be qualified for tremie placement methods based on a trial placement approved by the Port Authority.

For underwater concrete, cast compressive strength trial samples by placing concrete in four 5-gallon buckets below water using similar placement as the project. Permanently mark buckets as "3 days," "7 days," "28 days," and "Extra." Include date and station. Provide specimen sets at every 50 cubic yards per structure with a minimum of one set per day of underwater concrete placement. Retrieve buckets at specified intervals and extract three cores from each bucket. Conduct compressive strength test in accordance with ASTM C42/C42M. Strength of underwater concrete shall be satisfactory if the compressive strength result from extracted cores at the age of the specified strength is greater than 0.85 f'c with no individual strength test result less than 0.75 f'c.

F. Contractor shall engage a testing laboratory acceptable to the Port of Houston Authority to perform material evaluation tests and to design concrete mixes. Mix design shall be based on the procedures of ACI 318. Proportions may be established on the basis of field experience with the materials to be employed or on the basis of laboratory trial batches. All Laboratory testing except for concrete mix design, welder certification, and timber inspection will be paid for by the Port Authority by a lab selected by the Port Authority. Re-testing due to Contractors failures will be done at the Contractors expense.
G. Where mix design is based on trial batches, the Contractor, at least sixty days prior to placing concrete, shall submit a mix design and samples of all concrete materials. The laboratory will make up at least two batches of each class of concrete using the proportions of materials as submitted. A minimum of four standard size cylinders from each batch shall be molded, properly cured, and tested for seven-day compressive strengths as outlined in the latest ASTM test standards. If these cylinders fail to meet the required breaking strength, the mix shall be redesigned, and more batches and specimens made and tested as above. This procedure shall be repeated until a satisfactory batch design has been determined. After the mix proportions and water-cement ratio required to produce

H. Where mix design is based on prior performance record, the laboratory will verify the experience required by ACI 318 and that those materials and proportions to be furnished are the same as those on which experience records are based. Submit a copy of the prior approvals indicating the project name, project number, and project location. Include ingredient material test data conducted within 12 months of submittal date, copies of previously approved trial batch test data. If the Contractor changes material type, class, sources, or suppliers; chemical composition; and/or mix proportions, the Contractor shall provide a written opinion of the significance of the change(s). The change(s) may require additional testing at the discretion of the Port Authority in consultation with the agency's Subject Matter Expert in Concrete Materials.

I. Cement content shall be based on the following water cement ratios, except that minimum cementitious material content shall be 470 pounds per cubic yard:

<table>
<thead>
<tr>
<th>Type of Structure</th>
<th>Max. Water-Cement Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures constructed in, above or immediately adjacent to the water; other structures exposed to the action of water</td>
<td>0.40</td>
</tr>
<tr>
<td>Moderate sections, such as retaining walls, abutments, piers, girders and beams; concrete protected from weather or below ground</td>
<td>Determined by strength requirements</td>
</tr>
</tbody>
</table>

J. Unless indicated otherwise on the Drawings, Technical Specifications or other Specifications, the maximum slump shall be four inches (4") for structural concrete without high range water reducers. A maximum slump of 8" for concrete mixes with high range water reducers may be approved if achieved without detrimental effects to the concrete.

K. Maximum Size of Coarse Aggregate: The nominal maximum size of the aggregate shall not be more than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between reinforcing bars. These limitations may be waived if workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids.

L. Use of Admixtures:
   1. Water-reducing admixtures may be added to improve workability or reduce the amount of water required for hydration.
   2. All concrete placed in slabs when the ambient temperature is 85 degrees F., or higher, shall contain a set-retarding admixture.
   3. Amounts of admixtures to be added to the mix shall be in accordance with the manufacturer's instructions to achieve the desired results.
   4. All concrete shall contain Calcium Nitrite corrosion inhibitor at a rate of 4.0 gallons per cubic yard of concrete.
PART 3 EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS
Contractor shall comply with standards for air quality or air emissions associated with concrete production during construction.

3.2 FORMS
A. General:
   1. Forms shall conform to the shape, lines and dimensions of the concrete as called for on the Drawings and shall be sufficiently tight to prevent leakage of mortar. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances. Forms placed on successive units for continuous surfaces shall be fitted to accurate alignment to assure a smooth completed surface area free from irregularities.
   2. Earth cuts shall not be used to form vertical surfaces unless so indicated on the Drawings or in the Technical Specifications.
   3. Drawings of complex or prefabricated forming systems shall be submitted for review. Since formwork is the Contractor's responsibility, these Drawings will not be approved or disapproved, but are submitted for information and comments only.

B. Design and Installation of Formwork:
   1. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor.
   2. The formwork shall be designed for the loads, lateral pressure, and allowable stresses as outlined in ACI 347.

C. Chamfer Strips: Chamfer strips shall be placed in the corners of forms to produce a 3/4" bevel or radius on all exterior corners.

D. Form Ties: Bolts and rods or rigid metal form ties of an approved type which are especially designed for use in connection with concrete work shall be used for temporary internal ties. They shall be coated with grease and so arranged that when the forms are removed no metal will be within one inch of any concrete surface. Wire ties will be permitted only for minor or special form areas where the use of rigid type metal ties would be impracticable. Wire ties will not be permitted where the concrete surface will be exposed to weathering, or at any point where discoloration will be objectionable.

E. Camber: To maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork prior to hardening of the concrete.

F. Adjustment: Positive means of adjustment (wedges or jacks) of shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Wedges shall be secured in position after final adjustment. Forms shall be securely braced against lateral deflections.

G. Inspection: Temporary openings shall be provided at the base of column forms and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

H. Formwork: Formwork shall be so anchored to shores or other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will be prevented.

I. Preparation of Form Surfaces:
1. All surfaces of forms and embedded material shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed in them.

2. Before placing of either the reinforcing steel or the concrete, the surfaces of the forms shall be covered with an approved coating material that will effectively prevent absorption of moisture and prevent bond with the concrete and will not stain the concrete surfaces. A field applied form release agent or sealer of approved type or a factory applied non-absorptive liner may be used.

3. Excess form coating material shall not be allowed to stand in puddles in the forms nor shall such coating be allowed to come in contact with hardened concrete against which fresh concrete is to be placed.

J. Unless otherwise specified, the following tolerances shall govern:

**Tolerances for Formed Surfaces**

1. Variation from plumb: In the lines and surfaces of columns, piers, walls, and in arises:
   - In any 10 ft. of length: 1/4 inch
   - Maximum for the entire length: 1 inch
   - a) For exposed corner columns, control-joint grooves, and other conspicuous lines:
      - In any 20 ft. length: 1/4 inch
      - Maximum for the entire length: 1/2 inch

2. Variation from the level or from the grades specified in the concrete documents:
   - b) In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores:
      - In any 10 ft. of length: 1/4 inch
      - In any bay or in any 20 ft. length: 3/8 inch
      - Maximum for the entire length: 3/4 inch
   - c) In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
      - In any bay or in 20 ft. length: 1/4 inch
      - Maximum for the entire length: 1/2 inch
   - d) Thickness:
      - Decrease in specified Thickness: 5 percent
      - Increase in specified Thickness: No limit
   - e) For distances less than the 10 and 20 foot distances shown above, the tolerances specified shall be reduced directly in proportion to the tolerances shown, down to a minimum tolerance of 1/8 inch.

3.3 REMOVAL OF FORMS AND FALSEWORK

A. General: Forms and falsework shall not be removed without prior approval. The removal of forms and falsework shall be accomplished in such a manner as to prevent injury to the concrete. All forms shall be removed before completion of the work; if necessary, temporary access openings shall be provided for removal of forms from otherwise inaccessible places. The size and method of closing such openings shall be submitted and approved.

B. Removal of Side Forms: Except as hereinafter provided, forms may be removed from the sides of beams, columns, and walls, and from other parts of formwork not supporting the weight of the concrete when the concrete has been cured for 48 hours. The exposed surfaces shall then be cured for the remaining curing period, as specified. Alternatively, the forms can be stripped at the end of curing period of four days.

C. Other Formed Surfaces: All other formed surfaces may have their forms and falsework removed after the concrete has achieved the required seven-day compressive strength, but in no case until the concrete has been cured for four days.
D. Removal Strength: When removal of formwork or reshoring is based on the concrete reaching a specified strength, the concrete shall be presumed to have reached this strength only when test cylinders, field cured along with the concrete they represent, have reached the strength specified for removal of formwork. The cost of testing shall be borne by the Port of Houston Authority; however, the Contractor is responsible for making and providing the cylinders to the testing laboratory.

3.4 CONSTRUCTION JOINTS

A. Joints not shown in the contract documents shall be so made and located at least to impair the strength of the structure and shall be approved. In general, they shall be located near the middle of the spans of slabs, quarter points on the beams and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

B. All reinforcement shall be continued across joints. Keys and dowels shall be provided as directed by the Port of Houston Authority. Longitudinal keys at least 1-1/2 in. deep and one-third the width of the member shall be provided in all joints in walls and between walls and slabs or footings. Slab joints shall also be keyed.

C. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed prior to placing adjoining concrete.

D. When required or permitted, bond shall be obtained by the use of an approved adhesive or by roughening the surface of the concrete to expose the aggregate and remove laitance or damaged concrete.

3.5 EXPANSION JOINTS

A. Reinforcement or other embedded metal items bonded to the concrete (except dowels bonded on only one side of joints) shall not be permitted to extend continuously through any expansion joint.

B. Premolded expansion joint filler shall be of the type required by the Technical Specifications and shall conform to ASTM D 1751, ASTM D 1752, or ASTM D 6690.

3.6 EMBEDDED ITEMS

A. All sleeves, inserts, anchors, conduits and embedded items required for adjoining work or for its support shall be placed prior to concreting. Such items shall be accurately positioned and secured against displacement. Voids in sleeves inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete. Embedded steel items projecting from or within three inches of the edge of the concrete shall be galvanized or shall be stainless steel, as indicated in the Drawings or Technical Specifications. Embedded steel items no closer than three inches from the edge of concrete are not required to be galvanized, unless specified otherwise.

3.7 PRODUCTION OF CONCRETE

A. Ready-Mix Concrete:
   1. Except as otherwise provided in these Specifications ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94. Plant equipment and facilities shall be NRMCA certified.
   2. Discharge of the concrete shall be completed within sixty minutes after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregate.
3.8 PLACING

A. Preparation before Placing:
1. Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.
2. Formwork shall be completed; water and construction debris shall be removed; reinforcement shall be secured in place; expansion joint material, anchors and other embedded items properly located and secured prior to placing concrete. The Contractor shall give sufficient advance notice that those items may be inspected and approved before concrete placement begins.
3. Subgrade shall be dampened prior to placement, but without puddles, muddy or soft places.
4. Concrete shall not be placed on frozen or frosty ground or in forms containing ice, frost or snow.
5. Pipes buried under concrete construction shall have satisfied all required tests before the concrete is placed.

B. Conveying:
1. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner, which will assure that the required quality of the concrete is maintained.
2. Conveying equipment shall be approved and shall be of a size and design such that detectable setting of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or workday. Conveying equipment and operations shall conform to the following additional requirements.
   a. Truck mixers, agitators, and non-agitating units and their manner of operation shall conform to the applicable requirements of ASTM C 94.
   b. Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An approved arrangement shall be used at the discharge end to prevent apparent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.
3. Chutes shall be metal or metal-lined and shall have a slope not exceeding 1 vertical and 2 horizontal and not less than 1 vertical to 3 horizontals. Chutes more than 20 ft. long and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
4. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete. The loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 inches. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.

C. Depositing:
1. General: Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the contract documents or as approved. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign materials shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.
2. Placing: Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.
3. Segregation: Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation.

4. Consolidation:
   a. All concrete shall be consolidated by vibration so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 8000 vibrations per min. and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18 inches apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 sec. A spare vibrator shall be kept on the jobsite during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented if necessary, by spading to work the coarse aggregate back from the formed surface.
   b. Any placing or finishing operation requiring more than ten hours or night work shall have prior approval. Nighttime operations shall be adequately lighted.
   c. Concrete shall not be dropped freely more than five feet in unexposed work or more than three feet in exposed work. Where greater drops are required, especially in columns and drilled shafts, an approved tremie or other suitable method shall be employed to lower the concrete into place.
   d. Grade strips (screeds) shall be set at the proper elevations. They shall be substantial enough to maintain their proper position during placement of concrete. Screeds and grade strips shall be removed after finish has been applied. Voids remaining shall be filled with stiff concrete tamped into place. Finish making surface uniform with adjacent areas.

D. Protection:
   1. Unless adequate protection is provided and approval is obtained, concrete shall not be placed during rain, sleet, or snow.
   2. Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.

E. Placing Temperature: When the temperature of the surrounding air is expected to be below 40 degrees F. during placing or within 24 hrs. thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 55 degrees F. for sections less than 12 inches in any dimension nor 50 degrees F. for any other sections. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints, and should not exceed 90 degrees F. When the temperature of the concrete exceeds 90 degrees F., precautionary measures shall be put into effect. When the temperature of the steel is greater than 120 degrees F., steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. Salt, chemicals or other foreign materials shall not be added to the concrete for the purpose of preventing freezing.

F. Bonding:
   1. The surface of joints shall be prepared in accordance with one of the methods specified in Paragraph 3.4, CONSTRUCTION JOINTS. Forms shall be tight against previously placed concrete.
   2. Unless noted otherwise, the hardened concrete of joints shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout of proportions similar to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 1/2 in. thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained its initial set.
3. Joints receiving an adhesive shall have been prepared and adhesive applied in accordance with the manufacturer's recommendations prior to placing of fresh concrete.

G. Concreting under Water: When required or permitted, concrete shall be deposited under water by an approved method in such a way that the fresh concrete enters the mass of previously placed concrete from within, causing water to be displaced with minimum disturbance at the surface of the concrete.

H. Installation of dowels and anchor bolts shall conform to TxDOT Item 420.4.G.10.

3.9 REPAIR OF SURFACE DEFECTS

A. General: Surface defects, including tie holes, unless otherwise specified by the contract documents, shall be repaired immediately after form removal.

B. Repair of Defective Areas:
   1. All honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. No featheredges will be permitted. The area to be patched and an area at least 6 in. wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.

   2. The patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. Cement shall be the same used in the concrete. The quantity of mixing water shall be no more than necessary for handling the placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

   3. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least 1 hr. before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

C. Tie Holes: After being cleaned and thoroughly dampened, the tie holes shall be filled solid with patching mortar.

D. Proprietary Materials: If permitted or required, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations.

3.10 FINISHING OF CONCRETE SURFACES

A. After removal of forms and patching defects, the surfaces of concrete shall be given one or more of the following treatments. Locations of the various finishes shall be as indicated elsewhere or as follows:

   1. Rough Form Finish: For surfaces not exposed to view such as under wharves; grade beams and retaining walls receiving backfill; and areas to receive another finish material such as masonry.

   2. Smooth Form Finish: For areas exposed to view but not requiring rubbed finish such as exposed face of grade beams and retaining walls, or other areas as directed in the Technical Specifications.

   3. Rubbed Finish: Exposed surfaces such as columns, building walls, spandrel beams, frontal beams and columns on walls, and retaining walls at loading docks.
4. Scratch Finish: For slabs to receive later topping course.
5. Floated Finish: For surface to receive roofing or waterproofing membrane and wharf decks
ewith ear fill.
6. Troweled Finish: For interior and warehouse floors intended as walking surfaces or for
reception of floor finish.
7. Broom or Belt Finish: For wharf decks, loading platforms, and transit shed floors, and other
exterior slab surfaces.
8. Other approved methods.

B. Finishing Tolerances:
1. Finishes with Class A tolerances shall be true planes within 1/8 in. in 10 ft., as determined
by a 10-ft. straightedge placed anywhere on the slab in any direction.
2. Finishes with Class B tolerances shall be true planes within 1/4 in. in 10 ft., as determined
by a 10-ft. straightedge placed anywhere on the slab in any direction.
3. Finishes with Class C tolerances shall be true planes within 1/4 in. in 2 ft., as determined
by a 2 ft. straightedge placed anywhere on the slab in any direction.

C. Description of Finishes:
1. Rough Form Finish: No form facing materials are required for rough form finish surfaces.
Tie holes and defects shall be patched. Fins exceeding 1/4 in. in height shall be chipped
off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

2. Smooth Form Finish: The form facing material shall produce a smooth, hard, uniform
texture on the concrete. It may be plywood, tempered concrete-form-trade hardboard,
metal plastic, or other approved material capable of producing the desired finish. The
arrangement of the facing material shall be orderly and symmetrical, with the number of
seams kept to the practical minimum. It shall be supported by studs or other backing
capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn
edges, patches, dents, or other defects which will impair the texture of the concrete surface
shall not be used. Tie holes and defects shall be patched. All fins shall be completely
removed.

3. Rubbed Finish: Rubbed finish shall be produced on concrete with a smooth form finish as
soon as possible after forms are removed and patching is completed. Surfaces shall be
wetted and rubbed with carborundum brick or other abrasive until uniform color and texture
are produced. No cement grout shall be used other than the cement paste drawn from the
concrete itself by the rubbing process. After the paste has reset, the surface shall be
washed with clean water.

4. Scratched Finish: After the concrete has been placed, consolidated, struck off, and leveled
to a Class C tolerance, the surface shall be roughened with stiff brushes or rakes before
final set.

5. Floated Finish: After the concrete has been placed, consolidated, struck off, and leveled,
the concrete shall not be worked further until ready for floating. During or after the first
floating, planeness of surface shall be checked with a 10-ft. straightedge applied at not less
than two different angles. All high spots shall be cut down and all low spots filled during
this procedure to produce a surface within Class B tolerance throughout. The slab shall
then be reflated immediately to a uniform sandy texture.

6. Troweled Finish: The surface shall first be float-finished as specified in Section 3.9 C. 5.,
Floated Finish. It shall next be power troweled, and finally hand troweled. The first troweling
after power floating shall produce a smooth surface which is relatively free of defects, but
which may still show some trowel marks. Additional trowelings shall be done by hand after
the surface has hardened sufficiently. The final troweling shall be done when a ringing
sound is produced as the trowel is moved over the surface. The surface shall be thoroughly
consolidated by the hand troweling operations. The finished surface shall be essentially
free of trowel marks, uniform in texture and appearance and shall be plane to a Class A
tolerance, except tolerance for concrete on metal deck shall be Class B. On surfaces
intended to support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

7. Broom or Belt Finish: Immediately after the concrete has received a float finish, as specified in Section 3.9 C. 5. Floated Finish, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

3.11 CURING AND PROTECTION

A. General: Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval. Poor procedures or materials shall be cause to stop all concrete work on the project until proper provisions for curing are made.

B. Preservation of Moisture: For concrete surfaces not in contact with forms one of the following procedures shall be applied immediately after completion of placement and finishing:

1. Ponding or continuous sprinkling.
2. System of wet absorptive mats and impervious sheeting: Completely cover surface and edges of the concrete with wet cotton mats (12 oz./SY). Overlap mats 12 inches over adjacent mats. Mats shall be at least as long as the width of the surface to be cured. During application, do not drag the mats over the finished concrete nor over mats already placed. Wet mats thoroughly and keep continuously wet throughout the curing period. After applying wet cotton mats, cover with impervious sheeting throughout the curing period. Lay impervious sheeting with an overlap edges 12 inches minimum. Impervious sheeting shall be a clear or white (10 mil minimum) polyethylene film. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.
3. Application of a curing compound conforming to ASTM C 309 and containing a light-colored fugitive dye. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.

C. Moisture Loss: Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the prescribed curing time by one of the methods of Paragraph 3.11 B Preservation of Moisture.

D. Curing Time:

1. Concrete shall be cured a minimum of 4 days, except suspended structural slabs shall be cured 7 days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, curing may be terminated when the average compressive strength has reached 70 percent of the specified 28 day strength. If one of the curing procedures of Section 3.11 B., Preservation of Moisture, Items (i) through (iv) above is used initially, it may be replaced by one of the other procedures any time after the concrete is one day old, provided the concrete surface is not permitted to become dry during the transition.

2. The length of time the concrete has been cured in the structure shall be determined by the cumulative number of days or fractions thereof, not necessarily cumulative, during which the temperature of the air in contact with the concrete is above 50 degrees F. and the concrete has been damp or thoroughly sealed from evaporation and loss of moisture.
E. Temperature, Wind and Humidity:
1. Cold Weather: When the mean daily outdoor temperature is less than 40 degrees F., the temperature of the concrete shall be maintained between 50 degrees F. and 70 degrees F. for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hrs. unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
2. Hot Weather: When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.
3. Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5 degrees F. in any 1 hr. or 50 degrees F. in any 24-hr. period.
4. Protection from Mechanical Injury: During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete. Pile driving and earth compaction operations shall not be closer than 100 feet to concrete elements whose age is 7 days or less.

3.12 QUALITY ASSURANCE
A. Provide necessary controls during evaluation of materials, mix designs, production and delivery of concrete, placement and compaction to assure that the Work will be accomplished in accordance with Contract Documents. Maintain records of concrete placement. Record placement dates, placement locations, volume of concrete, batch ticket numbers, air temperatures, and test samples taken. The batch tickets shall indicate amounts of mix water to be withheld at the plant for later addition at Project site.
B. Contractor shall conduct preconstruction meeting at the project site prior to submitting design mixes. The intent of the meeting is to discuss “Quality Control” requirements of the specifications, review concrete mix design requirements and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
1. Contractor’s Project Manager (shall conduct the meeting)
2. Contractor’s Superintendent
3. Contractor’s Lead Foreman
4. Contractor’s Concrete CQC personnel
5. Independent Testing Agency responsible for concrete design mixes.
6. Ready-mix concrete batch plant operator
7. Port Representative
The contractor shall conduct regular quality control team meetings with above-said attendees to review plans for future placements, review test results, and discuss dispensation of non-conforming materials. It is recommended that the meetings be held on a weekly or bi-weekly basis during the submittal phases and then monthly, as the construction progresses and in coordination with the Port Authority.
The Contractor shall prepare quality control team meeting minutes for each meeting. The minutes shall include the date of each meeting, attendees, key discussion points, findings, recommendations, assigned tasks, assigned personnel, task completion dates and status of each task.

C. Concrete construction for buildings shall conform to ACI 318.

3.13 SAMPLING AND TESTING FOR CONCRETE

A. Concrete testing required in this section will be performed by an independent commercial testing laboratory employed and paid by the Port of Houston Authority, except as set out herein, in accordance with Material Testing in the General Conditions. Tests to be made at the Port of Houston Authority’s expense shall be ordered by the Port of Houston Authority, and not by the Contractor.

B. Standard Services: The testing agency will perform the following services:
   1. Verification that plant equipment and facilities conform to NRMCA certification requirements.
   2. Testing of proposed materials for compliance with this Section.
   3. Review of proposed mix design submitted by Contractor.
   4. Obtaining production samples of materials at plants or stockpiles during work progress and testing for compliance with this Section.
   5. Strength testing of concrete according to following procedures:
      a. Obtaining samples for field test cylinders from every 100 cubic yards and any portion less than 100 cubic yards for each mix design placed each day, according to ASTM C 172, with each sample obtained from a different batch of concrete on a representative, random basis. Selecting test batches by any means other than random numbers chosen before concrete placement begins is not allowed.
      b. Molding four specimens from each sample according to ASTM C 31 and curing under standard moisture and temperature conditions as specified in Sections 7(a) and (b) of ASTM C 31.
      c. Testing two specimens at 7 days and two specimens at 28 days according to ASTM C 39, reporting test results averaging strengths of two specimens. However, when one specimen evidences improper sampling, molding or testing, it will be discarded, and remaining cylinder considered test result. When high-early-strength concrete is used, specimens will be tested at 3 and 7 days.
   6. Air content: For each strength test, determination of air content of normal weight concrete according to ASTM C 231.
   7. Slump: For each strength test, and whenever consistency of concrete appears to vary, conducting slump test in accordance with ASTM C 143.
   8. Temperature: For each strength test, checking concrete temperature in accordance with ASTM C 1064.
   9. Lightweight concrete: For each strength test, determination of air content by ASTM C 567 and unit weight by ASTM C 567.
   10. Monitoring of current and forecasted climatic conditions to determine when rate of evaporation, as determined by Figure 2.1.5 of ACI 305R, will produce loss of 0.2 pounds of water, or more, per square foot per hour. Testing lab representative will advise Contractor to use hot weather precautions when such conditions will exist during concrete placement and note on concrete test reports when Contractor has been advised that hot weather conditions will exist.
   11. Concrete Shrinkage Tests: Performance of drying shrinkage tests for trial batches as follows:
       Preparation and Testing of Specimens: Compression test specimens will be taken in each case from the same concrete sample. 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C 157, modified as follows:
a. Wet curing: Remove specimens from molds at an age of 23 hours 1 hour after trial batching and immediately immerse in water at 70 degrees F ±3 degrees F for at least 30 minutes;

b. Measure within 30 minutes after first 30 minutes of immersion to determine original length (not to be confused with "base length");

c. Then submerge in saturated limewater, at 73 degrees F ±3 degrees F, for 7 days;

d. Immediately store specimens in a temperature- and humidity-controlled room maintained at 73 degrees F, ±3 degrees F and 50 percent ±4 percent relative humidity, for the remainder of the test.

C. Additional Testing and Quality Control Services: The following will be performed by an independent commercial testing laboratory employed and paid by the Port of Houston Authority.

1. Checking of batching and mixing operations.
2. Review of manufacturer's report of each cement shipment and conducting laboratory tests of cement.
3. Molding and testing reserve 7-day cylinders or field cylinders.
4. Conducting additional field tests for slump, concrete temperature and ambient temperature.

D. Authority of the Testing Agency: Representatives of the agency shall inspect, sample and test the materials and monitor the production of concrete as required by the Managing Director, Engineering & Construction. When it appears that any material furnished or work performed by the Contractor fails to fulfill specification requirements, the testing agency shall report such deficiency to the Port of Houston Authority and the Contractor. The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirement of the contract documents, nor to approve or accept any part of the work.

E. Contractor’s Responsibility:

1. It shall be the responsibility of the Contractor to furnish materials and construction in full compliance with the contract documents. As specified previously, he shall submit mix design and representative samples for approval.
2. To facilitate testing and inspection, the Contractor shall furnish any necessary labor to assist the designated testing agency in obtaining and handling samples at the project or other sources of materials. He shall cooperate fully with the laboratory and shall correct or replace any defective work.
3. The Contractor shall employ an independent commercial testing laboratory, acceptable to the Port of Houston Authority, and shall pay the costs of laboratory services required to establish mix designs for Portland cement concrete. The Contractor shall pay for the costs of analyzing aggregates, fixing gradations, preparing and testing of design cylinders or specimens and other such services required to establish mix design, or to redesign any mix when required due to any change in source of materials or other conditions.
4. The Contractor shall notify the Port of Houston Authority Construction Manager 24 hours prior to placing concrete to allow for completion of quality tests and for the assignment of personnel.

F. Testing of Deficient Concrete in Place:

1. When averages of three consecutive strength test results fail to equal or exceed specified strength, or when any individual strength test result falls below specified strength by more than 500 psi, strength of concrete shall be considered potentially deficient and core testing, structural analysis or load testing may be required.
2. When concrete in place proves to be deficient, Contractor shall pay costs, including costs due to delays, incurred in providing additional testing and analysis services, or the independent commercial testing laboratory selected by the Port of Houston Authority.
3. Replace concrete work judged inadequate by core tests, structural analysis or load tests at no additional cost to the Port of Houston Authority.
4. Core Tests:
   a. Obtain and test cores in accordance with ASTM C 42. Here concrete in structure will
      be dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative
      humidity less than 60 percent) for 7 days before test; test dry. Where concrete in
      structure will be more than superficially wet under service conditions, test cores after
      moisture conditioning in accordance with ASTM C 42.
   b. Take at least three representative cores from each member or area of concrete in place
      that is considered potentially deficient. Location of cores shall be determined so as to
      least impair strength of structure. When, before testing, one or more cores shows
      evidence of having been damaged during or after removal from structure, replace the
      damaged cores.
   c. Concrete in area represented by core test will be considered adequate when average
      strength of cores is equal to at least 85 percent of specified strength, and when no
      single core is less than 75 percent of specified strength.
   d. Patch core holes in accordance with the guidelines of this Section.
5. Structural Analysis: When core tests are inconclusive or impractical to obtain, the Port of
   Houston Authority may perform additional structural analysis at Contractor's expense to
   confirm safety of structure.
6. Load Tests: When core tests and structural analysis do not confirm safety of structure,
   load tests may be required, and their results evaluated, in accordance with ACI 318.
7. Testing by impact hammer, sonoscope, probe penetration tests (Windsor probe), or other
   nondestructive device may be permitted to determine relative strengths at various locations
   in structure, to evaluate concrete strength in place, or for selecting areas to be cored.
   However, such tests, unless properly calibrated and correlated with other test data, shall
   not be used as basis for acceptance or rejection of structure's safety.

END OF SECTION
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS FOR

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

SECTION 05 50 00.00 Add – MISCELLANEOUS METALS

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; the furnishing of all labor, materials, equipment, supervision, and other things necessary to provide all miscellaneous metal work, including but not limited to: Pipe Sleeves, Angle Frames for manholes, inlets, vaults, trenches or other openings, Expansion Joint Armoring, Floor Plates, Mooring Devices and other Metal Constructions of a nature similar to those above as described and specified herein and as shown on the Drawings, or otherwise required to complete the work.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities

SECTION 35 31 16.20 Add – Steel Sheet Pile Bulkhead

1.3 REFERENCES

A. ASTM International Publications, latest editions:

ASTM A-36 Standard Specification for Carbon Structural Steel
ASTM A-53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A-153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A-240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A-269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A-283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A-307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A-434 Standard Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered

ASTM A-489 Standard Specification for Carbon Steel Lifting Eyes

ASTM A-501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

ASTM A-511 Standard Specification for Seamless Stainless-Steel Mechanical Tubing

ASTM A-653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM F-593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM F-594 Standard Specification for Stainless Steel Nuts

B. American Society of Mechanical Engineers (ASME) Publications, latest editions:

   B18.21.1 Lock Washers (Inch Series)

   B18.22.1 Plain Washers

C. American Welding Society (AWS) Designation

   A 5.1 Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

1.4 SUBMITTALS

A. Product Data and shop drawings for: Steel, pipes, plates, shapes, tubing, bars, bolts, rods and nuts, electrodes, sleeves, and anchors.

B. Samples

1.5 HANDLING AND STORAGE

   NOT USED

PART 2 PRODUCTS

2.1 CARBON STEEL

Steel shapes, plates and rods shall comply with the Standard Specifications for Carbon Structural Steel, ASTM A-36, unless otherwise noted on drawings.

Steel pipe, including guard posts, bollards and railing, shall conform to the requirements of Standard Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless, ASTM A-53, for Type E, Grade B, or for Type S, Grade B. Carbon steel pipe made under other ASTM Specifications will be acceptable provided the yield point of the steel is not less than 35,000 psi and the ultimate strength not less than 60,000 psi.

Round, square or rectangular steel tubing shall conform to Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing, ASTM A-501.

No carbon steel shapes, plates, pipe, tubing, bars, or rods shall be used in work governed by this Technical Specification that has become rusted and pitted to a degree more severe than that defined by "Pictorial Surface Preparation Standards for Painting Steel Structures" (Designation SSPC-Vis-1 of the Steel Structures Painting Council) as Condition "B". When the surface is more
severely corroded than that defined as Condition "B", the Inspector may require a higher grade of surface preparation than is set out herein or in 1.2 Related Sections prior to applying shop coating.

2.2 BOLTS, RODS AND NUTS

Common bolts, threaded rods, rod braces, sag rods, and nuts or other similar threaded parts shall conform to the requirements of Standard Specification for "Carbon Steel, Bolts and Studs, 60,000 PSI Tensile" ASTM A-307 for Grade A bolts. Bolt heads and nuts shall be provided with standard cut washers. Bolts, rods, nuts, and washers used for fastening galvanized steel parts or for fastening parts required to be coated with organic or inorganic zinc coating material shall be galvanized. Threads in nuts shall be cut to allow for thickness of zinc coating. Bent anchor rods shall be hot forged in the plastic ranges of temperatures to the shape shown on the Drawings.


Eyebolts: ASTM A 489.


2.3 ARC-WELDING ELECTRODES

Electrodes for arc-welding structural steel plates and shapes shall conform to the requirements of Specification for Mild Steel Arc-Welding Electrodes AWS Specification A5.1 for E6010, E6011, or E6012 electrodes, and shall be suitable for the positions of the welds and the type and polarity of the current used. For A-36 steel one inch or more in thickness, only the E70 series of electrodes shall be used.

Electrodes for welding stainless steel shall conform to the requirements of Specifications for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes, AWS Specifications A5.4 Class E308L rods will be used for welding stainless steel to stainless steel. Class E309 rods shall be used to weld stainless steel to carbon steel. Welding rods shall be suitable for the position of the weld and the type and polarity of current used.

2.4 PIPE SLEEVES

Pipe for sleeves shall comply with Standard Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless (ASTM A-53). Pipe to be inserted in concrete, and pipe for the other purposes designated to be galvanized, shall be galvanized in accordance with the paragraph cited above.

2.5 GALVANIZING REPAIR COMPOUND

Galvanizing compound for repairs to damaged zinc coating shall be a cold-applied compound, ZRC Cold Galvanizing Compound as manufactured by ZRC Worldwide, Marshfield, MA, 1-800-831-3275, or approved equal.

2.6 SHOP PAINT

Coating to be applied under these specifications shall be as specified in Sections found in Division 9.
2.7 OTHER MISCELLANEOUS METALS

Miscellaneous metals not specified herein shall be furnished to details shown on the Drawings and to the provisions of the Related Sections.

2.8 GALVANIZING

A. All miscellaneous iron and steel items to be installed in concrete, except those required to be of stainless steel, and all items specified in the Related Sections to be galvanized shall be zinc coated in accordance with the applicable specification of the American Society for Testing and Materials set out below. All cutting, welding, threading, or other shop operations except machining of bearing surfaces of moving parts shall be completed before the item is galvanized.

B. Cast iron, malleable iron, and cast steel parts, all rolled, pressed or forged articles, and all rods, nuts, bolts, washers, rivets and similar items required to be galvanized, shall be coated in accordance with Standard Specification for Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Hardware (ASTM A-153).

C. Fabricated welded construction of rolled, pressed, or forged steel shapes, plates, bars or sheets, including steel gratings, when required to be galvanized shall be coated after fabrication is complete in accordance with Standard Specifications for Zinc Coatings (Hot-Dipped Galvanized) on Iron and Steel Products (ASTM A-123).

D. Steel sheet required to be galvanized, but not to be welded or flame-cut, shall conform to the requirements of Standard Specifications for Steel Sheet Zinc Coated (Galvanized) by the Hot-Dipped Process Structural (Physical Quality), (ASTM A-446) for Grade A Sheets with a 2-Ounce Coating.

E. All galvanized surfaces that have become damaged during shipping, handling, erection, or installation, or that have been burned by welding or flame-cutting, or damaged in any other way, shall be repaired with a cold-applied galvanizing compound conforming to this Section applied in strict compliance with the manufacturer's specifications.

PART 3 EXECUTION

3.1 FABRICATION

A. Workmanship:

All cuts shall be sheared or flame-cut with automatic, guided equipment. Edges cut with a hand torch shall be ground neat, smooth, and straight. All edges shall be ground free of sharp edges, burrs, and weld splatters. All fits shall be accurate.

B. Bolt Holes:

Bolt holes shall be punched, drilled, or sub-punched and reamed. If holes are flame-cut they shall be burned undersize and reamed to correct size.

C. Welding:

All welding shall be performed in accordance with the provisions of Code for Welding in Building Construction (AWS Designation D1.1). Multipass welds for stainless steel shall be chipped or ground completely free of slag between passes. All welds shall be of uniform quality. Butt welds shall be continuous. Edges of faying surfaces of lapped joints shall be continuously seal welded in addition to welding required for strength.

END OF SECTION
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS FOR

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

SECTION 09 96 56.01 Add - EPOXY COATINGS – COAL TAR

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; the furnishing and the application of a two-component polyamide coal tar epoxy coating to steel surfaces as described and specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities
SECTION 05 50 00.13 Mod – Miscellaneous Metals
SECTION 35 321 16.20 Add – Steel Sheet Pile Bulkhead

1.3 REFERENCES

A. National Association of Corrosion Engineers
   SP0188-2006-SG Discontinuity (Holiday) Testing of New Protective Coatings on Conducive Substrates

B. The Society for Protective Coatings (SSPC) Publications, latest edition:
   SSPC 16 Coal Tar Epoxy Polyamide Black (or Dark Red) Coating
   SSPC SP-10 Near White Blast Cleaning
   SSPC Vis-1 Guide and Reference Photographs for steel Surfaces Prepared by dry Abrasive Blast Cleaning

1.4 SUBMITTALS

A. Product Data for: Coatings with certified affidavit attesting SSPC Paint No.16.

1.5 HANDLING AND STORAGE

A. All material shall be delivered to the point of application in unopened factory containers with labels intact and shall be accompanied by the manufacturer's instruction for use. Any material found to not comply with these Specifications shall be removed from the job site immediately after notification by the Chief Construction Manager.

B. All coating materials shall be stored as required to protect them from the weather. Exposure to heat or cold in excess of that recommended by the manufacturer shall be cause for rejection. The coating shall be stored in areas complying with City, County, State and Federal safety codes for flammable materials.
PART 2 PRODUCTS

2.1 MATERIAL

A. Color shall be black unless red is approved by the Chief Construction Manager.

C. The coating shall consist of a two-component polyamide cured coal tar epoxy conforming to The Society of Protective Coatings Specification No. 16 – latest ed., formulated with Type 1 coal tar pitch. The coating manufacturer shall furnish a certified affidavit attesting that his product’s conforms to SSPC Paint No. 16 – latest ed., specifications. The Inspector reserves the right to take samples and perform tests as required to establish the quality of the coating materials (see Paragraph titled “Material Testing” of the General Conditions). The sample shall be a complete unopened kit selected at random and furnished at the Contractor’s expense.

PART 3 EXECUTION

3.1 GENERAL

The manufacturer shall furnish the services of one of his representatives who is fully conversant with the application of the material and who shall be on call while coating is applied to advise the Contractor and the Chief Construction Manager concerning the preparation of surfaces and the application of coating.

3.2 SURFACE PREPARATION:

All surfaces to be coated shall be solvent cleaned to remove all grease, dirt or wax and shall be blast-cleaned in accordance with the Society for Protective Coatings Specification SP-10 – latest ed., (near-white blast). All rust, burrs, mill scale and welding slag and splatter shall be removed. Sharp irregular protuberances of weld metal and irregular edges and burrs on flame-out or sheared pieces shall be ground smooth. Blast cleaning shall extend six inches beyond the area to be coated and shall be continuous on the entire circumference or perimeter of the member. The type and size of abrasive shall be selected to obtain a profile depth of 1.5 mils minimum. The abrasive for blast cleaning shall be grit or a mixture of grit with not more than fifteen percent of steel shot. If used grit is reclaimed, all makeup shall consist entirely of grit. The air supply system for blast cleaning shall be provided with means for removing all entrained moisture before air reaches the nozzle.

All work blast cleaned in any day shall be coated the same day before the atmospheric temperature drops to within 5 degrees above the dew point. Any blast-cleaned areas not coated on the same day as cleaned shall be whip-blast cleaned to remove rust bloom. All surfaces shall be completely free of moisture, dirt, sand, grit, oil, grease, or other contaminants at the time coating is applied. Oil or grease smudges shall be removed by cleaning with a solvent complying with the coating manufacturer’s recommendation.

Blast cleaning of each piece to be coated shall be inspected and approved by the Chief Construction Manager before any coating is applied. The coating contractor shall schedule his work and notify the Chief Construction Manager in adequate time so that arrangements can be made for inspection. Safe access to all areas to be inspected, shall be provided by the Contractor.

All cleaning shall be performed so that dust or other contaminants do not fall on uncured painted surfaces. Surfaces not to be painted shall be suitably protected from the effects of cleaning or painting operations.
3.3 MIXING OF COATING
The two components shall be mixed strictly in accordance with the manufacturer's instructions and only in quantities that will be used within the mixed materials pot-life. No additives shall be used to extend the pot-life except as may be specifically set out in the manufacturer's instructions. Mixed materials not used within the pot-life shall be discarded. No thinner shall be used without prior approval by the Chief Construction Manager. Thinner, if used, shall be that specified by the manufacturer of the coating. Except when specifically waived in writing by the PHA Chief Construction Manager, all mixing shall be done in the presence of the Chief Construction Manager.

3.4 AIRLESS SPRAY EQUIPMENT
The coating shall be applied with the “airless spray” method using Grayco or equal airless spray equipment which has a minimum ratio of fluid pressure to air pressure of 30:1. Hose shall be aromatic solvent resistant nylon or “Teflon”. Tips shall be selected to produce a uniform coating of the thickness required by these specifications, free of pinholes, and without running, curtaining or sagging.

Equipment shall be completely clean and free of any other coating material and shall be thoroughly cleaned after each use, using a solvent that will remove the specified coating from the equipment. When resuming operations, sufficient coating materials shall be pumped through the system so that any residual solvent will be completely removed before applying coating.

3.5 APPLICATION OF COATING
The surfaces to be coated shall be sandblasted, dry and free of dust, burrs, grit, sand, dirt, rust, mill scale, welding slag, splatter, oil, grease, or other contaminants at the time coating is applied. No coating shall be applied when the air temperature is under 50 degrees F. or when the temperature is less than 5 degrees F. above the dew point.

The coal tar-epoxy shall be applied in a minimum of two uniform coats of eight to ten mil dry film thicknesses to produce not less than a total of 16 mils (0.016 inch) or more than 20 mils of dry film thickness for the system.

All areas not easily accessible by spray equipment such as sharp edges, interlocks, drilled holes, welds, cracks, crevices, rivets, bolts and nuts, may be pre-coated by brush or other suitable means approved by the Chief Construction Manager.

Where feasible, the entire area shall be coated as one continuous operation applying the first coat and following with the second coat approximately one hour later. In the case of steel sheet piling, steel bearing piles and steel pipe piles that are to receive welded attachments or joints after being driven, coating shall be interrupted for at least one foot each way from such welding or at least two feet from any flame cutting that may be required. The skipped areas shall be coated as a second phase. The edge of the first phase coating shall be feather-edged for at least one foot. Just prior to applying the second phase of coating, the first phase shall be lightly blasted, lightly sanded or hand-wire brushed to produce a tooth and shall be wiped generously with methyl isobutyl ketone (MIBK).

3.6 APPEARANCE
The finished coating shall be smooth, glossy, free of sharp protuberances, and shall be free of pin holes. Minor sags, dimpling or curtaining that does not exceed two percent of the entire surface of a pile or other element, will be allowed provided they do not present sharp edges. Protuberances and sharp edges shall be cut off carefully with sharp wood chisel laid flat against the surface. The zones from which excess has been removed shall be sanded or hand wire-brushed, lightly wiped with MIBK and re-coated to a smooth surface.
3.7 INSPECTION

Only after the Contractor has made his own thorough inspection and is satisfied that he has performed the work in accordance with the specifications, shall he request an inspection.

Surface preparation of each piece of material to be coated shall be inspected and approved by the Chief Construction Manager prior to the application of coating. The quality of surface preparation will be determined by comparison with Pictorial Surfaces Preparation Standards for Painting Steel Surfaces (The Society for Protective Coatings Designation SSPC-Vis-1). Inspection for thickness and coating will be by means of a magnetic dry film thickness gauge; and inspection for pin holes and holidays will be made with non-destructive electrical equipment.

All areas having insufficient thickness of coating shall be recoated to the required thickness, and all areas containing pinholes shall be over-coated sufficiently to close these imperfections. When more than five such areas are found on any one piece, the Chief Construction Manager may require the entire piece to be over-coated.

All areas to be over-coated shall be lightly blasted or hand-wire brushed lightly and wiped with MIBK before applying additional material.

Hand wire brushing will only be permitted in the first 48 hours after application.

3.8 HANDLING OF COATED MATERIAL

Coated material shall be handled carefully with slings that will not mar the coating. All areas marred in handling, shipping, erecting, welding or pile-driving shall be recoated as soon as possible after they are discovered, using the techniques set out in this specification.

Coated pieces shall be shipped and stored with padded dunnage separating pieces and with pads under tie down chains or straps. Coated material shall not be stacked more than 42" high, except that pipe more than 20" in diameter and structural shapes more than 20" in depth may be stacked in two layers with padded dunnage between layers.

No markings shall be made on members with lead-based paints, grease crayon or other material incompatible with the coating. If marking is necessary, coal tar enamel or stamp markings shall be used.

Surfaces coated with coal tar-epoxy shall not be immersed in water until the coating has cured for at least 72 hours. Piling coated with coal tar epoxy shall not be driven until the coating has cured for at least seven days.

3.9 COATING CONTAMINATION

The Contractor is cautioned that the location designated on the drawings as the pile coating area may be subject to blowing dust by construction activity. He shall, therefore, take precautions to prevent contamination of the coating. Contaminated coating shall be cause for rejection and shall be removed and recoated at no cost to the Port Houston.

3.10 DAMAGE AVOIDANCE PRECAUTIONS

The Contractor shall take all precautions to control overspray and shall be liable for all damage incurred.

END OF SECTION
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Point Bulkhead

SECTION 31 23 00.00 Add – EXCAVATION AND FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; all clearing and grubbing and all excavating, filling, backfilling, grading and compacting of soils for preparation of subgrade for pavement and railroad trackage and for preparation of other soil areas as described and specified herein and as shown on the Drawings.

Drilled shafts, lime or cement stabilization of subgrade, cement stabilized sand fill, flowable fill, and trenching and backfill for sewers, water lines and other underground utilities, clearing and grubbing, topsoil, hydromulching and sodding are not included in this Section.

Preparation of subgrade and other designated areas shall include the excavation, loading, hauling, dumping and spreading of soil; undercutting to remove unstable soil areas; compacting existing soil surfaces, and bottom of excavated areas to receive fills and backfills; compacting excavated areas for subgrade; placing and compacting soil in fills and backfills; pumping to keep excavated areas dry; finish grading for subgrades and other designated soil areas; disposing of unsuitable and excess excavated material; and all work incidental to such work, all as shown on the Drawings and specified herein.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities

1.3 REFERENCES

ASTM International Publications, latest editions:

ASTM D-422 Standard Test Method for Particle Size Analysis of Soils

ASTM D-698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

ASTM D-1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft3 (2,700 kN m/m3))

ASTM D-2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)


ASTM D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
1.4 SUBMITTALS

A. Test Data for Fill Material: Proctor, Atterberg Limits, Gradation, Soil Classification.

B. Topographic Surveys: Topographic surveys before and after construction, with calculations, to establish final quantities for payment, in the medium or software designated in the contract documents.

C. Borrow Sources: Location, extent, quantity and planned depth of each on-site borrow source. For off-site borrow sources, submit site name, location, and contact information.

D. Where shoring is required due to depth of excavation: Shoring Plan, certified by a Texas registered professional engineer, describing the methods for shoring of excavations.

E. Where water levels will impact excavation operations: Dewatering Plan.

1.5 HANDLING AND STORAGE

Refer to the General Conditions.

PART 2 PRODUCTS

2.1 COMMON FILL

Common fill for areas that do not require compaction shall be free of organic matter such as roots and other vegetable matter subject to decay and any other material which would affect the stability of the fill. Fill may be obtained from the areas indicated on the plans or from borrow sources approved by the Chief Construction Manager.

2.2 COMPACTED FILL OR BACKFILL

Soil classification GW, GP, SW, or SP, free of organic matter such as roots and other vegetable matter subject to decay and any other material which would affect the stability of the fill, and shall have the following characteristics:

Plasticity Index - Between 25 and 35 (unmodified) (ASTM D-4318)

2.3 TOPSOIL

Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than 1", brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

PART 3 EXECUTION

3.1 USE AND MAINTENANCE OF ROADS

The Contractor shall conduct its grading and hauling operations in an orderly and safe manner, and shall protect the traveling public, the operations of the Port Authority and the operations of other contractors. The Contractor's hauling equipment operating on public roads and streets shall comply with the load limit, speed limit, and other Applicable Law. On the property of the Port Authority, the Contractor's hauling operations shall not interfere with the normal operations of the Port Authority's port facilities or with truck and rail traffic to and from such facilities.
The Contractor shall maintain dirt surfaced haul roads used by it and leave them in a condition acceptable to the Chief Construction Manager upon completion of their use. Flexible base surfaced and paved roads used by the Contractor shall be repaired by the Contractor at its expense wherever damaged by Contractor’s operations, and Contractor shall restore such roads to the condition existing prior to such damage.

The Contractor shall prevent spillage of earth and other materials being hauled. Where material is spilled on public roads or streets, or on the Port Authority's surfaced and paved roads, the Contractor shall promptly remove such material so as to maintain such roads and streets in a reasonably clean condition.

3.2 CROSSING FENCES

In the event fences must be crossed by the Contractor, such fences shall be opened only as directed by the Chief Construction Manager and be kept closed between passage of traffic except as permitted by the Chief Construction Manager. Upon completion of the work, the fences shall be repaired to their condition existing prior to the beginning of the Contractor’s work.

3.3 STRIPPING

Strip suitable topsoil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be stockpiled or disposed as approved by the Chief Construction Manager.

3.4 EXCAVATION

Excavation is defined as the removal of earth, loose rock, gravel, shell, and any other materials encountered in securing the proper subgrade in each area as shown on the Drawings. Excavation shall include the removal of unsuitable materials from the subgrade or existing ground to receive fill and the excavation of drainage ditches, side slopes of cuts, and shoulder areas adjoining subgrades for pavements and railroads.

All excavation will be unclassified as to type.

Only acceptable excavated materials shall be used in making fills and backfills, as required, within the limits of the project.

The Contractor shall remove from pavement and railroad subgrades, from all other areas to be graded, and from areas to receive fill, all muck and spongy or unstable materials which will not consolidate to a depth to be determined by the Chief Construction Manager and refill the space with acceptable material. Backfill material shall be placed in accordance with the requirements for compacted fills and backfills.

If the Contractor for any reason fails to comply with its Standard of Care in excavating and preparing rough grade for compaction and there is a deficiency of earth after compacting of finish subgrade surfaces, then Contractor shall fill such low areas and recompact as directed by Chief Construction Manager without extra compensation.

Excavations shall be made to the cross sections, lines and elevations shown on the Drawings.

3.5 DRAINAGE AND DEWATERING

Provide for the collection and disposal of surface and subsurface water encountered during construction.
A. Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish storm drainage to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, dikes, swales, pumps, and other drainage features and equipment as required to maintain dry soils. It is the responsibility of the Contractor to assess the soil and ground water conditions prior to excavation or fill, and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and any other area affecting operations at the site shall be continually and effectively drained.

B. Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of the work. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure.

3.6 COMPACTION OF NATURAL GROUND AND SUBGRADE

A. Compaction Requirements:

All natural ground and excavated areas which are to receive compacted embankment shall be compacted to a depth of eight inches (8”). All railroad subgrades shall be compacted to a depth of not less than eight inches (8”) for a width of not less than ten feet (10') each side of the center line of each track. All pavement subgrades shall be compacted likewise over the area of such pavement and its sub-base. Shoulders for roadway pavements and other areas, if designated to be compacted on the Drawings or in the Technical Specifications, shall be compacted likewise.

The top six inches (6”) of natural ground and cut sections to be compacted within the above limit shall be scarified, wetted or dried to produce optimum moisture content, and compacted to a density of not less than 95 percent of maximum laboratory dry density as determined in accordance with ASTM D-698 (Standard Proctor compaction test). Compaction tests will be performed by the Chief Construction Manager or by a commercial testing laboratory retained and paid for by the Port Authority.

3.7 CONSTRUCTION OF COMPACTED FILLS AND BACKFILLS

The hauling, placing and compaction of excavated material for earth embankments, fills or backfills, shall be performed in accordance with the following requirements.

The Chief Construction Manager shall be the judge of the suitability or unsuitability of excavated materials for use in fills and backfills. Unsuitable materials shall be disposed of as provided in this specification.

In the event that ground water or natural ground conditions warrant, at the discretion of the Chief Construction Manager, the following techniques may be used to “bridge” the existing material. Semi-compacted fill or backfill may be placed from the bottom of the excavation to one foot above the elevation of ground water. Fill or backfill shall be placed in maximum lifts of one foot each (loose measurement) and compacted by crawler tractor or other approved means to obtain the maximum practical density. Bottom of excavation will not require compaction in this event.

All compacted fill or backfill called for under these specifications or as shown on the Drawings shall be placed from one foot above groundwater level, from the bottom of the excavation or from natural
EXCAVATION AND FILL

ground as the case may be, in maximum lifts of 1-foot each (loose measurement). If it is
demonstrated that required density is not being achieved throughout the depth of the compacted lift,
the maximum allowable loose lift may be reduced to 8-inches. Each layer shall extend across an
entire fill or backfill section. Each layer shall be wetted or dried to produce optimum moisture
content, and compacted to a density of:

1. For subgrade and embankment under proposed pavement or structures, not less than ninety-
five percent of maximum laboratory dry density at +/-3 percent of optimum moisture in
accordance with ASTM D-698 (Standard Proctor), including the top layer.

2. For embankment and fill areas outside the limit of proposed pavement compacted to a minimum
density of ninety percent (95%) of maximum density at +/-3 percent of optimum moisture in
accordance with ASTM D 698 (Standard Proctor).

If the material to be compacted contains excessive or insufficient moisture to permit compaction in
accordance with the above requirement, the Contractor shall manipulate the material to reduce
moisture content or add water to increase moisture content to obtain the specified density. The Chief
Construction Manager may test soil for moisture content before compaction, and in the event the soil
has less than optimum moisture, or is likely to lose enough moisture prior to completion of
compaction to bring the moisture content below optimum, the Contractor shall add water and
thoroughly mix the soil layer before compacting.

When necessary to key in the previous layer, the upper surface of each compacted layer of the fill or
backfill and the upper surface of ground compacted in place shall be scarified to a depth of one inch
(1") just prior to the placing of the succeeding layer of embankment thereon, to provide a blending
and interlocking of the adjoining surfaces of the two layers. In areas where the previous compacted
layer has compactor roller teeth indentations one-half inch (1/2") to one inch (1") deep and, in the
opinion of the Chief Construction Manager, has good anchorage for the next layer, no scarification
shall be necessary. The soil shall be placed in layers not greater than eight inches (8") in depth
(compacted depth) after each preceding layer has been prepared as described hereinabove.

After the compaction of each layer of soil is completed, density tests will be made by Chief
Construction Manager. If the material fails to meet the density specified the course shall be
reworked as necessary, at the expense of the Contractor, to obtain the specified density. Subject to
the approval of the Chief Construction Manager, the Contractor may alter his compaction method on
subsequent work to obtain the specified density.

Compacted strips that are to be left temporarily or overnight may be partially sealed by rolling with
pneumatic tire or smooth drum roller to reduce the loss or gain of moisture.

Contractor shall blade-off areas for compaction testing, as requested by the Chief Construction
Manager.

3.8 FINISH GRADING

Compacted subgrades and the top surfaces of fills and backfills in areas to receive pavements or
railroad tracks or in other areas specified shall be sealed with a pneumatic or smooth drum roller
and finished to a smooth surface with a grader blade to the line and grade required.

All grading shall conform to the location, size and elevations shown on the Drawings. Railroad and
pavement subgrades shall be graded to the planned elevations so that the thickness of pavement
base and pavement and track sub-ballast and ballast will not be less than that shown on the
Drawings.

No equipment or hauling shall be permitted on finished subgrades unless approved by the Chief
Construction Manager. Any damage caused to such portions of the subgrade by the operations of
the Contractor shall be repaired by Contractor at the Contractor's expense.

Should the subgrade, for any reason or cause, lose the required stability, density or finish before the pavement base or railroad sub-ballast is placed, it shall be recompacted and refinished at the expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or sealing.

For pavement only, the subgrade shall be thoroughly wetted down sufficiently in advance of the placing of any base course to insure its being in a firm and moist condition for at least two inches (2") below the surface.

Sufficient subgrade shall be prepared in advance to ensure satisfactory prosecution of the work of placing pavement base or railroad sub-ballast.

3.9 BACKFILL BEHIND CURBS

The space behind curbs or roadway pavements, except areas to be paved, shall be backfilled with selected material and compacted with truck traffic or by other suitable means. The first layer of backfill may be of sufficient depth to permit the use of truck traffic for compacting the material. Succeeding layers shall not exceed eight inches (8") in depth, loose measurement.

Backfill shall be placed above the top of the curbs and finished to the roadway cross sections shown on the Drawings or, if not shown, to a rounded surface to provide drainage of the area behind the curbs.

3.10 DITCHES AND SLOPES

Drainage ditches, including the bottom and side slopes thereof, and the side slopes of cut sections and subgrade for railroads in cut sections beyond ten feet (10') from the center line of any track shall be excavated without undercutting and fine graded to the cross sections, lines and elevation shown on the Drawings. Any of these areas undercut below finish grade shall be backfilled with acceptable material and compacted to a dry density equal to or greater than that of the surrounding undisturbed natural ground. No other compaction will be required for these areas except as may be provided by these Technical Specifications.

The side slopes of embankment fills shall be compacted in each layer of compacted fill from base to top of embankment. The width of embankment layers shall be constructed slightly in excess of the planned width to permit the blading of side slopes to remove the loose edge material, to eliminate irregularities in the sloping surfaces, to complete the embankment to the cross section shown on the Drawings and to insure compaction of the entire fill.

3.11 DISPOSAL OF EXCESS MATERIALS

Unless otherwise provided in these Technical Specifications, all unstable excavated materials and all excess unsuitable earthen materials, trash, and debris shall become the property of the Contractor and shall be removed and disposed from Port Authority's premises at the Contractor's expense as per requirements stated in the General Conditions.

3.12 PROTECTION OF EXISTING STRUCTURES

The Contractor will be held responsible for any damage to manholes, inlets, valves, pipes, or other facilities that are caused by him in making the necessary excavation and fills. The Contractor shall repair all such damage at Contractor's expense.
3.14 PROOF ROLLING

The Contractor shall proof roll earthwork, base or subbase using pneumatic tire rollers, dump trucks or other compaction equipment approved by the Chief Construction Manager. Use equipment that when loaded weighs at least 10 tons. The maximum acceptable load is 50 tons. Material that exhibits rutting or pumping shall be undercut and replaced, at Contractor’s expense.

3.15 UTILITIES

The Contractor shall be responsible for identifying and locating utilities in the vicinity of the excavation. Contractor shall be responsible for obtaining permits and/or approvals from utility owners to cross and/or excavate or fill in or around utilities or utility rights-of-way. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor’s risk.

END OF SECTION
PORT OF HOUSTON AUTHORITY

STANDARD TECHNICAL SPECIFICATION

SECTION 31 23 33.00 Add - TRENCHING AND BACKFILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes, inlets, and other pipeline structures as described and specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities
SECTION 03 30 53.00 Std - Miscellaneous Cast-In-Place Concrete
SECTION 31 41 33.00 Std - Trench Safety System
SECTION 33 10 00.00 Std - Water Distribution System
SECTION 33 40 00.00 Std - Storm Drainage Utilities

1.3 REFERENCES

ASTM International Publications, latest editions:
ASTM D-558 Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D-698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³))
ASTM D-1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D-2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D-2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D-3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
1.4 SUBMITTALS

A. Submit a written description for information only of the planned typical method of excavation, backfill placement and compaction, including:

1. Sequence of work and coordination of activities.
2. Selected trench widths.
4. Procedure for use of trench boxes and other pre-manufactured systems while assuring specified compaction against undisturbed soil.
5. Procedure for installation of Special Shoring at locations identified on the Drawings.

B. Submit a ground and surface water control plan in accordance with requirements in this Section and Section 01 57 25.00 - Ground Water and Surface Water Control.

C. Submit select fill material sources and quality information in accordance with requirements of this Section.

D. Submit a trench excavation safety plan, for depths of 4 feet or greater, in accordance with requirements of the Section for Trench Safety System.

E. Where shoring is required due to depth of excavation, submit designs for special shoring design requirements; for locations identified on the Drawings.

Special shoring shall be designed to provide support for the sides of the excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a pre-manufactured system to meet the project site requirements based on the manufacturer’s standard design. All design work performed shall be signed and sealed by an engineer licensed in the State of Texas.

1.6 HANDLING AND STORAGE

All excavated material shall be stockpiled adjacent to the trench for backfilling after pipe is laid. Place material suitable for backfilling in stockpiles at a distance from the trench to prevent slides or cave-ins. Stockpiles shall be maintained in a neat condition and protected from eroding. Use only excavated materials which are suitable as defined in this Section.

1.7 DEFINITIONS

A. Pipe Foundation: Suitable and stable native soils that are exposed at the trench subgrade after excavation to depth of bottom of the bedding as shown on the Drawings, or foundation backfill material placed and compacted in over-excavations.

B. Pipe Bedding: The portion of trench backfill that extends vertically from top of foundation up to a level line at the springline of pipe from one trench sidewall to opposite sidewall.

C. Initial Backfill: The portion of trench backfill that extends vertically from springline of pipe up to a level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
D. Pipe Embedment: The portion of trench backfill that consists of bedding and initial backfill.

E. Trench Zone: The portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.

F. Unsuitable Material: Unsuitable soil materials are the following:
   1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
   2. Materials that cannot be compacted to required density due to either gradation, plasticity, or moisture content.
   3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
   4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

G. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement are considered suitable, unless otherwise indicated.

H. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.

I. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01 57 25.00 - Ground Water and Surface Water Control.

J. Surface Water Control: Diversion and drainage of surface water runoff and rainwater away from trench excavation. Rainwater and surface water accidentally entering trench shall be controlled and removed as a part of excavation drainage.

K. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using a drainage layer, as defined in ASTM D 2321, placed on the foundation beneath pipe bedding or thickened bedding layer of Class I material.

L. Trench Conditions are defined with regard to the stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of bedding material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
   1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as a result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
   2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.

b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in the embedment zone in combination with ground water control in predominately sandy or silty soils.

3. Unstable Trench: Unstable trench conditions exist in the pipe embedment zone if ground water inflow or high-water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

M. Subtrench: Subtrench is a special case of benched excavation. Subtrench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of a subtrench depends upon trench stability and safety per OSHA 29 CFR 1926.

N. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings and backfilled with foundation backfill material.

O. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.

P. Trench Safety Systems include both protective systems and shoring systems as defined in Section for the Trench Safety System.

Q. Trench Shield (Trench Box): A portable worker safety structure moved along the trench as work proceeds, used as a protective system and designed to withstand forces imposed on it by cave-in, thereby protecting persons within the trench. Trench shields may be stacked if so designed or placed in a series depending on depth and length of excavation to be protected.

R. Shoring System: A structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of the ground affecting adjacent installations or improvements.

S. Special Shoring: A shoring system meeting special shoring, SPECIAL SHORING DESIGN REQUIREMENTS, for locations identified on the Drawings.
PART 2 PRODUCTS

2.1 MATERIAL CLASSIFICATIONS

A. Embedment and Trench Zone Backfill Materials: Conform to the following classifications and material descriptions.

1. Random Backfill – Excavated material from the trench stockpiled to be used as backfill that does not require tested compaction, however does require a minimal compaction effort and is free of organic material such as roots and other vegetable matter subject to decay or other material which would affect the stability of the backfill.

2. Compacted Backfill – Excavated or selected material having a soil classification of GW, GP, SW, SP, and CL free of organic material such as roots and other vegetable matter subject to decay or other material which would affect the stability of the backfill with a Plasticity Index greater than 7 and above the A line.

B. Topsoil: Natural friable soil representative of productive, well drained soils in the area, free of subsoil, stumps, brush, weeds, stones larger than 1.5”, toxic substances, and other substances detrimental to plant growth. Amend topsoil pH range to obtain pH of 5.5 to 7.

2.2 TESTING

A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory employed and paid by the Contractor.

B. Density testing of compacted backfill material in trench shall be performed by an independent laboratory employed and paid by the Port Authority.

PART 3 EXECUTION

3.1 EXCAVATION

A. Except as otherwise specified or shown on the Drawings, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on the Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths as shown on contract drawings.

D. Use sufficient trench width or benches above the embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from the surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.

E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify the Construction Manager and obtain instructions before proceeding.
F. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

G. Trench Shields. When a trench shield (trench box) is used as a worker safety device, the following requirements apply:

1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to the trench sidewalls.

2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged or disturbed, and the degree of compaction is not reduced.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath the shield. For backfill above bedding, lift the shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.

4. Maintain trench shield in position to allow sampling and testing to be performed in a safe manner.

H. Shoring of Trench Walls:

1. Where indicated, install Special Shoring in advance of trench excavation or simultaneously with the trench excavation, so that the soils within the full height of the trench excavation walls will remain laterally supported at all times.

2. For all types of shoring, support trench walls in the pipe embedment zone throughout the installation. Provide trench wall supports sufficiently tight to prevent washing the trench wall soil out from behind the trench wall support.

3. Unless otherwise directed, leave sheeting driven into or below the pipe embedment zone in place to preclude loss of support of foundation and embedment materials. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and the trench wall in the vicinity of the pipe zone.

4. Employ special methods for maintaining the integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.

5. If sheeting or other shoring is used below top of the pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into the embedment zone shall be the equivalent of a 1-inch-thick steel plate. Fill voids left on removal of supports with compacted backfill material.

3.2 GROUND WATER CONTROL

Implement ground water control where required according to the Section for Ground Water and Surface Water Control. Provide a stable trench to allow installation in accordance with these Sections.
3.3 PIPE BEDDING, PLACEMENT AND COMPACTION

A. Immediately prior to placement of bedding materials, the bottoms and sidewalls of trenches shall be free of loose, sloughing, caving, or otherwise unsuitable soil.

B. Place bedding and initial backfill as shown on Drawings.

C. For pipe installation, manually spread bedding materials around the pipe to provide uniform bearing and side support when compacted. Do not allow materials to free-fall from heights greater than 24 inches above top of pipe. Perform placement and compaction directly against the undisturbed soils in the trench sidewalls, or against sheeting which is to remain in place.

D. Do not place trench shields or shoring within height of the embedment zone unless means to maintain the density of compacted bedding material are used. If moveable supports are used in embedment zone, lift the supports incrementally to allow placement and compaction of the material against undisturbed soil.

E. Place geotextile, where indicated on drawings, to prevent particle migration from the in-situ soil into open-graded bedding materials or drainage layers.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place bedding material manually around the pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside the pipe with sandbags or other suitable means.

H. Place electrical conduit, if used, directly on foundation without bedding.

I. Shovel into place and compact bedding material around pipe, using pneumatic tampers in restricted areas, and vibratory-plate compactors, or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

J. For water line embedment, use bank run sand, gem sand, or pea gravel, and adhere to the following:

Sand and Gravel Embedment Materials:
1. Maximum 6-inch compacted lift thickness.
2. Compact to achieve a minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
3. Moisture content to be within -3 percent to +3 percent of optimum as determined according to ASTM D 698, unless otherwise approved.
K. For utility installation other than water, adhere to the following:

1. Sand Bedding Materials:
   a. Maximum 6-inch compacted lift thickness.
   b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed the pipe to meet the deflection test criteria.
   c. Moisture content as determined by Contractor for effective compaction without softening the soil of trench bottom, foundation or trench walls.

2. Clayey Sand, Sandy Clay and Lean Clay Embedment and Cement-Stabilized Sand:
   a. Maximum 6-inch compacted lift thickness.
   b. Compaction by methods determined by Contractor to achieve a minimum of 95 percent of the maximum dry density as determined according to ASTM D 698 for sand/clay materials and according to ASTM D 558 for cement stabilized sand.
   c. Moisture content of backfill materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on the dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

3.4 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction.

B. Where damage to completed pipe installation work is likely to result from withdrawal of shoring, leave the shoring in place. Cut off shoring 1.5 feet or more above the crown of the pipe. Remove trench supports within 5 feet from the ground surface.

C. For sewer pipes, use backfill materials described here as determined by trench limits. As trench zone backfill in paved areas for roads and to one foot back of curbs and pavements, use cement stabilized sand for pipe of nominal sizes less than 36 inches. Uniformly backfill trenches partially within limits one foot from streets and curbs according to the paved area criteria. Use select backfill within one foot below pavement subgrade for rigid pavement. For asphalt concrete, use flexible base material within one foot below pavement subgrade.

D. For water lines, backfill in trench zone with bank run sand or select fill.

E. For sanitary sewers and storm drainpipe, a random backfill of suitable material may be used in trench zone for trench excavations outside pavements.

F. Place trench zone backfill in lifts and compact by methods selected by the Contractor. Fully compact each lift before placement of the next lift.
1. Bank Run Sand:
   a. Maximum 9-inch compacted lift thickness.
   b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
   c. Moisture content within 3 percent of optimum determined according to ASTM D 698.

2. Select Fill:
   a. Maximum 6-inch compacted lift thickness.
   b. Compaction by equipment providing tamping or kneading impact to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
   c. Moisture content within +3% percent of optimum determined according to ASTM D 698.

G. For trench excavations outside pavements, a random backfill of suitable material may be used in the trench zone.

1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor’s option. If the required density is not achieved, the Contractor, at his option and at no additional cost to the Port of Houston Authority may use lime stabilization to achieve compaction requirements or use a different suitable material.


3. Compact to a minimum of 90 percent of the maximum dry density determined according to ASTM D 698.

4. Moisture content as necessary to achieve density.

H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.5 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

Meet the requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Drawings. Unless otherwise shown on drawings, the use of heavy compacting equipment within 10' of structures is not allowed. Use hand compaction for those areas.

3.6 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in this Section.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to Port of Houston Authority.
C. Tests will be performed on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with ASTM 2487. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement-stabilized sand in accordance with ASTM D 558. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.

E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 6938 and ASTM D 3017, and at the following frequencies and conditions.

1. Density tests will be distributed among the placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.

2. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.

3. Density tests may be performed at various depths below the fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.

4. Recompacted placement will be retested at the same frequency as the first test series, including verification tests.

F. Recondition, recompact, and retest at Contractor’s expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor’s expense.

G. Acceptability of crushed rock compaction will be determined by inspection.

3.7 DISPOSAL OF EXCESS MATERIAL

A. All excess materials shall be disposed of by the Contractor.

B. Dispose of excess materials in accordance with requirements of the General Conditions.

END OF SECTION
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Bulkhead

SECTION 31 62 16.16 Add – STEEL H PILES

PART 1   GENERAL

1.1   SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes; the furnishing of all labor, materials, equipment, supervision, and every other thing necessary to furnish and drive steel H piles as described and specified herein and as shown on the Drawings.

1.2   RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities

SECTION 35 31 16.20 Add – Steel Sheet Pile Bulkhead

1.3   REFERENCES

A.   ASTM International Publications, Latest Editions:

ASTM A-36    Standard Specification for Carbon Structural Steel

ASTM A-572  Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

B.   American Welding Society (AWS) Publications, Latest Editions:

AWS D1.1 Structural Welding Code - Steel

1.4   SUBMITTALS

A.   Submit description of proposed pile vibrating and pile driving equipment at least three weeks prior to mobilizing pile driving equipment to the site. Include the following information.

1. Make and model of pile driving hammer including capacity and rated energy.

2. Hammer details including weight of cap block assembly, cushion dimensions, type of cushion material, and cushion stiffness.

3. Wave equation analyses of hammer, cap block, cushion, and sheet pile and H-pile.

4. History of proposed pile driving equipment installing similar sized piles in similar soils.

B.   Pile Installation Procedures

C.   Material Certificates:

Submit for each shipment of piling certificates identified with specific lots prior to installing piling. Include identification data about piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.
D. Submit noise reduction and emission monitoring program.

E. Mill Certifications

1.5 HANDLING AND STORAGE

Load and unload materials by use of hoists, skids, or other suitable means, to avoid damage and store in designated areas.

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 10 feet or less along its length (ends inclusive) to prevent exceeding the maximum camber or sweep. Do not stack piles more than 5 feet high.

Lift piles using a cradle or multiple points pick-up to ensure that the maximum permissible camber or sweep is not exceeded due to insufficient support, except that a one-point pick-up may be used for lifting piles that are not extremely long into the driving leads. Point pick-up devices must be of the type that clamp to both pile flanges at each pick-up point. Holes may be burned in the flanges or webs of piles above the cutoff length for lifting piles into the leads. Do not drag piles across the ground.

Inspect piles for excessive camber and sweep and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Camber, curvature in the pile in the direction normal to the pile flanges, must be measured with the pile flange base laying on a flat surface and is the distance between the flange base at the mid-length of the pile and the flat surface. Sweep, curvature in the pile in the direction parallel to the pile flanges, must be measured with the pile flange tips laying on a flat surface and is the distance between the flange tips at the mid-length of the pile and the flat surface. The maximum permissible camber and sweep is 2 inches over the length of the pile. Piles having excessive camber or sweep will be rejected.

PART 2 PRODUCTS

2.1 MATERIALS

Steel bearing piles and attachments thereto shall be furnished in conformity with the requirements of Standard Specification for Carbon Structural Steel, ASTM A-572, Grade 50. All splice weld shall be complete joint penetration butt welds and shall be 100% inspected per AWS D1.1.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Unless otherwise provided in the Drawings or these Technical Specifications, piles shall not be driven until all excavation or embankment has been completed to grade and compacted as provided in the governing specifications. Foundation piling under footings shall not be driven until the excavation has been completed to within six inches of finish grade of the bottom of the footing.

A sufficient number of skids shall be used to prevent deflection in the stored piling and prevent contact with the ground. The methods of handling shall prevent damage to the piling and when stored, Piles shall be kept clean and fully drained at all times.
3.2 PROTECTION OF TOPS OF PILE

A structural steel driving head suitable for the type and size of pile being driven shall be used. Cap block cushioning shall be used between ram and anvil when necessary to prevent damage to the pile. Cushioning material shall consist of layers of southern pine or fir plywood, oak, burl, rope mats, micarta plastic, or other material that may be approved by the Chief Construction Manager.

Careful attention shall be given to the condition of the cushion material which shall be changed as frequently as necessary to prevent damage to the pile.

3.3 PRELIMINARY WORK

A. Wave Equation Analysis of Pile Drivability
   1. Prior to driving any pile, the contractor shall submit a pile Wave Equation Analysis, performed by the Contractors’ Engineer. This analysis shall take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths, and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

   2. The Wave Equation Analysis shall demonstrate that the piles will not be damaged during driving, shall indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities, stated within the contract drawings.

      Allowable Driving Stresses

      Steel

      Compression: 0.9 f_y
      Tension: 0.9 f_y
      Where f_y is yield strength of steel.

3.4 DRIVING EQUIPMENT

Driving shall be done with vibratory, diesel power, or compressed air for operating hammers. When specified on the Drawings, gravity hammers may be used. The hammer shall be capable of delivering not less than two and one-half foot-pounds of energy per each blow for each pound of weight of the pile as determined from plan length.

The valve mechanism and other parts of all power hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained.

Power hammers shall be provided with an air compressor capacity at least equal to that specified by the manufacturer of the hammer to be used. The compressor shall be equipped with an accurate pressure gauge. The ram shall weigh at least 3,000 pounds and shall have a ram stroke of not over four feet.

The diesel hammers shall have a minimum weight of 2,000 pounds and shall have a maximum ram stroke of eight feet. Diesel hammers which have an enclosed ram shall be equipped with a gauge and charts which will evaluate the equivalent energy actually being produced under any driving condition.
Gravity hammers, when permitted, shall weigh at least 2,000 pounds, but not more than 5,000 pounds. The height of drop shall be regulated so as not to damage the pile but shall not exceed ten feet. The Contractor shall furnish the Chief Construction Manager with a certified public scale weight of the hammer.

Pile drivers shall be equipped with leads which are constructed in such a manner as to permit freedom of movement of the hammer and which will hold the pile in correct alignment during driving. The vertical axis of the leads and hammer shall coincide with the axis of the pile. Free-swinging leads will not be permitted, and arrangement shall be made to hold the pile in correct alignment by braces or templates while it is being driven. Leads must extend to the lowest point to which the top of the pile is to be driven.

When piles are driven through water, the bottom of the leads shall be braced to the working platform. When the pile driving is mounted on a floating barge, the barge shall be equipped with spuds of sufficient length to hold the barge in position during the driving operation.

3.5 TOLERANCES FOR DRIVING

Foundation piles shall be driven to the vertical or batter lines indicated and the top of completed piles shall not be more than four inches in any direction from the position shown on the Drawings. Manipulation of piles will not be permitted. A variation of not more than 0.25 inch per foot of pile length from the vertical for vertical piles or from the required angle for batter piles will be permitted. In addition to complying with the tolerances stated herein, the clear distance between the heads of piles and the edges of caps must be not less than 6 inches. With prior approval of Port Authority, the Contractor may provide additional concrete and reinforcement to maintain the required minimum clear distance. Redesign of pile caps or additional work required due to improper location of piles is the responsibility of the Contractor. A final variation in rotation of the pile about the center line of the web of not more than 7.5 degrees is permitted. A vertical deviation of not more than 2 inches from the correct cutoff elevations shown is permitted. Inspect piles for heave. Redrive heaved piles to the required tip elevation. Maintain the correct relative position of all piles by the use of templates or by other approved means. Piles damaged or not located properly or exceeding the maximum limits for rotation, lateral and vertical deviation, and variation in alignment must be pulled and new piles redriven, or provide additional piles, at a location directed at the Contractor's expense.

The minimum concrete cover for piling shall be as shown on the Drawings, and all piles shall be in position to permit proper placement and cover of reinforcing steel. If necessary, to meet these requirements, the Chief Construction Manager may revise the dimensions of the concrete member and all costs resulting therefrom shall be at the Contractor's expense.

Braced templates shall be provided to insure correct alignment of piles. Where necessary, pilot holes may be drilled to a depth of not over five feet to facilitate maintaining of alignment.

3.6 PILE PENETRATION CRITERIA

The tip elevation for job/production piles will be verified based on the dynamic testing of selected piles during installation for the project. Pile acceptance should be determined by the Geotechnical Engineer's representative based primarily on tip elevation as shown on the drawings and the pile penetration data from dynamic testing. The available geotechnical data for the project shall also be referenced for acceptance of the pile penetration acceptance. After piles have achieved tip elevation the secondary requirement is that the minimum axial resistance shown on drawings shall be achieved as estimated blow count and hammer performance.
3.7  JETTING

Jetting of piles is not permitted.

3.8  CUT-OFFS, SPLICES AND BUILD-UPS

All splices for steel piling shall be made in accordance with the Steel Bearing Piling Splice Detail shown below. If the required penetration has not been secured, the spliced piling may be driven the additional depth required as soon as the splice has been completed.

The Contractor may at its expense, fabricate piling by welding together not more than three sections of the project piling, provided the distance between welds is not less than five feet. All welding of splices and build-ups shall comply with Standard Technical Specification section for Structural Steel Framing.

After the piling has been driven to the penetration shown on the Drawing, the piling shall be cut off level using a cutting torch, or by other suitable methods, to the Drawing grade or the grade established by the Chief Construction Manager. Where pile heads are required by the Drawings, the end surfaces of the piling shall be made as smooth as practicable before the pile heads are welded in place. The pile heads shall conform to the Drawing details.

If the top of the piling is appreciably distorted or otherwise damaged below cut off level, the damaged portion shall be cut off and replaced with an undamaged section spliced in place at the Contractor’s expense.

Welding shall be done in compliance with the requirements of the American Welding Society Structural Welding Code, Designation D1.1.

3.9  ATTACHMENTS

Cap plates, brackets, stiffeners, beam connections, and other attachments to the piling shall be fabricated and installed in accordance with details shown on the Drawings and the Standard Technical Specification Section for Structural Steel Fabrication and Erection.

3.10  COATING

Coating for steel bearing pile shall be as required by the Standard Technical Specifications.
PORT OF HOUSTON AUTHORITY

TECHNICAL SPECIFICATIONS

HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT

Segment 3 – Barbours Cut Channel, Morgan’s Bulkhead

SECTION 35 31 16.20 Add - STEEL SHEET PILE BULKHEAD

PART 1 GENERAL

1.1 SECTION INCLUDES

Subject to the requirements of the General and Special Conditions, this Section includes:

A. Furnishing all material necessary to complete the bulkhead and anchorages as shown on the Drawings, except material to be furnished by the Port Authority as specifically provided in these Technical Specifications.

B. Receiving and hauling to the site materials furnished by the Port Authority.

C. Furnishing all labor, equipment, supervision, and any other thing necessary to complete the bulkhead and its anchorage system, including coating of sheet piles, wales, steel caps, and steel batter piles, and wrapping tie rods.

1.2 RELATED SECTIONS

SECTION 01 22 10.00 Std – Measurement of Quantities
SECTION 03 31 00.00 Add – Structural Concrete
SECTION 03 21 00.00 Std – Reinforcing Steel
SECTION 31 62 16.16 Add – Steel H Piles

1.3 REFERENCES

A. ASTM International Publications, latest editions:

ASTM A-6 Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A-36 Standard Specifications for Structural Steel
ASTM A-108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A-307 Standard Specifications for Carbon Steel, Bolts and Studs
ASTM A-328 Standard Specification for Steel Sheet Piling
ASTM A-325 Standard Specifications for Structural Bolts
ASTM A-328 Standard Specifications for Steel Sheet Piling
ASTM A-490 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

ASTM A-572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A-668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use

ASTM A-690 Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments

ASTM A992 Standard Specification for Structural Steel Shapes

B. AASHTO Publications, latest edition:

AASHTO M-36 Standard Specifications for Corrugated Metal Culvert Pipe

AASHTO M-190 Standard Specifications for Bituminous Coasted Riveted Corrugated Metal Culvert Pipe and Pipe Arches

C. SP 10 Steel Structures Painting Council ‘Near-White” Blast Cleaning

D. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings

E. American Welding Society, latest edition:

Structural Welding Code – Steel; Serial Designation AWS D1.1

F. American Concrete Institute

Standard 318 – Building code requirements for structural concrete

1.4 SUBMITTALS

A. Submit description of proposed pile-driving equipment at least two weeks prior to driving piling. Data shall include:

1. Make and model of pile driving hammer, including capacity and rated energy.

2. Weight of cap block assembly, cushion dimensions, type of cushion material, and cushion stiffness.

3. History of proposed pile driving equipment installing similar sized piles in similar soils.

4. Submit a Wave Equation Analysis of pile drivability (WEAP) for selection of the hammer along with a statement of driving procedures. The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each pile type and for each location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:
a. Complete Pile and Driving Equipment data, for each proposed pile hammer and pile type combination.

b. Copies of WEAP computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis shall be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. The Wave Equation Analysis shall demonstrate that the piles will not be damaged during driving, shall indicate that the driving stresses will be maintained at less than 0.9 times fy (yield strength of steel), in both tension and compression.

d. The services of an independent, Registered Professional Geotechnical Engineer, licensed in the State of Texas, and experienced in soil mechanics and Pile Foundation analysis, shall be hired by the Contractor to perform the work stated above. The Geotechnical Consultant shall be independent of the Contractor and shall have no employee of employer relationship which could constitute a conflict of interest.

B. Submit detailed fabrication and erection drawings for steel sheet piles, king/pipe piles, fabricated wales, tie rods, turnbuckles, heavy plate washers and accessories prior to installation. Drawings shall include:

1. Detailed bulkhead wall layout drawings, indicating each standard steel sheet pile, each king/pipe pile, each special fabricated section, each corner section, and showing quantity and length of each type; including tie rods, anchor walls, fabricated wales, etc.

2. Details of special fabricated sections, including complete dimensions and minimum section properties.

3. Details of wales, wale splices, fixing bolts and heavy plate washers.

4. Details of tie rods, including wrapping/coating system, couplers, sleeve nuts, double nuts and heavy plate washers at each end.

5. Details and dimensions of templates and other temporary guide structures for installing the steel sheet pile bulkhead system.

C. Submit manufacturer's product data and material certification that steel sheet piles, connectors, tie rods, tie rod wrapping/coating system, couplers, sleeve nuts and hardware meet the specified requirements.

D. Submit certification that surface preparation and protective coating have been applied in conformance with specifications and/or manufacturers requirements.

E. During pile driving, submit records to the Chief Construction Manager each day, including the following for king/pipe piles, and steel sheet pile:

1. Name of steel sheet pile pair number.

2. Driven pile length.

3. Pile length after cut off (if required).
4. Top of pile elevation.

The Chief Construction Manager is the Port Construction Representative of the Port of Houston, as defined in DIVISION 00 - Procurement and Contracting: Special Conditions of the Project Specifications.

F. Statements

1. Pile pulling method.

2. Material certificates:
   a. Submit for each shipment of piling; certificates identified with specific lots prior to installing piling. Identification data should include piling type, dimensions, chemical composition, mechanical properties, section properties, heat number and mill identification mark.
   
   b. Submit certificates and statements of conformance and acceptability for turnbuckles and ultrasonic test results.
   
   c. Submit mill certificates, with chemical composition and mechanical properties, and product cut-sheet data on headed anchor stud connectors.

3. Pile driving equipment: Submit descriptions of pile driving equipment to be employed in the Work to the Chief Construction Manager for approval. Descriptive information should include manufacturer’s name, model numbers, capacity, rated energy, hammer details, cushion material, helmet and templates.

G. Records: Submit Pile Driving/ Installation Records:

   a. Maintain a pile driving record for steel sheet piles
   
   b. Indicate on the installation record installation date and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per foot of each foot of penetration, final driving resistance in blows for final 6 inches, pile locations, tip elevations, ground elevations, and any reheading or cutting of piles.
   
   c. Record any unusual pile driving problems during driving.

H. Submit noise reduction and emission monitoring program.

1.5 HANDLING AND STORAGE

A. Deliver steel sheet piles in pairs, achieved by crimping of the interlocks.

B. Handle piling using handling holes or lifting devices. Handle long length piles with multiple lifting points and care to prevent damage. Handling of epoxy coated piles shall be by sling.

C. Support piling off the ground on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Supports between multiple lifts shall be aligned in a vertical plane.
D. Protect piling to prevent damage to coatings and to prevent corrosion prior to installation.
E. Pile shall not have a camber or sweep in excess of the permitted mill tolerance and ASTM A-6.

PART 2 PRODUCTS

2.1 STEEL SHEET PILES
A. Steel sheet piles shall be manufactured of hot-rolled steel conforming to the following:
   1. Pipe Piles and Connectors: ASTM A-690 or A-572, Grade 50, minimum yield strength 50,000 psi, may be applied in pairs.
   2. Steel Sheet Piles: ASTM A-690 or A-572, Grade 50, minimum yield strength 50,000 psi.
B. The connectors shall be continuously welded to the pipe full length on both sides, as shown on the drawings in accordance with AWS D1.1, latest edition. Interlocks of sheet piling shall be free sliding, allowing a swing angle of at least 5 degrees when threaded and maintain continuous interlocking when installed.
C. Sheet piling, including corner sections, and special fabricated sections, shall be full-length sections to the dimensions shown, or required to complete the bulkhead to the overall dimensions indicated.
D. Fabricated sections shall conform to the requirements herein and the piling manufacturer's recommendations for fabricated sections. Fabricated corners, tees and cross pieces shall be fabricated of piling sections with a minimum thickness of ½-inch.
E. Provide piling with standard pulling holes.
F. Provide elevation reference and mark each pile to permit determination of the pile tip and top elevation.

2.2 STEEL BATTER PILES
Steel batter piles shall be in accordance with the requirements set out in the Section for Steel H Piles.

2.3 TIE RODS
A. Conform to ASTM A-615, Grade 75, with 75 ksi yield strength.
B. High strength bars with rolled threads, complete with compatible, high-strength heavy hex nuts, splicing couplers.
C. Welded tie rod splices will not be permitted.
D. Protection system shall be DensylTape wrapping system or equal and approved by Owner. The wrapping system shall be applied according to manufacturer’s requirements. Tie rods shall be further protected and supplied with protective smooth-walled HDPE pipe sleeve, as indicated on the drawings.
2.4 COUPLERS
A. Conform to ASTM A-668, heat treated and ultrasonic tested, hot dipped galvanized.
B. Manufactured to carry 133 percent of tie rod tensile capacity.
C. Couplers shall be manufactured by the all-thread bar tie rod manufacturer.
D. Provide Couplers, as required, to splice tie rods and take-up excess slack in tie rods.

2.5 BOLTS AND NUTS
A. Bolts shall conform to ASTM A-325X, hot-dipped galvanized.
B. Nuts shall conform to ASTM A-563, heavy hex head, hot-dipped galvanized.
C. Washers shall conform to ASTM F-436, plain carbon steel, hardened, hot-dipped galvanized.

2.6 SHOP PROTECTIVE COATING
A. Apply to all tie rods, couplers, and accessories. Tie rods and couplers shall be wrapped with DensylTape or equal and approved by Owner. Tie rods shall be supplied with protective smooth-walled HDPE pipe sleeve, as indicated on the drawings.
B. Bulkhead sheet pile, king/pipe pile, and other structural steel not otherwise specified, shall be protectively coated as specified in the Section for Epoxy Coatings to the limits noted on the Drawings.

2.7 CONCRETE CAP AND ENCASEMENT
A. Concrete, Forms and Reinforcement: As specified in Sections for Structural Concrete and Reinforcing steel.
B. Surface preparation: Remove all rust and mill scale, earth and other deleterious materials from the pile surfaces, which reduce or destroy bond with concrete.

PART 3 EXECUTION
3.1 COATING OF STEEL SHEET PILING AND OTHER STEEL MEMBERS
A. General: Material coating shall be protected during handling, transportation, and final installation.
B. Touch-Up:
After the sheet piling is erected into position in the bulkhead wall, and before it is driven to its final position, the Contractor shall touch-up all holidays, scratches, abrasions, etc. with the same materials and methods used on the original coating as required by the Inspector. Should any of such touch-up points fall below the ground or water line in final position, that pile shall remain undriven for at least 24 hours after being touched-up.
After excavation of earth from against any coated surface, all scratches or abrasions caused by driving, excavating, or other causes that are disclosed, shall be touched-up.
After welding of wales, brackets, caps, or other attachments, all damaged areas of coating that are accessible shall be cleaned and recoated.

3.2 EARTHWORK

Perform in accordance with applicable Division 31 sections. Backfill bulkhead retaining wall system as indicated, with select structural backfill material.

3.3 CUT-OFFS, SPLICES AND BUILD-UPS

All splices for steel piling shall be made with continuous butt welds to develop the full strength of the member. All the butt welds shall be complete penetration, pre-qualified welds. Provide 100% radiographic or ultrasonic examination of the welds in accordance with AWS D1.1/D1.1M. The welding shall be performed in accordance with the requirements of AWS D1.1.

After the piling has been driven to the penetration required by the Drawings, the surplus length of piling, if any, shall be cut, to the Drawing grade or the grade established by the Chief Construction Manager. If the head of the piling is appreciably distorted or otherwise damaged below cutoff level, the damaged portion shall be cut off and built up to correct elevation with an undamaged section at the Contractor's expense. All cutoffs, regardless of reason for cutoff, shall be delivered to the Chief Construction Manager at the end of each day's work. When piling is furnished by the Port Authority, an allowance of one foot of extra length will be made for damage to the top.

Where pile heads are required by the Drawings, the end surfaces of the piling shall be made as smooth as practical before the pile head is welded in place. The pile head shall conform to the Drawing details.

Welding shall comply with the requirements of the American Welding Society Structural Welding Code, Serial Designation D1.1.

3.4 TOLERANCES

Piling shall be driven at the locations and to the depths shown on the Drawings. The piles shall be driven vertically and in correct alignment so that the top of straight walls will not deviate from a straight line more than one and one-half inch in either direction after driving. In circular cofferdams, the tops of piles shall form a circle in which any diameter will not deviate from the specified diameter by more than one inch. The driven pile shall not deviate more than one-sixteenth inch per foot from the vertical.

All sheet piling shall be driven to within one inch of the elevation of top of pile as shown on the Drawings, or, if a cutoff is necessary, the pile may be cut off to grade with an acetylene torch within a tolerance of plus or minus 1/2-inch. In the event a pile is overdriven, a piece shall be spliced on to building the pile to the elevation called for on the Drawings. No increase in contract price will be allowed by reason of such cutting, splicing or overdriving.

The Contractor shall remove and replace any pile that deviated from its correct position as shown on the Drawings. If permitted tolerances result in closures or intersections that vary in dimension from those shown on the Drawings, the Contractor shall alter or provide the closure section as directed by the Chief Construction Manager at no cost to the Port Authority.
Piling must be driven so that the interlocks will be completely engaged. Any pile ruptured at the interlock or injured in any other way, shall be removed, the hole filled with sand, and other pile driven. Such work is to be done at the Contractor’s expense.

3.5 PROTECTION OF PILE HEADS

A structural steel driving head suitable for the type and size of pile being driven shall be used. Wood cushion blocks shall be used as necessary to prevent damage to the pile. Rope mat, belting, or other similar cushioning material may be used in addition to wood cushion blocks.

3.6 DRIVING EQUIPMENT

Pile Hammer: Use a hammer having a delivered force of energy suitable for the total weight of the pile and the character of the sub surface materials to be encountered. Operate hammer at the rates recommended by the manufacturer throughout the entire driving period. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

Gravity hammers, if permitted, shall weigh not less than 2,000 or more than 5,000 pounds and shall have a maximum height drop of 10 feet pile drivers shall be equipped with leads which are constructed in such a manner as to afford freedom of movement of the hammer and which provide adequate support to the pile during driving. The vertical axis of the leads and hammer shall coincide with the vertical axis of the pile. Free swinging leads will not be permitted, and arrangements shall be made to hold the pile firmly in the correct position by braces or templates while it is being driven. Leads must extend down to the lowest point the hammer must reach. When driving through water, the bottom of the leads must be braced to the working platform. When the pile driver is mounted on a barge, the barge shall be equipped with spuds of sufficient length to hold the barge in position during the driving operation.

3.7 PENETRATION

All piles shall be driven to the penetration shown on the Drawings. Allowance for loss of pile length due to damage of the top shall be made in ordering pile lengths.

When the pile cannot be driven to the required penetration without excessive damage, or within the aforesaid tolerances, the Chief Construction Manager shall require the Contractor to use jetting, or pilot holes, depending upon the character of the materials through which the pile is to be advanced.

3.8 JETTING

Jetting is not permitted.

3.9 PILOT HOLES

When the material to be penetrated is unsuitable for jetting, the Chief Construction Manager may permit, or direct, the use of pilot holes drilled to a depth not lower than five feet above the bottom elevation of the piles. Pilot holes may not be used without the written permission from the Chief Construction Manager, and their use shall not be grounds for any increase or decrease in the Contract price. Pilot holes shall be centered on the diagonal web of the pile and shall be at least one inch less in diameter than the depth of the sheet pile. Pilot holes shall be filled with graded gravel passing a 3/4-inch sieve after the piles are in place.
3.10 PILE DRIVING METHODS AND PROCEDURES

A. The Contractor shall be responsible for the selection of methods and procedures for driving piles and for the design of templates and bracing that will advance the piles within the tolerance required by these Specifications. The methods and procedures shall be consistent with the requirements set out in these Specifications. All piles shall be kept under close observation during driving in order that drift or other tendency toward misalignment may be detected and corrections made before misalignment become serious. When misalignments occur, the Chief Construction Manager may order the Contractor to modify his methods and rigging.

B. Pile Driving:

1. Making piling vertical during driving. Drive piles in such a manner as to prevent damage to the piles and to provide a continuous closure. Where possible, drive sheet piles with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into the socket and ease driving for the next.

2. Incrementally sequence driving of individual piles such that the tip of any king/pipe pile and steel sheet pile combination shall not be more than 4 feet below that of any adjacent pipe/king pile and sheet steel pile combination, nor ¼ of its length between adjacent sheet piles. When the penetration resistance exceeds five blows per inch, the tip of any pile combination shall not be more than 2 feet below that of any adjacent pile combination.

C. Templates and guides shall be used while driving all steel sheet piling. The design, arrangement, and anchoring of templates and guides shall be adequate to ensure that the piling will be driven to the proper location, and, as otherwise required by these Specifications.

Templates:

1. Prior to driving, provide template or driving frame suitable for aligning, supporting, and maintaining bulkhead wall piling in the correct position during setting and driving. The piles shall be erected between two well-braced sets of templates (two-tier system), one at/near ground level and the other at or above mid-height of the piling. The templates shall be rigid and shall support and guide both the interior and exterior of the piling. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the piling until design tip elevation is achieved.

2. Templates shall not move when supporting piling. Fit templates with wood blocking to hold the piling at the design location alignment. Provide outer template straps or other restraints as necessary to prevent piling from warping or wandering from the alignment.

3. Mark template for the location of the leading edge of each piling.

D. The distance between the guide wales shall not exceed the depth of the pile plus one inch. When driving is difficult, the Chief Construction Manager may require blocking between the trough of the pile and the guide wale. The piles shall be erected in a true vertical position and shall be so maintained throughout the driving operation.
E. When the sheet piling to be driven under this Contract form an extension of an existing wall or bulkhead, driving shall start at the last existing pile and shall proceed in one direction to the far end of the wall being constructed. In constructing a new wall that does not connect with an existing bulkhead, driving may start at either end and proceed in one direction toward the other end, or, may start at an intermediate point and proceed toward each end. In no case shall the driving of two portions of a bulkhead be advanced toward a common meeting point.

F. Before driving, the correct location of each pile shall be marked on the bottom template so that drift may be detected as soon as it begins. Piles shall be prevented from drifting or “walking”, by pulling on the pile as it is driven, by directing the hammer blows so as to correct drift, or by other effective means. If necessary, "anchor" piles may be driven at suitable intervals and advanced ahead of intervening piles to assist in holding alignment and to prevent drift.

G. Changes in direction, except in circular cofferdams, shall be made with fabricated corners in accordance with details on the Drawings. Expansion joints shall be constructed where shown in the Drawings and in accordance with the accompanying details.

3.11 INSPECTION

A. Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Chief Construction Manager.

B. Inspection of Driven Piling:

1. Contractor shall inspect the interlocks of the portion of driven piles that extend above ground. Remove and replace piles found to be out of interlock.

2. Contractor may be required to use divers to inspect the underwater portions of sheet piling interlocks should the question of piles out of interlock below water level be raised.

C. Pulling and Redriving:

1. Contractor may be required to pull selected piles after driving to determine the condition of the underground portions of pile.

2. Contractor may be required to pull and redrive piles that do not meet specified tolerances.

3. The pile pulling method must be approved by the Chief Construction Manager.

4. Remove and replace at the Contractor's expense any pile pulled and found to be damaged to the extent that its usefulness in the structure is impaired.

5. Redrive piles pulled and found to be in satisfactory condition.

3.12 STRUCTURAL STEEL FABRICATION AND INSTALLATION

A. Description:
1. The Contractor shall furnish, fabricate and install, all structural steel wales, caps, brackets, or other attachments shown on the Drawings.

2. The Contractor shall furnish, fabricate and install all fittings, corners and connections to the sheet piling necessary to construct the bulkhead in the location and to the alignment shown on the Drawings.

3. The Port Authority will limit the period of effectiveness of qualifications for welders, welding operators, and tackers as set out below.

   a. Certificate of Qualification submitted for a welder, welding operator, or tacker in a fabricating shop, or manufacturing plant, will be accepted provided that he has been tested by an approved testing laboratory within the preceding twelve months, and that it is shown to the satisfaction of the Chief Construction Manager that the operator has been doing satisfactory welding of the required type within the preceding three months.

   b. Certificates of qualification for a welder, welding operator, or tacker in the field, will be accepted provided that he has been tested by an approved laboratory within the preceding six months and that the operator has been doing satisfactory welding of the required type within the preceding three months.

   c. If the quality of the work of any operator is substandard, he may be required to retake qualification tests.

B. Formation of Holes:

   Except as set out hereafter, holes for bolts, rivets, and pins shall be punches, drilled, or sub-punched and drilled as called for on the Drawings, and in accordance with Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings of the American Institute of Steel Construction; however, field holes may be made by gas burning the hole undersize all around and reaming to the proper size.

C. Steel Wales:

   Steel wales shall be installed, using shims where necessary so that the wale members contact the bearing face of each pile in at least two places. Weld, or bolt wale to piling as shown on the Drawings.

D. Holes for Anchor Rods:

   When anchor rods are to be inserted through bored holes, the diameter of the holes through the bulkhead and anchor wall shall be only large enough to insert the boring tool. In all other cases, the hole diameters shall be more than 1/4" larger than the anchor rod diameter. The excess opening around rods through the bulkhead shall be made water tight to prevent the loss of the backfill.

E. Coated Members:

   Whenever burning, drilling, welding or other operations cause damage to coating, such damage shall be repaired by recoating in accordance with the requirements set out above for coating. Where such damage is to the back side of the piling and would require excavation of more than three feet of earth solely in order to make the damaged area accessible, such inaccessible areas need not be repaired unless otherwise ordered by the Chief Construction Manager, in which case the cost of such excavation will be borne by the Port Authority.
3.13 ANCHORAGE STRUCTURES

A. The Contractor shall construct all anchorage structures as they are shown on the Drawings.

B. All concrete anchor walls, caps, walers, and waler encasement, shall be constructed in accordance with the section for Structural Concrete.

C. All drilled concrete shafts and reamed footings used for anchors shall be constructed in accordance with the section for Uncased Drilled Concrete Piers.

D. All reinforcing steel except pre-stressed tendons shall be furnished, fabricated, and placed in accordance with applicable provisions of the section for Reinforcing Steel.

E. All steel bearing piles shall be furnished and driven in accordance with applicable provisions of the section for Steel H- Piles. Steel piles shall be driven to the batter lines shown on the Drawings. The tops of piles shall not vary from planned locations by more than four inches in a plane through the axis of the pile that is normal to the face of the bulkhead.

F. Drilled-in pre-stressed concrete shafts shall be constructed in accordance with provisions of this section.

3.14 INSTALLATION OF TIE RODS

A. Tie Rods in Pipe Casings:

1. Anchor rods shall be installed in HDPE pipe casings wherever trenches are required by the Drawings and wherever they are installed in a zone to be filled after the rods are in place. Fill at the bottoms of rods and the bottoms of trenches shall be accurately fine graded so that the rods, when laid in a straight line from the wale to the anchorage, will rest on the invert (inside bottom) of the casing.

2. Fill below the anchor rods shall be placed and compacted carefully so as not to disturb the rods. Fine grading of fill beneath rods and of bottoms of trenches may be accomplished by accurate and careful cutting of the soil, or by use of compacted bank sand or cement stabilized sand.

3. The casing shall be carefully slipped over the rods so as not to damage the wrapping on the rods or the coating on the casing. The casing shall be settled into the subgrade accurately to the correct alignment, and couplings shall be installed and tightened. Ends of casings not set into concrete shall be caulked with an approved compound and plugged with at least 4-inches of concrete.

4. Filling above rods shall be carried out carefully to avoid forcing the casing into the subgrade.

Where a casing is placed in a trench, the trench shall be filled to a depth of at least two feet above the top of the casing with well compacted cement stabilized sand. In area fills, the casing shall be covered with compacted cement stabilized sand in a mound at least two feet above the top of the pipe, having bottom width at the invert of the pipe of five feet and top width of two feet.

3.15 DRAIN WELLS AND WEEP HOLES

Drain wells where shown on the Drawings, shall be constructed to the size and depth and at the locations, as shown on the Drawings, and shall be drilled in accordance with the applicable provision of the section for Uncased Drilled Concrete Piers, the wells shall be filled with a mixture of graded gravel and sand meeting the requirements for coarse and fine aggregates for concrete as set out in the section for Structural Concrete, well mixed in the proportions of three parts of gravel passing a 1-1/2-inch screen and two parts of sand.
Prior to filling the drain wells, install a weep hole consisting of a length of 4-inch steel pipe extending through and welded to the steel sheet piling as shown on the Drawing. The pipe is to be coated as required for steel sheet piling, its inner end to be covered with a No. 4 mesh 0.080-inch wire woven stainless steel screen bent over and securely wired to the pipe with four turns of 0.054-inch stainless steel wire attached before pipe has been coated. Damage to coating due to welding shall be repaired on the front face of bulkhead in accordance with the requirements for coating.

Horizontal drains, where called for on the Drawings, shall be constructed using the gravel and sand fill specified above, laid down on the lines and grades required by the details. The drain fill shall be compacted to a stable density.

END OF SECTION