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ENGINEERING SUPPORT PROGRAM

WO-LT-0077 PRT Technical Engineering Support
Gardez to Khost Road, Afghanistan
Construction of Bridge #09
Technical Specifications – 30% Design Submittal

November 8, 2013

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GARDEZ TO KHOST ROAD, AFGHANISTAN

CONSTRUCTION OF BRIDGE #09

Project No. WO-LT-0077

SECTION 02 41 19 - SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Complete demolition and removal of the existing bridge superstructure.
2. Partial demolition and removal of the existing bridge substructure.
3. Removal of existing asphaltic pavement within the Project limits.
4. Demolition and removal of selected site elements, as noted on the drawings.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off site.

B. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to USAID that may be uncovered during demolition remain the property of USAID.

1. Carefully salvage in a manner to prevent damage and promptly return to USAID.

1.5 PREDEMOLITION CONFERENCE

A. Predemolition Conference: Conduct conference at Project site.

1. Discuss limits of selective demolition.
2. Review and finalize selective demolition schedule.
3. Review areas where existing construction is to remain and requires protection.

1.6 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Other Submittals:

a. Schedule of Selective Demolition Activities: Indicate the following:

1) Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.

2) Interruption of utility services. Indicate how long utility services will be interrupted.

3) Coordination for shutoff, capping, and continuation of utility services.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing local regulations before beginning selective structural demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6, "Safety and Health Program Requirements for Demolition Operations" and NFPA 241, "Standard for Safeguarding Construction, Alteration, and Demolition Operations" or equivalent industry standards.

1.8 PROJECT CONDITIONS

A. Selective demolition shall be performed in such a manner that it creates no adverse impact to existing traffic, by-pass roads, utility infrastructure or to the crossing below.

B. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify USAID. Hazardous materials will be removed by USAID under a separate contract.

a. Contractor shall move his operations to Project areas where there are no materials suspected of containing hazardous materials and continue working.
b. Contractor shall return to area where suspected hazardous materials were encountered only upon written direction from USAID and complete selective structural demolition work.

D. Storage or sale of removed items or materials on site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

3.2 UTILITY SERVICES

A. Existing Services to Remain: Maintain services indicated to remain and protect them against damage.

B. Existing Services to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility owner and USAID.
2. If services are required to be removed, relocated, or abandoned, provide temporary services that bypass area of selective demolition and that maintain continuity of services.
3. Disconnect, demolish, and remove piping indicated to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris removal operations to ensure minimum interference with roads and walkways.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations, using good demolition procedures and practices and as follows:

1. Proceed with selective demolition systematically, from higher to lower level.
2. Existing substructure shall be demolished to a limit of 600mm below proposed grade.
3. Dispose of demolished items and materials promptly.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry full depth at junctures with construction to remain, using power driven saw, then remove masonry between saw cuts.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items indicated to remain USAID's property, remove demolished materials from Project site and legally dispose of off site.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Return adjacent areas to condition existing before selective demolition operations began.

1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, accessories, placement procedures, and finishes, for the following:

1. Footings.
2. Piers.
3. Abutments.
4. Deck slabs.
5. Bridge sidewalks and barriers.
6. Approach slabs.
7. Bridge beams.

B. Alternate Construction Methods:

1. The Contractor may cast the following items as precast concrete components for installation:

    a. Bridge beams.

2. The Contractor shall use the same requirements for precast concrete components as specified for cast-in-place work in this Section.

3. The Contractor shall provide a casting area for the precast concrete work, unless a precast plant is available.

    a. The casting area shall be level, adjacent to the Project site and have ready access to the Project site for transport of the precast concrete items to the installation location.

4. The Contractor shall submit a written description of his means and methods, including a list of equipment, for precasting the components, and a list of equipment to be used to transport the components.

5. The Contractor shall submit precast erection procedure.

6. If precast beam construction is used, the Contractor is fully responsible for the analysis of the beams to include the stresses during erection. This includes modifications to the beam reinforcement as well as design of the lifting devices which shall be adequate for

the safety factors required by the erection procedure. The Contractor shall submit design calculations and details with the erection procedure.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 DESIGN REQUIREMENTS FOR PERMANENT STEEL BRIDGE DECK FORMS (IF USED)

A. The following criteria shall govern the design of permanent steel bridge deck forms:

1. The steel forms shall be designed on the basis of dead load of form, reinforcement and plastic concrete plus 2.4 kPa for construction loads. The unit working stress in the steel sheets shall not be more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 250 MPa.
2. Deflection under the load of the forms, the plastic concrete and reinforcement shall not exceed 1/180 of the form span or 13 mm whichever is less. In no case shall this design loading be less than 5.75 kPa total. The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.
3. The design span of the form sheets shall be the clear span of the form plus 50 mm measured parallel to the form flutes.
4. Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute (AISI), “Specification for the Design of Cold Formed Steel Structural Members”, or equivalent industry standard.
5. Longitudinal reinforcement shall have minimum concrete cover, as measured from the permanent steel deck form, of 25 mm. Main reinforcement shall have minimum concrete cover, as measured from the permanent steel deck form, of 38 mm.
6. The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.
7. Permanent steel bridge deck form shall not be considered as lateral bracing for compression flanges of supporting structural members.
8. Permanent steel bridge deck form shall not be used in panels where longitudinal deck construction joints are located between stringers.
9. Welding will not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.
10. Fabricator’s shop and erection drawings shall be submitted to USAID for approval. These drawings shall indicate the grade of steel deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.

1.5 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Shop Drawings:

a. Formwork and Falsework Shop Drawings: Prepared by or under the supervision of a qualified structural engineer designing and detailing fabrication, assembly, falsework and support of formwork. Submit calculations and elevation views showing panel layout dimensions, joint and tie hole locations.
b. Deck Placement Drawings: Include layout and types of deck panels, support locations, anchorage details, dimensions, panel lengths, accessories and attachments to other construction.
c. Steel Deck Shop Fabrication and Erection Drawings: Fabrication shop fabrication and field erection drawings, if used.

2. Product Data:

a. For each type of product indicated.

3. Other Submittals:

a. Certified Test Data:

1) Closed cell foam joint filler.

b. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Pumping of concrete requires a mix design specifically prepared and previously used for pumping.

1) Indicate amounts of mixing water to be withheld for later addition at Project site.
2) Include compressive strength test reports.
3) Include all ingredient certifications.
4) Concrete Heat of Hydration Analysis and Plan: A concrete heat of hydration analysis and a detailed plan indicating how temperature differential restrictions for mass concrete are to be achieved, methods of observing and recording concrete temperatures, and methods of applying immediate corrective action should the temperature differential approach 21 deg C so as to limit the temperature differential to 21 deg C.

c. United States Army Corps of Engineers Review: Submit copy of the independent testing agency's latest review documentation showing a satisfactory or better rating, or similar rating status.

1) Independent testing agency performing material evaluation tests and concrete mix design.

d. Written description of the procedures and a list of the equipment, including hand tools, to be used for the measuring, mixing, transporting, placement, finishing and curing of concrete (Placement and Curing Plan for Hot and Cold Weather Concrete Placement.)

e. Erection Procedure: Written description of the procedures and list of the equipment including hand tools to be used for erection of bridge components.

1) Written description shall include drawings and calculations.

f. Falsework Procedure: Written description of the procedures and list or equipment to be used for erection of falsework.

1) Written description shall include drawings and calculations.

g. Placement and Curing Plan: Written description of the procedures and list of equipment to be used for concrete placement and curing of bridge deck.

1) Include methods of observing and recording concrete temperatures.

h. Precast Concrete Erection Procedure: Written description of the procedures and list of the equipment to be used for erection of precast concrete components. The written description shall include the following:

1) The procedures shall be submitted with a detailed procedure which includes drawings and calculations sufficient to enable USAID to determine the adequacy of the proposed method. The method and all submissions shall be prepared under the supervision of a licensed qualified engineer, who is familiar with these specifications, AASHTO, the work, and experienced in this technical field. All submitted sheets shall be signed and dated by the supervising engineer. As a minimum the following information shall be included in the submittal:

a) Drawings showing the location of existing roadway and features in areas of erection.
b) The location of cranes, both horizontally and vertically, and their operating radii.
c) Lifting equipment information including rating data. Information shall include counter weights to be used and boom capability. The manufacturer's rated capacity of the crane and of all lifting and connecting devices shall be adequate for 125 percent of the total pick load including spreaders and other material except that in the areas within the potential influence area of the crane where vehicular or pedestrian traffic has access, the rated capacity shall be adequate for 150 percent of the total pick load. The limits of the potential crane influence area shall be taken as circular areas with radii matching the boom length and radius points located at the boom pivot point. Crane capacity rating charts and the rated capacity of all lifting and connecting devices shall be clearly shown in the submittal. The 125 percent or 150 percent factors of safety are to be used in addition to any factors of safety used by the manufacturer to calculate the rated capacity.
d) The type, size and arrangements of slings, shackles or other lifting and connecting devices including relative technical data.
e) The order of lifts, repositioning of equipment and counterweights, and location and method of attaching deadmen. Methods and materials for temporary structures or the strengthening or bracing of a member (either temporarily or permanently) for erection purposes.

f) The stresses shall be investigated at each stage of erection with allowance for wind pressure determined by the table shown below.

Height of Members Above Ground *	Wind Pressure
5 meters	0.9 KPa
10 meters	0.9 KPa
15 meters	1.0 KPa
30 meters	1.2 KPa
90 meters	1.5 KPa

* For heights not given wind pressure shall be interpolated.

2) Long span straight girders shall be stabilized with falsework, temporary braces, or holding cranes until a sufficient number of adjacent girders are erected with all diaphragms connected to provide necessary lateral stability.

3) In instances where falsework is proposed as part of the erection procedure, it shall be properly designed, constructed, and maintained for the loads that it will bear. Plans for falsework along with necessary engineering data and calculations shall be submitted to USAID for review, comment, and approval under the same guidelines as the erection procedure. The Contractor shall keep a full record of piles driven for falsework.

i. Material Certificates: For each type of the following, signed by manufacturers:

1) Cementitious materials.

j. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1) Aggregates, including record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

k. Proposed curing method for all concrete elements.

l. Proposed cold and/or hot weather concrete protection procedures.

m. Temperature log records.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on the Project a supervisor who is experienced with concrete bridge construction.

B. Testing Agency: An independent testing agency shall perform material evaluation tests and design concrete mix designs mixtures.

1. The independent testing agency shall have been reviewed within the last 12 months by the United States Army Corps of Engineers (USACE) and have received a satisfactory or better rating, or similar rating status.
2. Personnel performing laboratory tests shall be Concrete Strength Testing Technicians and Concrete Laboratory Testing Technicians. Testing Agency laboratory supervisor shall

have at least 5 years' experience as a Concrete Laboratory Testing Technician.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. ACI Publications or Equivalent Industry Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5 or equivalent industry standard.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials" or equivalent industry standard.

E. Structural Preconstruction Conference: Attend conference at Project site.

F. Slab Pre-Pour Conference: Attend conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Protect steel decking, if used, from corrosion, deformation, and other damage during delivery, storage, and handling.

C. Stack steel decking, if used, off the ground on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with US Department of Commerce, DOC PS 1 "Structural Plywood" or equivalent industry standard, and as follows:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips 19 by 19 mm, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 25 mm to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 25 mm in diameter in concrete surface.

2.2 NONCOMPOSITE FORM STEEL DECKING (IF USED)

A. Performance Requirements:

1. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" or equivalent industry standard.

B. Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31 or equivalent, with the minimum section properties indicated, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 550 (minimum yield strength of 550 MPa), Z275 (minimum weight of coating: 275 g/sm – total both sides) zinc coating or equivalent industry standard.
2. Profile Depth: As indicated on Drawings.
3. Design Uncoated-Steel Thickness: As indicated on Drawings.
4. Span Condition: Single span, unless otherwise shown on Drawings.

C. Accessories:

1. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 420 (minimum yield strength of 420 MPa), or equivalent industry standard, deformed.

B. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 420 (minimum yield strength of 420 MPa), deformed bars, ASTM A 775/A 775M, “Epoxy-Coated Steel Reinforcing Bars” or ASTM A 934/A 934M, “Epoxy-Coated Prefabricated Steel Reinforcing Bars” or equivalent industry standards, epoxy coated, with less than 2 percent damaged coating in each 300 mm bar length.

C. Galvanized Reinforcing Bars: [ASTM A 615/A 615M, Grade 420 (minimum yield strength of 420 MPa)] [ASTM A 706/A 706M, “Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcements”, (Grade 420)], or equivalent industry standard deformed bars, ASTM A 767/A 767M (610 g/sm), Class II “Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcements”, or equivalent industry standard, zinc coated after fabrication and bending.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 420 (minimum yield strength of 420 MPa) or equivalent industry standard, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 420 (minimum yield strength of 420 MPa) or equivalent industry standard, plain-steel bars, ASTM A 775/A 775M or equivalent industry standard, epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M or equivalent industry standard.

D. Zinc repair material: ASTM A 780 or equivalent industry standard, zinc-based solder, paint containing zinc dust or sprayed zinc.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice" or equivalent industry standard, of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 or equivalent industry standard, plastic-protected steel wire or CRSI Class 2 or equivalent industry standard, stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

F. Reinforcement Mechanical Bar Splicer (if used for precast items):

1. Mechanical splices shall be compatible with epoxy coated rebar. Mechanical splices shall develop 125 percent of the yield strength of the connected bars. Splices shall not have rebar stops.

2.5 MISCELLANEOUS MATERIALS

A. Closed Cell Foam Joint Filler:

1. Closed cell foam shall be used as a joint filler between different components of the bridge. Closed cell foam joint filler shall have a compact closed cell structure composed of synthetic isomeric polymers and shall be gray in color. It shall offer sufficient heat resistance so that it is compatible with hot applied sealing compounds. Closed cell foam joint filler shall meet the requirements of Section 5.1 through 5.4 of ASTM D 1752, or equivalent industry standard, with the compression requirement modified to 70 to 170 kPa. Typical physical properties, as determined using test method ASTM D 545, or equivalent industry standard, shall be as follows:

Compression, 50%	89.6 kPa
Extrusion	2.5 mm
Recovery	99.21 %
Water Absorption, Volume	0.246 %

B. Tar Paper:

1. Tar impregnated felted paper shall conform to the requirements on ASTM D 227, or equivalent industry standard.

C. Expanded Polystyrene Filler:

1. Expanded polystyrene filler shall conform to the requirements of ASTM C 578, or equivalent industry standard.

D. Methacrylate Crack Sealer:

1. Methacrylate crack sealer shall consist of a high molecular weight low viscosity methacrylate monomer that when catalyzed will produce a crack-healer/penetrating-sealer that is a rapid-curing, modified-methacrylate resin. The methacrylate material shall, as a minimum, provide the following as applied properties:

Property Value	Test *
Viscosity < 25 cps	ASTM D 2393
Bond Strength >10.34 MPa	ASTM C 882
Tensile Elongation > 3%	ASTM D 638

* (or equivalent industry standard)

E. Silane Crack Sealer:

1. Silane crack sealer shall consist of a clear, breathable, high-performance, 100 percent solids by weight silane sealer for protecting new and existing concrete surfaces. It shall penetrate deeply, sealing out water, chloride ions, and acids, and prevent damage from freeze/thaw cycles. Silane crack sealer material shall, as a minimum, provide the following as applied properties:

Property Value	Test *
Water Weight Gain at 6.17 sm/l, 88 percent reduction	NCHRP 244 ** Series II-Cube test
Absorbed Chloride at 6.17 sm/l, 89 percent reduction	NCHRP 244 ** Series II-Cube test
Absorbed Chloride at 6.17 sm/l, 94 percent reduction	NCHRP 244 ** Series IV – Northern Climate

* or equivalent industry standard

** National Cooperative Highway Research Program 244, "Condition Evaluation of Concrete Bridges Relative to Reinforcement Corrosion, Volume 5: Methods of Evaluating the Effectiveness of Penetrating Sealers"

F. Epoxy-Resin:

1. Epoxy-Resin for Cement Concrete Crack Injection shall conform to AASHTO M235, Type IV, Grade I, or equivalent industry standard.

G. Sand Filler:

1. Sand filler gradation and characteristics shall conform to sealer manufacturer's requirements. Sand filler shall be clean sand and contain no unsuitable material.

2.6 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I (special properties as provided by other types not required) or Type II (moderate sulfate resistant or moderate heat of hydration required or equivalent industry standard. Supplement with the following (optional):

a. Fly Ash: ASTM C 618, Class F or C or equivalent industry standard.

1) Class F fly ash has pozzolanic properties.
2) Class C has pozzolanic properties and some cementitious properties.

b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120 or equivalent industry standard.

1) Performance in a slag activity test determines slag grade.
2) Slag activity shall be evaluated by determining the compressive strength of both Portland cement mortars and corresponding mortars made with the same mass of 50-50 mass combinations of slag and portland cement.

2. Blended Hydraulic Cement: ASTM C 595 - Type IS, portland blast-furnace slag; Type IP, portland-pozzolan; Type I (PM), pozzolan-modified portland; or Type I (SM), slag-modified portland cement or equivalent industry standard.

B. Silica Fume: ASTM C1240, amorphus silica, or equivalent industry standard.

C. Normal-Weight Aggregates:

1. Provide aggregates from a single source.

2. ASTM C 33, or equivalent industry standard coarse aggregate.

   a. Aggregate shall be double washed with clean water. The washed aggregate shall contain no unsuitable material.

3. ASTM C 33, or equivalent industry standard coarse aggregate for exterior concrete.

   a. Aggregate shall be double washed with clean water. The washed aggregate shall contain no unsuitable material.

4. Maximum Coarse-Aggregate Size:

   a. Slabs on Grade: 38 mm nominal.
   b. All Other Concrete: 25 mm nominal.

5. Fine Aggregate: Free of materials with harmful reactivity to alkali in cement. Fine aggregate shall conform to the following gradation requirements:

   a. Fine aggregate shall be natural aggregate or manufactured aggregate or a combination of natural and manufactured aggregate.
   b. The aggregate shall consist of hard, tough grains and shall be free of organic material, clay, loam and other harmful materials.
   c. The aggregate shall conform to the following gradation:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
9.5 mm	100
4.75 mm	95 to 100
2.36 mm	80 to 100
1.18 mm	50 to 85
600 um	25 to 60
300 um	5 to 30
150 um	0 to 10

D. Water: Potable.

2.7 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260 or equivalent industry standards. An admixture that is used as an ingredient of the concrete, added before or during batch mixture, for entraining air in the concrete mix.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A (water-reducing admixture), or equivalent industry standard.
2. Retarding Admixture: ASTM C 494/C 494M, Type B (retarding admixture), or equivalent industry standard.
3. Accelerating Admixture: ASTM C 494/C 494M, Type C (accelerating admixture), or equivalent industry standard.
4. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D (water-reducing and retarding admixture), or equivalent industry standard.
5. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E (water-reducing and accelerating admixture), or equivalent industry standard.
6. Mid-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type A or Type F (mid-range, water-reducing admixture), or equivalent industry standard.

    a. Water content reduction to be greater than 7 percent.

7. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F (high-range, water-reducing admixture) or equivalent industry standard.
8. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G (high-range, water-reducing and retarding admixture), or equivalent industry standard.
9. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II (plasticizing and retarding admixture) or equivalent industry standard.

2.8 SEALED CONCRETE

A. Sealer: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ChemMasters; Chemisil Plus.
    b. ChemTec Int'l; ChemTec One.
    c. L&M Construction Chemicals, Inc.; Seal Hard.
    d. Meadows, W. R., Inc.; LIQUI-HARD.
    e. Nox-Crete Products Group; Duro-Nox.
    f. Approved equal.

2.9 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, or equivalent industry standard, clear or white opaque polyethylene film or white burlap–polyethylene sheet, used in conjunction with potable water.

1. Minimum thickness of the polyethylene film shall be 0.10 mm (4 mils).
2. White burlap-polyethylene sheet shall be made of burlap weighting 305 g/sq. m on one side with white opaque polyethylene sheet on the other side. The polyethylene sheet shall be securely bonded to the burlap. Minimum thickness of the polyethylene film shall be 0.10 mm (4 mils).

B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1-D (clear with fugitive dye), Class B (resin type), dissipating, or equivalent industry standard.

C. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

D. Insulation: Blanket, batt or board insulation with a thermal conductivity of less than 0.8 w/sm for a thermal gradient of 0.02 deg C/mm.

E. Ensure compatibility of curing materials with finish flooring and adhesives.

2.10 RELATED MATERIALS

A. Bond breakers: Waterborne, form release agent.

B. Bonding Agent: Liquid bonding agent specifically designed to bond fresh cementitious materials to a variety of substrates for exterior applications and provide an anti-corrosion coating for reinforcing steel.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals; Emaco P24.
b. Sika Corporation; Sika Armatec 110 EpoCem.
c. Approved equal.

C. Nonshrink Grout: ASTM C 1107, “Packaged Dry, Hydraulic-Cement Grout (Nonshrink)” or equivalent industry standard, factory-packaged, shrinkage-resistant, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum 28 day compressive strength shall be 34 MPa.

D. Epoxy Adhesive: ASTM C 881/C 881M or equivalent industry standard. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 4 deg C, Class B if placement temperature is between 4 and 16 deg C or Class C if placement temperature is above 16 deg C.

2.11 REPAIR MATERIALS

A. Repair Mortar: Site-mixed Portland-cement mix for vertical and overhead surfaces. Mix dry-pack repair mortar, consisting of one part shrinkage-compensating, Portland cement to two and

one-half parts fine aggregate passing a 1.18-mm sieve by damp, loose volume, using only enough water for handling and placing.

B. Thin Coat Patching Mortar: Polymer modified, Portland cement, suitable exterior applications. Featheredge up to 5 mm. For thicker applications manufacturer's recommendations to extend mix with an aggregate may apply.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals; Chemrex Levelprep.
b. ChemMasters, Inc.; ChemFlow HS.
c. Approved equal.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301M, "Specifications for Structural Concrete", or equivalent industry standard.

1. Use a testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures. See "Quality Assurance" article in this section for additional requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Fly Ash: 25 percent, but if used, a minimum of 15 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in all concrete. Design mix for optimum placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use a mid-range, water-reducing admixture in pumped concrete, all concrete slabs (including concrete walks), concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.13 CONCRETE MIXTURES FOR BRIDGE ELEMENTS

A. Footings, Piers, Abutments, Approach Slabs, Bridge Sidewalks, and Barriers. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 27.5 MPa at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 100 mm plus or minus 25 mm; or 200 mm for concrete with verified slump of 50 to 100 mm before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 25 mm.
4. Air Content: 6 percent, plus or minus 0.5 percent at point of delivery (25-mm) nominal maximum aggregate size.

B. Bridge Deck: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 27.5 MPa at 28 days.
2. Minimum Cementitious Materials Content: 309 kg/cu. m.
3. Slump Limit: 100 mm, plus or minus 25 mm.
4. Air Content: 6 percent, plus or minus 0.5 percent at point of delivery for 25 mm normal maximum aggregate size.
5. Maximum Water-Cementitious Materials Ratio: 0.45.

2.14 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice" or equivalent industry standard.

2.15 CONCRETE MIXING

A. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M or equivalent industry standard. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 0.76 cu. m or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 0.76 cu. m, increase mixing time by 15 seconds for each additional 0.76 cu. m.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Examination:

1. Verify that subgrade conditions are satisfactory prior to forming or pouring concrete.
2. Verify reinforcing is properly in place and that framework is complete and properly secured prior to placing concrete.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Footings: No concrete shall be placed until after the Contractor's engineer has confirmed the depth and dimensions of the excavation to be in accordance with the design documents, and that the character of the material and the condition of the foundation is as indicated in the geotechnical engineering recommendations. No footing shall be supported partially on rock and partially on soil. The rock shall be excavated as necessary to allow the placement of select granular material. USAID may direct, in writing, such changes in dimensions or elevations of footings as may be necessary to obtain satisfactory foundations.

C. Precast concrete erection procedures shall be in accordance with submitted description, procedures and list of equipment.

D. Transportation of Concrete:

1. The concrete shall be transported from the mixer and placed in the forms by a method that will permit handling concrete of the slump required without segregation. Buggies and wheelbarrows used for this purpose shall be equipped with pneumatic tires. Chutes may be used but the use of long chutes will be permitted only on authority from USAID. If such conveyors are allowed and the quality of the concrete as it reaches the forms or the methods of placing or working it therein are not satisfactory, USAID may order their use discontinued and the substitution of a satisfactory method of placing. Chutes shall be constructed of aluminum free metal or metal lined and shall extend as nearly as possible to the point of concrete placement. Long chutes shall be provided with reverse flow or remixing hoppers in order to correct for segregation. All chutes shall be kept clean and free from coatings of hardened concrete. Concrete shall not be permitted to be transported through chutes or pipes composed of aluminum.
2. Transportation of concrete by pumping will be permitted provided that the required slump or air content can be maintained at the discharge end of the hose and there is no adverse effect to the mix design.
3. Concrete shall be sampled and tested at the end of the chute or if pumping is allowed, from the discharge end of the hose. The equipment shall be suitable in kind and adequate in capability for the work. The operation shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline shall be ejected in such a manner that there will be no separation of the ingredients. Pumping through aluminum pipes will not be permitted. All pipes and chutes shall be kept clean and free from coatings of hardened concrete.

3.2 FORMS, FALSEWORK AND CENTERING

A. Approved centers and forms shall be provided by the Contractor. Piles shall be used for falsework if required by USAID. No extra compensation for falsework or falsework piling shall be allowed, such work shall be considered part of the form work. Falsework shall be set to give the structural camber indicated on the Drawings or as specified, plus allowance for shrinkage, shortening under load or settlement.

B. Forms, falsework, and centering shall be designed for a liquid head, equal to the maximum height of the liquid concrete in the forms for various placing conditions assuming the load of the liquid concrete to be 2400 kg/m3, and in addition thereto a live load allowance of 2.4 kPa on horizontal surfaces.

C. All falsework or centering shall be adequate for the type of construction involved. The Contractor shall submit all shop drawings for falsework and centering, including design computations, formally signed and sealed by the Contractor's engineer. The Contractor's engineer shall certify that the falsework system has been assembled and constructed according to the approved falsework drawings, prior to placing loads on such falsework.

D. Unless otherwise shown on the Drawings or specified, forms for all exposed portions of bridges and structures shall be lined with approved material, or form sheathing which shall consist of five-ply water-proof plywood, approved metal sheathing or other approved material in order to give the concrete a smooth even finish and uniform appearance. This requirement shall not apply to any part of a structure that will be at least 600 mm below the surface of adjacent ground in the completed project that will not be coated with bituminous dampproofing. Any material that will provide tight forms will be acceptable for such locations.

E. Full sheets of plywood or other approved material shall be used wherever possible and shall be placed in a regular pattern. The use of small pieces and leftovers will not be permitted except as they may be needed to complete the design. Forms in good condition may be reused, but forms for any one exposed face shall be all new or all used material and a mixture of old and new forms will not be permitted.

F. The sheathing shall be jointed tightly to prevent leakage from the mix and it shall be of sufficient strength to hold the concrete without bulging between supports. Forms shall be properly braced and tied so as to maintain proper dimensions. Bolts, rods, or other approved form ties shall be used for internal ties. Wire ties will not be permitted except when directed or where concrete is not exposed to view. USAID may require the Contractor to employ screw jacks or hard wood wedges in connection with the centering of falsework in order to take up any distortion or settlement in the form work either before or during the placing of the concrete.

G. Approved inserts required for form and/or falsework support shall be used in connection with all ties in the region of exposed surfaces on the concrete. They shall be so designed as to permit their removal from the concrete without injury to the concrete, and the metal remaining in the concrete shall not be closer than 40 mm to the surface. The inserts shall be truly round, not more than 40 mm in outside diameter and shall be treated with non-staining mineral oil or other satisfactory material adequate for preventing any adherence to surrounding concrete. Special tools and methods shall be used to remove the inserts from the concrete in a manner to prevent damage to the concrete. All ties and embedded devices required for form and/or falsework support that are to be left in place shall be either epoxy coated or galvanized to match the reinforcement within the concrete placement.

H. Form ties of a design with a weakened section 40 mm back from the concrete face may be used at places of minor pressure when permitted by USAID, but such ties shall be provided with special inserts so as to assure the breaking off of the ties at the proper depth inside the face of the concrete. When such ties fail to break off at the designed depth, the tie metal shall be drilled out before the tie hole is patched. Voids and forming accessory holes shall be patched as necessary to match the surrounding texture and color to produce a uniform appearance.

I. The use of wooden struts within forms, or of metal ties without approved inserts, as required, will not be permitted.

J. The centers shall be true to the lines, satisfactorily supported and firmly secured. They shall remain in place as long as directed by USAID and shall be replaced with new ones if they lose their proper dimensions and shape.

K. Forms for the roadway deck slabs shall be so constructed that under full dead load, the thickness of the slabs shall be the required thickness shown on the Drawings and the surface of the pavement will accurately conform to the profile grades, cross sections and alignment shown on the Drawings. Allowance shall be made for the camber of the floor members as erected and for the additional dead load deflections of the floor members. Slab haunches shall be provided over steel girders, floor beams or stringers. The depth of haunches shall be variable as required to maintain the uniform thickness of slab between the steel supports.

L. All exposed edges and corners of concrete not otherwise specified on the Drawings shall be formed with a wooden triangular 45 degree chamfer strip 19 mm on the square sides. These triangular chamfer strips shall be machine surfaced on all sides and shall be of uniform dimensions throughout the Project. Any chamfered or beveled corners of concrete specified on the Drawings of larger size shall be formed and finished as required for other parts of the adjacent forms.

M. Bridge bearing anchor bolts shall be set accurately by a secured template prior to placing concrete.

N. The shape, strength, rigidity, water-tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber shall be resized before being used. Forms that are unsatisfactory in any respect shall not be used and shall be removed immediately from the work.

O. The inside of forms shall be coated with non-staining mineral oil or other approved material to prevent adherence of the concrete to the forms, immediately before placing the concrete. When oil is used, it shall be applied before the reinforcing steel is placed. Any material that will adhere to, discolor or affect the concrete in any manner shall not be used. Forms for bridge decks shall not be oiled but shall be dampened with water ahead of concrete placement.

P. In the construction of copings, railings and other intricate sections, extreme care shall be taken in the construction to insure true lines.

Q. Prior to placing concrete in the forms all foreign matter and any extraneous materials shall be removed. Forms shall be inspected immediately preceding and during the placing of the concrete. All dimensions shall be checked carefully and any errors, bulges, warping or other defects shall be remedied before any concrete is placed. Temporary openings shall be provided for inspection at the base of columns and wall forms and near the bottom of all deep members.

R. Temporary openings shall be provided for inspection at the base of wall forms and near the bottom of all deep members.

S. The foregoing specifications for forms as regards to design, mortar-tightness, chamfers or moldings, bracing, alignment, treatment by coating with oil or other approved material, removing and reuse, shall apply to metal forms when such forms are approved for use. The

metal forms used shall be of such strength that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or which do not line up properly shall not be used. Special care shall be exercised to keep metal forms free from rust, grease or other foreign matter that will tend to discolor the concrete. Metal forms shall be provided with an adjustable metal section or occasional sections where wooden forms may be inserted to compensate for slight inaccuracies in measurement.

T. Removable or stay-in-place forms for bridge decks may be used as alternates. Removable forms shall be used for forming end diaphragms, bays with longitudinal construction joints, and overhanging portions of decks. Material to prevent concrete from adhering to the forms shall not be used when stay-in-place forms are used.

U. The Contractor's method of construction shall be observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement and vibration; and finishing of the bridge deck. Should USAID determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least one section of the forms at a location and time selected by USAID for each span in the contract at no additional cost to the Project. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed at no additional cost to the Project if USAID determines that there has been any change in the concrete mix or in the Contractor's procedures warranting additional inspection.

V. After the deck concrete has been in place for a minimum period of 2 days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by USAID. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength. This removal of the permanent steel bridge deck forms shall be at no cost to the Project. At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities do not justify rejection of the work, the concrete shall be repaired as USAID may direct and shall be given an Ordinary Surface Finish, in accordance with the specifications.

3.3 NONCOMPOSITE FORM DECK INSTALLATION

A. Examination:

1. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected

B. Installation, General:

1. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, “Design Manual for Composite Decks, Form Decks and Roof Decks” or equivalent industry standard, manufacturer's written instructions, approved deck placement shop drawings and requirements in this Section.
2. Place deck panels on supporting beams and adjust to final position with ends accurately aligned and bearing on supporting member before being permanently fastened.
3. Place deck panels flat and square and fasten to supporting beams without warp or excessive deflection. Do not stretch or contract side lap interlocks.
4. Deck Accessories to Supporting Members: Fasten in accordance with manufacturer’s recommendations.

3.4 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagram, instructions, and directions furnished with items to be embedded.

3.5 REMOVAL OF FORMS AND FALSEWORK AND LOADING ON STRUCTURES

A. The terms falsework and centering, as used herein, shall include all supports of the actual forms enclosing and supporting the concrete. No external loads of any kind, except as provided for herein, shall be allowed until the members reach at least the designated strengths.

B. Removal of Forms and Falsework:

1. The forms, falsework, and centering for any portion of the structure shall not be removed until the concrete is strong enough, as determined by USAID, to avoid possible injury from such removal. Forms, falsework, and centering shall not be removed or disturbed without the prior approval of USAID. Forms, falsework, and centering shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.
2. When test cylinders are taken from the concrete in the members of a structure for the purpose of controlling the timing of form removal operations, the forms shall be left in place until the concrete has attained the minimum percentage of the specified design strength and, regardless of the strength attained, for the minimum period of time with test cylinder testing as designated in the following table. If test cylinders are cast for this purpose, concrete cylinders shall be cast, cured, and tested as specified in “Field Quality Control” Article. When test cylinders are not taken from the concrete in the members of a structure for the purpose of controlling form removal operations, the minimum days without test cylinder testing designated in the following table shall be used as a guide. The number of days counted shall be measured from the time of the last placement of concrete in the forms or falsework supports and shall exclude days when the surrounding temperature is below 4 deg C for a total of 4 hours or more. The complete curing process shall be continued after removal of forms, falsework, or centering as required. In order to facilitate any particular finishing operations, side forms carrying no load may be removed 24 hours to 72 hours (depending on weather conditions and type of concrete) after the placing of the concrete has been completed, subject to the approval of USAID and with the complete curing process to be continued as required.

Structural Member	Minimum Percentage of Specified Design Compressive Strength (fc)	Minimum Days with Test Cylinder Testing	Minimum Days without Test Cylinder Testing
Free Standing Walls and Piers	40 %	3 days	5 to 7 days
Slabs	80 %	10 days	14 to 28 days
Girders	90 %	14 days	21 to 28 days
Cantilevered Slabs	90 %	14 days	21 to 28 days

3. Any defective work discovered after the forms have been removed shall be immediately removed and replaced. If the surface of the concrete is bulged, uneven or show excessive voids or form joint marks that cannot be repaired satisfactorily, the entire section shall be removed and replaced. All repairs and renewals due to defective work shall be done at the expense of the Contractor. Any proposal by the Contractor to remove forms, falsework, and centering prior to the concrete attaining the specified minimum percentage of the design compressive strength shall satisfy each of the following requirements:
4. USAID has reviewed and approved the Contractor's justifying calculations. The calculations shall be based upon the concrete strength from the time of the proposed early removal until the concrete has attained its design strength. The calculations shall demonstrate that the capacity of the structure shall not be exceeded by computing the loads, resultant stresses, and deformations to which the concrete and reinforcing steel will be subject to at the time of the proposed removal.
5. Cured concrete cylinders tested immediately prior to the start of removal of forms, falsework, and centering, and all of the test results equal or exceed the anticipated strength used in the Contractor's calculations. USAID will accept the field curing of the test cylinders as being representative of the field curing of the production concrete in order for this approval to occur.

C. Application of External Loads:

1. Loads shall not be applied to concrete structures until the concrete has, as determined by USAID, attained sufficient strength so that damage will not occur. Nothing, except for curing materials and related curing equipment and devices, may be carried on bridge decks until the entire 14 day wet curing operation is completed. A live load not exceeding 2,400 kg, operated at a speed not to exceed 8 km/h, may be allowed on bridge deck concrete no sooner than completion of the 14 day wet curing operation provided that the concrete has reached a compressive strength of 23 MPa. Full traffic loading shall not be allowed on bridge deck concrete until completion of the 14 day wet curing operation and until the concrete has reached its specified strength.
2. Precast concrete shall not be placed on substructure elements until the substructure concrete has attained 70 percent of its specified strength. When the placement of backfill will cause flexural stresses in the concrete, the placement shall not begin until the concrete has reached not less than 80 percent of its specified strength.

3.6 INSTALLATION OF PERMANENT STEEL BRIDGE DECK FORMS (IF USED)

A. All forms shall be installed in accordance with approved fabrication and erection plans. Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 25 mm at each end. Form supports shall be placed in direct contact with the flange of stringer or

floor beam. All attachments shall be made by permissible welds, bolts, or clips of other approved means. However, welding of form supports to flanges of steels not considered weldable and to portions of flange subject to tensile stresses will not be permitted. Welding and welds shall be in accordance with the provisions of AWS D1.3, or equivalent industry standard, pertaining to fillet welds except that 3 mm fillet welds will be permitted.

B. Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned and painted with galvanizing repair paint. Minor heat discoloration in areas of welds need not be touched up.

C. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed at no additional cost to the Project to inspect and repair the slab, and the Contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired as directed by USAID.

D. The amount of sounding and form removal may be moderated, at USAID's discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor's methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained through the slabs. The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of USAID's inspection procedure

3.7 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" or equivalent industry standard for placing reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
2. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
3. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
4. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
5. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
6. Clean areas where zinc coating is damaged or missing and repair zinc coating with zinc rich repair paint. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.
7. Field bending or straightening of bars partially embedded in concrete is permitted only where shown on the Drawings.
8. All openings in concrete walls with a dimension of 300 mm or greater are to have two 16 mm diameter (16 M) bars on all sides of opening, unless noted otherwise.

3.8 CONCRETE PLACEMENT OF BRIDGE SUBSTRUCTURE

A. Depositing:

1. The concrete shall be placed in the form in the approved manner to prevent stone pockets, voids or segregation and to reduce handling and flowing in the form to a minimum. The concrete shall not be dropped more than 1 m or dragged more than 3 m in the forms. Vibrators shall not be used to transport concrete. Epoxy coated steel reinforcement shall be protected from damage from dropping concrete by limiting the maximum height of concrete drop to 600 mm. Points of deposit shall be spaced not more than 6 m apart nor more than 3 m from the ends of the forms.
2. Concrete shall be distributed in the forms by hand shoveling. The forms shall be filled at a rate of 300 mm to 1 m in depth per hour unless an alternate form design is submitted and approved by USAID. Care shall be taken to avoid splashing the forms and reinforcing above the level of the concrete as placed. Beams and slabs shall be placed in one continuous operation.

B. Consolidation:

1. Each layer shall be thoroughly consolidated by rodding and vibration. The face of the forms shall be carefully spaded, if possible, to bring a dense mortar to the face, and produce a good finish.
2. All concrete for structures, unless otherwise directed by USAID, shall be compacted by means of approved mechanical vibrators operated within the mass of the concrete. The Contractor shall provide vibration to fully consolidate the mix. Vibrators shall be of internal type of standard make and capacity, and shall be capable of transmitting vibrations within the concrete at frequencies of not less than 5500 vibrations per minute nor more than 13500 vibrations per minute. Epoxy coated steel reinforcement shall be protected from damage from exposed steel headed immersion-type vibrators
3. Immersion type vibrators used to consolidate concrete that is reinforced with epoxy coated reinforcement shall feature heads covered with rubber or other resilient non-metallic material approved for concrete consolidation. Vibration of forms or reinforcing shall not be permitted except where internal vibration is not practicable and then only with the approval of USAID.
4. The vibrator shall be applied directly to the concrete mass at the point and time of deposit and shall be moved throughout the mass continuously from point to point for a sufficient duration to accomplish thorough consolidation. The duration of vibration shall not be prolonged to the point where segregation, serious loss of entrained air, or excessive water bleeding occurs. Vibrators shall not be used close to the forms.
5. When concrete is placed in lifts, vibrators shall be inserted into at least half the depth of the underlying lift so as to thoroughly consolidate the two lifts into an integral mass without streaks or hardened lift lines. Vibrators shall not be used to move concrete in the forms. A sufficient number of vibrators shall be provided to obtain proper compaction in accordance with the rate of deposit. Extreme care shall be taken to prevent penetrating or disturbing previously placed concrete that has become partially set.

C. Hot and Dry Weather Requirements:

1. During hot dry weather, and as directed by USAID, all new concrete shall be kept shaded from the sun, shielded from the wind and kept wet with water, or protected by other approved methods to retain the moisture in the concrete throughout the curing period.

During concrete placement operations in hot weather, appropriate measures shall be taken in accordance the Contractor's Placement and Curing Plan to reduce the hazards of increased rate of cement hydration, flash set, loss of water due to evaporation, high concrete ingredient temperatures, and the increased difficulty of concrete placing and finishing. The following requirements shall be met during concrete placement operations in hot weather:

a. Concrete Temperature: The temperature of the concrete at the point of discharge shall not exceed 32 deg C.
b. Cooling Materials: The Contractor may reduce the temperature of the concrete by cooling one or more of several ingredients. The aggregates may be cooled by fogging, or other suitable means that will not result in a high variation of moisture content within the stockpile. Chipped or crushed ice made from potable water may be used in the mix as a portion of the mixing water on a kilogram for kilogram basis, provided such measure is determined at the time it is placed in the mix. If used, all ice shall be melted before the batch is discharged from the mixing unit. Water may also be cooled by refrigeration or other means that provide a uniform mixing water temperature.
c. Concrete Placing: Immediately before the concrete is placed, the forms and reinforcement steel shall be cooled by spraying with water. In no case shall there be any standing water in the concrete forms as a result of the spraying procedures. The Contractor shall have sufficient skilled men and adequate equipment to place the concrete without delays which may cause excessive slump loss and evaporation due to over-mixing or exposure before it is placed.
d. Finishing: To prevent shrinkage cracking resulting from moisture loss, the Contractor may be required to furnish windscreens, to use water fogging, or other approved means of supplying moisture. If the use of windscreens is required, the windscreens shall consist of canvas barriers of suitable height erected on the windward side of the concrete placement. Finishing operations shall follow as closely as practicable behind the placing operation so that curing may begin as soon as possible.

D. Rainy Weather Requirements:

1. During rainy weather all new concrete shall be properly covered, as may be necessary to prevent damage. Sufficient approved material for covering shall be available at the site of the work for immediate use as may be needed.

E. Cold Weather Requirements:

1. Cold weather is defined as any time during the concrete placement or curing period the ambient temperature at the work site drops below 5 deg C or the ambient temperature at the site drops below 10 deg C for a period of 12 hours or more. Any concrete placed during cold weather shall be placed at the Contractor's risk and any damage or unsatisfactory concrete shall be removed and replaced at the Contractor's expense. When cold weather is reasonably expected or has occurred within 7 days of anticipated concrete placement, the Contractor shall include as part of their Placement and Curing Plan detailed procedures for the production, transporting, placing, protecting, curing, and temperature monitoring of concrete during cold weather. Procedures for accommodating abrupt changes in weather conditions shall be included. Placement of concrete shall not commence until the plan is accepted by the USAID.

2. All material and equipment required for cold weather placement and curing protection shall be available at the Project site before commencing concrete placement. All snow, ice, and frost shall be removed from the surfaces, including reinforcement and subgrade, against which the concrete is to be placed. The temperature of any surface that will come into contact with fresh concrete shall be at least 2 deg C and shall be maintained at a temperature of 2 deg C or above during the placement of concrete.
3. During the curing period, the Contractor shall provide suitable measures to maintain the concrete surface temperature which shall be monitored by continuously recording surface temperature measuring devices that are accurate within 1 deg C. One temperature measuring device shall be required to be randomly placed in an accessible location for every 140 square meters of concrete surface area being cured.
4. The minimum concrete surface temperature requirements indicated in the Table below shall be continuously maintained for a curing period of at least 7 days. The 7 day minimum curing period of time will be extended when necessary to develop satisfactory strength in the concrete.
5. Any day during which the minimum concrete surface temperature requirement is not continuously maintained shall not count as a day contributing to the curing period.

Cold Weather Concrete Surface Temperature Requirements				
	Minimum Section Size Dimension			
	Under 305 mm	305 – 915 mm	Over 915 mm up to 1.830 m	Over 1.830 m
Minimum temperature of concrete during curing period	14 deg C	12 deg C	10 deg C	10 deg C
Minimum allowable temperature drop in any 24 hour period after end of curing	28 deg C	22 deg C	16 deg C	11 deg C

6. The mixing water and/or aggregates may be heated (prior to cement being added) by methods so that the temperature of the aggregates and water mixture is not less than 20 deg C nor more than 60 deg C. The temperature of the concrete shall not be less than 15 deg C nor more than 30 deg C at the time of placing it in the forms. The heating shall be done in a manner to preclude the occurrence of overheated areas that might result in damage to the materials. Any material containing frost or lumps of hardened material shall not be used.
7. Blanket, batt or board insulation shall be applied to the forms. Insulation with breaks or tears will be rejected unless satisfactorily repaired. Openings for thermometers shall be provided where directed by USAID.
8. Where it may be expected that considerable heat will be generated by the hydration of the concrete, and in some cases where heat is not rapidly dissipated, suitable coverings shall

be used to protect concrete. Heavy footings in which the concrete is placed at a concrete temperature of 20 deg C where protection is provided by the surrounding earth, except on top, shall be protected by a tarpaulin placed over the top with an air space between the concrete and the tarpaulin and sufficient added artificial heat shall be provided to maintain the minimum required concrete surface temperature. Mass concrete, when concrete as such is so specified on the Drawings, placed at a concrete temperature of 20 deg C, shall be protected by enclosure with tight wooden forms at least 16 mm in thickness except at corners and edges and sufficient added artificial heat shall be provided to maintain the minimum required concrete surface temperature. Double sheathing, insulation board or tarpaulins with a dead air space between the covering and the forms shall be placed to equally protect such corners and edges. Supplemental enclosures and added artificial heat will be utilized when required to maintain the minimum concrete surface temperature.

9. As much as possible, any enclosure for protection shall be in place before depositing of any concrete and the remainder shall be installed as rapidly as possible in order to reduce heat losses to a minimum. Heating within the enclosure shall be attained by such means of artificial heat as will maintain the temperatures specified continuously and with a reasonable degree of uniformity in all parts of the enclosures. All exposed surfaces of concrete within the enclosure shall be kept sufficiently moist to prevent any drying of the surface concrete with possible resulting damage to the concrete in place.
10. Heating appliances shall not be placed in such a manner as to endanger the enclosure, forms or supports, or expose any area of concrete to drying out or other injury due to excessive temperatures.

F. Bonding to Concrete Already Set:

1. In bonding new concrete to concrete already set, the surface of the concrete shall be thoroughly cleaned, roughened, wetted with clean water, and then flushed with a mortar composed of equal parts of the cement and sand specified for the new concrete, before new concrete is placed adjacent thereto. New concrete shall be placed before mortar has taken initial set. In lieu of the mortar, an epoxy adhesive for bonding fresh concrete to hardened concrete for load bearing applications may be used. The epoxy adhesive shall be applied in accordance with the manufacturer's recommendations.

3.9 PRECAST CONCRETE COMPONENTS ERECTION

A. General:

1. Girders shall be stabilized, as required, with falsework, temporary braces, or holding cranes until a sufficient number of adjacent girders are erected with all diaphragms connected to provide necessary lateral stability.

3.10 FINISHING FORMED SURFACES

A. Finishing: The requirements of "Finishing Formed Surfaces" is applicable to all concrete placements with the exception of bridge deck, bridge sidewalk, and bridge safety barrier concrete placements. Refer to those specific requirements for bridge deck, bridge sidewalk, and bridge barrier concrete placements specified separately in this Specification.

B. The external surface of all concrete shall be thoroughly vibrated and spaded during the operation of depositing the concrete by means of hand tools. The vibrating and spading shall be such as to force all coarse aggregate away from the surface and slowly work the mortar against the forms to produce a smooth finish free from water, air pockets, and honeycombing. The use of mortar, cement water mixture, or neat cement for plastering over any concrete surface will not be permitted. Unless otherwise shown on the drawings, the final finish required on particular concrete shall be as follows:

1. Formed Surfaces Not Exposed to View:

   a. Immediately after forms have been removed and form ties cut back from the face of the concrete, all voids and cavities shall be filled with a stiff mortar of the same composition and air-entrainment as the mortar in the original concrete mix. The mortar for filling shall have been mixed and let set for 30 minutes and then remixed before placing in the work. In case the operation of filling is delayed, the surface of the concrete shall be thoroughly cleaned and washed with water, if necessary, before the mortar is applied.

2. Formed Surfaces Exposed to View:

   a. Within 48 hours after the forms have been removed and form ties cut back from the face of the concrete, all fins, projections and irregularities shall be carefully removed and all voids and cavities shall be carefully and completely filled with a stiff mortar of the same composition and air-entrainment as the mortar in the original concrete mix. The same brand and color of cement, and the same kind and color of aggregate as was used in the original concrete mix shall be used in this mortar. The mortar for filling shall have been mixed and let set for 30 minutes and then remixed before placing in the work. The surface film of all such pointed surfaces shall be carefully removed before setting of the mortar occurs. If USAID determines these surfaces as prepared do not present a uniformly smooth, clean surface of even texture and appearance, the surface shall be treated and rubbed to obtain a satisfactory finish.
   b. USAID shall be the sole judge of the amount of rubbing which will be required. If rubbing is required, the rubbing will start with 48 hours of notification that rubbing is required, the surface should be wetted with clean water and rubbed with a No. 16 carborundum brick or other abrasive of equal quality until even and smooth and of uniform appearance, without applying any cement or other coating. If additional finishing is necessary it shall be obtained by a thorough rubbing with a No. 10 carborundum rick or other abrasive of equal quality. Rubbing may be performed by use of satisfactory power equipment and tools, providing that the operational procedures shall be the same as those specified above for hand rubbing.
   c. Rubbing shall be kept to a minimum to produce smooth, even surfaces of uniform appearance. Rubbing will not be required to fill very small surface air bubble holes, to remove a uniform wood grain pattern left by forms, nor to remove inconspicuous lines or marking between form panels. Patches required for form ties, if carefully and properly done, may not necessitate rubbing. If however, this work is done in such a manner that these patches are conspicuous, the entire exposed face on which they occur shall be rubbed.
   d. After the final rubbing is completed, and the mortar has set up, the surface shall be thoroughly drenched and kept wet with clean water for a period of 5 days, unless

otherwise directed by USAID. No rubbing will be permitted when the air temperature is below 5 deg C.

3. Preparation of Bridge Seat Bearing Areas:

   a. General: Bridge seat bearing areas shall be considered to be those areas of the concrete bridge seats of the abutments, and piers that support the elastomeric bridge bearing pads. The limits of the bridge seat bearing area shall extend a minimum of 75 mm outside of the perimeter of the bearing device component that is in contact with the bridge seat. Bearing devices shall not be placed upon bridge seat bearing areas that are improperly finished, deformed or irregular. Bearing devices shall be set to the required grade in the exact positions called for on the Drawings and shall have full and even bearing upon the bridge seat concrete. Satisfactory drainage shall be provided as called for on the Drawings and where necessary to prevent water accumulation at the bridge seat bearing areas.
   b. Unless otherwise shown on the Drawings, the bridge seat concrete as cast shall be finished to the exact final required elevation and to the roadway profile grade slope in the direction parallel to the centerline of construction and to the cross slope set by the bridge seat elevations in the direction parallel to the centerline of bearings.
   c. For All Other Bearing Device Installations: The surface of the concrete within the limits of the bridge seat bearing area shall be cast a minimum of 5 mm higher than the required finished elevation. This additional concrete shall be cast monolithically with the rest of the bridge seat concrete and shall be sound and free of voids and laitance. After the concrete has been cured and thoroughly hardened, these areas shall be machine dressed down using methods to provide a true even surface at the following elevations and grades:

      1) Elevations: For bearing devices where the elastomeric bridge bearing pad is placed directly onto the as-finished bridge seat concrete surface, the surface of the bridge seat bearing area shall be dressed down to the exact final required elevation. For bearing devices that utilize a metal masonry plate, the metal masonry plate shall be set on a system of either rubber-cotton duck bearing pads or molded fabric bearing pads and the surface of the concrete shall be dressed down sufficiently below the required finished elevation so that the bearing pad will bring the bottom of the masonry plate to the exact final required elevation.
      2) Grades: The bridge seat bearing areas shall be finished level, except that the bridge seat bearing area for adjacent pre-stressed concrete deck and box beams shall be finished level in the direction parallel to the centerline of construction and shall be finished to follow the cross slope set by the bridge seat elevations in the direction parallel to the centerline of bearings.

4. Bridge Approach Slabs:

   a. After concrete is placed, the top surface shall be struck off to the proper crown and longitudinal profile with an approved template. Satisfactory supports, furnished by the Contractor, shall be set and maintained in place for proper operation of the template so that the surface shall be furnished to the required elevations. These supports shall be carefully removed from the concrete before any set of the concrete occurs, and the spaces left by such removal shall be immediately filled and finished to the level of the adjacent surfaces. The surface shall be checked, by

means of an approved straightedge, not less than 3 m in length, furnished by the Contractor, as USAID may direct. Any irregularities, measuring more than 5 mm vertically, shall be corrected and the whole surface shall be made smooth and even. No load of any kind shall be placed on the concrete after setting of the concrete has begun, and any work on the concrete then required shall be performed from approved bridges furnished by the Contractor, which will not rest on the new concrete in any manner.

3.11 PLACEMENT AND CURING PLAN

A. Placement and Curing Plan Submission Requirements:

1. At least 60 calendar days prior to the proposed start of placing the concrete bridge deck, the Contractor shall submit for approval, a submission (herein called the Placement and Curing Plan) specifying the method of concrete conveyance, placement, type and number of finishing machines and work bridges, rate of pour, estimated time of completion, screed and rail erection plan, sequence of concrete pours, and the concrete curing procedure. The Placement and Curing Plan shall take into consideration weather conditions. It shall also include details and a complete description of equipment to be used in the handling, placement, finishing and curing the concrete including the number and type of personnel who will be engaged in the operation. The personnel shall consist exclusively of persons with the experience and skill appropriate to their working assignment. Approval of this plan will not relieve the Contractor of the responsibility for the satisfactory performance of his/her methods and equipment. The Placement and Curing Plan shall include, but not be limited to, the following:

    a. Proof of the following minimum operator experience for the bridge deck finishing, or finishing machine operator experience:

        1) Five years of experience operating machines or similar type and manufacturer as that proposed.
        2) Proof of no less than five bridge decks of similar size, placed using a machine of the same manufacturer as that proposed.
        3) Or, as a substitute for 1) and 2): A representative of the manufacturer of the bridge deck finishing machine shall be present on the site a minimum of 24 hours in advance of the proposed deck placement to approve the set-up of the machine and rail system, and the representative shall be present for the entire duration of the placement of the deck concrete using the bridge deck finishing machine.

    b. Curing method.
    c. Provisions for enclosures, indicating method of holding down enclosure safely in place.
    d. When cold weather is reasonably expected or has occurred within 7 days of anticipated concrete placement, the Contractor shall include detailed procedures for the production, transporting, placing, protecting, curing, and temperature monitoring of concrete during cold weather, including a plan of heating devices, types and locations around structure.
    e. Procedures for accommodating abrupt changes in weather conditions.

1) Method of monitoring temperature of hardened concrete.
2) Backup systems as required.

2. Before concrete placement operations begin, the Contractor shall make all necessary arrangements and have all materials on hand for curing and protecting the concrete deck. Concrete placement shall not proceed until USAID is satisfied that all necessary steps have been taken to insure adequate compliance with these Specifications and that completion of the operation can be accomplished within the required scheduled time. It shall be the Contractor's responsibility to allow sufficient time to permit such an inspection by USAID.

3.12 PLACEMENT, FINISHING AND CURING OF CONCRETE BRIDGE DECKS

A. Placement of concrete bridge decks by using self-propelled finishing machines, all as indicated on the Drawings and in accordance with these Specifications.

B. Limitations on Placement:

1. In addition to the requirements contained herein, all weather and concrete temperature requirements contained in the Protection from Adverse Weather, provided within this specification, shall be satisfied. When placing concrete, the Contractor shall provide suitable equipment and take appropriate actions as approved by USAID to limit the evaporation rate of the exposed concrete surface to less than 0.75 kg/m2/hr. The deck surface evaporation rate shall be determined in accordance with FIGURE 1 (from "Plastic Cracking of Concrete" by Delmar Bloem for the National Ready Mixed Concrete Association and published in ACI 305R), or equivalent industry recommendations. To maintain the deck surface evaporation rate below 0.75 kg/m2/hr the Contractor shall take one or more of the following actions:

a. Misting the surface of the concrete with a triple head nozzle immediately behind the finishing machine and until the curing cover is applied. The nozzle shall be rated at 4 l/min or less and shall produce a fine fog mist that will maintain a “sheen” of moisture on the concrete surface without ponding.
b. Construct windscreens or enclosures to effectively reduce the wind velocity throughout the area of placement. If the use of windscreens is required, the windscreens shall consist of canvas barriers of suitable height erected on the windward side of the concrete placement.
c. Reduce the temperature of the concrete.

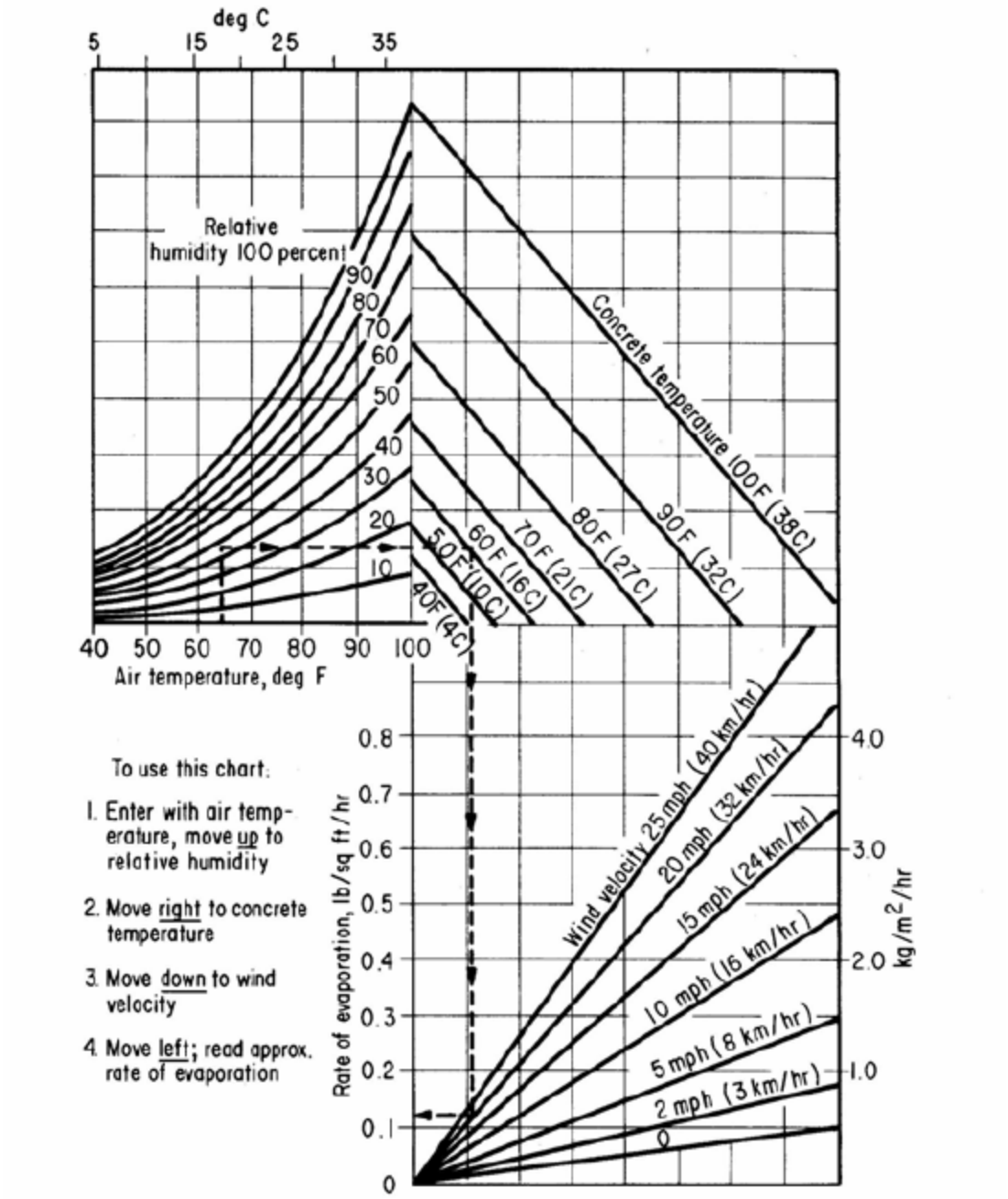

FIGURE 1

C. Placement:

1. Concrete placement shall take place during daylight and shall not begin unless the Contractor is certain that the placement can be completed and finished, to the satisfaction of USAID, during daylight hours. USAID may waive this requirement if adequate and approved lighting facilities are provided by the Contractor prior to the start of the deck placement. Before concrete placement operations begin substantial bulkheads or headers shall be shaped to the required deck surface cross-section.

2. In the event of unforeseen circumstances should the concrete placement be forced to cease, sufficient bulkheads shall be installed at locations determined by USAID and the concrete placement shall be discontinued. All concrete in place beyond the bulkhead shall be removed. Concrete placement will recommence only with the approval of USAID. Unless otherwise specified, the concrete shall be placed as a monolithic unit in a continuous operation between joints. A minimum rate of placement of 27m3/hr shall be maintained at each finishing machine.

D. Consolidation:

1. The concrete shall be consolidated by means of approved high frequency internal vibrators (9000 – 13500 vibrations per minute in concrete) that shall be applied in a manner to secure maximum consolidation of the concrete and by means of surface vibration from the vibrating pan(s) of the finishing machine. Consolidation shall leave the concrete free from voids and insure a dense surface texture, but not be continued so long as to cause segregation or bleeding. A small uniform quantity of concrete shall be maintained ahead of the screed on each pass. At no time shall the quantity of concrete carried ahead of the screed be so great as to cause slipping or lifting.
2. In the case where the vibratory action of the finishing machine does not provide consolidation in accordance with the rate of placement, the Contractor shall have in reserve at all times sufficient vibration equipment to guard against shutdown of the work. The Contractor shall take preventive measures to insure that the epoxy coated reinforcement is not susceptible to damage by the vibrators.

E. Finishing:

1. General:

a. Methods, procedures, and equipment shall be used which will insure a uniform riding surface without over-vibration or segregation of the components of the concrete. Regardless of the type of equipment used, freshly placed concrete should be distributed uniformly ahead of the strike-off and finishing operation, and as close to the final position as practicable. The finishing operations operation can be accomplished with either manual or mechanical equipment. If manual strike-off methods are used, they should be accomplished with a steel or steel-shod wooden screed. Manual floating methods, along the longitudinal direction, using plow-handled floats and long-handled “bull floats”, from working platforms spanning the deck transversely, are acceptable. Sprinkling the struck surface of the deck to facilitate floating will not be permitted.

2. Manual Methods:

a. Additional concrete shall be added to honeycombed and low spots, and the concrete struck off again. Proper finishing requires the skills of an experienced pavement finisher. These areas shall not be eliminated by tamping or grouting. The surface of the finished concrete after floating is to be checked with a 3 m straightedge placed parallel to the roadway centerline and at several positions from one edge of the deck to the other before moving to the next location. Successive locations should not exceed one-half the length of the straightedge. Any depressions found shall immediately be filled with fresh concrete, revibrated,

struck-off and refinished. Any areas not corrected in this manner may have to be corrected by grinding and will then lose the desired surface texture.

3. Mechanical Methods:

   a. Mechanical methods may also be used to provide the finished surface. When using a finishing machine, its weight shall not cause unaccounted deflection of the bridge members or falsework. The machine shall travel on steel rails, pipe or other approved grade control, which shall be supported by vertical supports securely fastened in place at a maximum spacing of 200 mm to prevent any appreciable deflection between rail supports. Screed rail supports may be located inside or outside of the placement width. Prior to placing the concrete, screed rails shall be completely in place, and accurately set to insure finishing of the concrete deck surface to the elevations shown on the Drawings.

   b. The supports for the rails, if embedded in the deck concrete, shall be of the type that can be removed without disturbing the concrete. Screed rails shall be set entirely above the finished surface of the concrete and shall be supported in a manner approved by USAID. Where stud type shear connectors are available, welding to the studs will be permitted. Where no studs are available, other means of attaching the screed rail supports shall be provided. No welding will be permitted directly on stringer or girder flanges or cover plates in tension areas, nor in areas subject to stress reversal, for attaching either screed rail supports of any type. Any welding in compression areas shall be approved by USAID.

   c. Screed rail supports set in the concrete shall be so designed that they may be removed to at least 50 mm below the surface of the concrete. Voids created by removal of the upper part of the screed rail supports shall be filled with mortar having the same proportions of sand and cement as that of the slab or wearing surface. The mortar shall contain an approved additive in sufficient proportions to produce non-shrink or slightly expansive characteristics. Screed rail supports shall not be treated with parting compound to facilitate their removal. Rails for finishing machines shall extend beyond both ends of the scheduled length for concrete placement. The extended length shall be of sufficient distance to allow finishing machine(s) to clear the concrete to be placed.

4. Finishing Machine:

   a. For concrete deck placements specified to be less than or equal to 4.5 m in width, or less than or equal to 15 m in total bridge length, the finishing machine shall be a lightweight vibrating screed with the following features:

      1) It shall be portable and easily moved, relocated, or adjusted by no more than four workers.
      2) The power unit shall be operable without disturbing the screeded concrete.
      3) It shall be self-propelled with controls, that will allow a uniform rate of travel and by which the rate of travel can be increased, decreased, or stopped
      4) It shall have controlled, uniform, variable frequency vibration, from end to end.
      5) It shall be fully adjustable for flats, crowns, or valleys.
      6) The screed length shall be adjustable to accommodate the available work area.

b. The finishing machine shall be operated over the full length of the bridge segment to be finished prior to beginning of concrete placement operations. The test run of the self-propelled finishing machine shall be performed in the presence of USAID at least 24 hours in advance of the concrete placement with the screed adjusted to its finishing position. During the test run, checks shall be made of the deflection due to the finishing machine, adjustment of guide rails and required covers for slab reinforcement. The required concrete cover over the top bars shall be checked by riding the screed over the bars and measuring the cover over the slab reinforcement. Discrepancies so found, which are in excess of the tolerances shall be rectified to secure the required concrete cover. All necessary corrections shall be made before concrete placement is begun.

c. The rate of concrete placement shall be coordinated with the initial strike-off so that the initial strike-off is never more than 3m behind the concrete placement. Sufficient depth checks shall be made behind the machine(s) and along the full length of the span to insure achievement of the required section and reinforcement cover. Improper adjustment or operation of the finishing machine(s) that results in inadequate reinforcement cover or smoothness shall be corrected immediately. Unsatisfactory performance, particularly with respect to the surface smoothness attained, shall be cause for rejection of the equipment and cement concrete placed.

5. Work Bridges:

a. Work bridges supported on the screed rails shall be provided by the Contractor in order to permit access to the surface of the deck for the purpose of finishing, straight-edging, making corrections, and setting curing materials. The Contractor shall furnish a minimum of two work bridges behind the bridge deck finishing machine, capable of spanning the entire width of the deck and supporting at least a 225 kg load without deflection to the concrete surface. These working bridges shall be available to USAID for inspection purposes. Workmen will not be permitted to walk in the fresh concrete after it has been screeded. All finishing work, including application of the fog spray and placement of curing mats, shall be performed from bridges supported above the deck surface.

6. Tolerances:

a. Verification that the completed surface of the deck has been constructed in accordance with the grades and cross slopes show on the Drawings shall be made immediately after finishing and again after the deck has been cured. The Contractor shall check the surface of the concrete with a 3 m long metal straightedge operated parallel and perpendicular to the centerline of the bridge.

b. Deck surfaces shall show no deviation in excess of 6 mm from the testing edge of the straightedge. The checking operation shall progress by overlapping the straightedge at least one half of the length of the preceding straightedge pass. Any area that requires finishing to correct surface irregularities shall be re-textured which may be performed with a hand-operated texture mat wrapped in a roll or attached to a round or curved shaped base. In the event that the tolerance is not met when tested after the concrete has hardened, variance in excess of 6 millimeters in 3 meters shall be marked and corrected at the Contractor's expense in a manner satisfactory to USAID. The Contractor shall correct out of tolerance hardened concrete surface irregularities by the use of concrete planing or grinding equipment that does not damage the remaining concrete or violate minimum cover

requirements on steel reinforcement. The straightedges shall be furnished and maintained by the Contractor. They shall be fitted with a handle and all parts shall be made of aluminum or other lightweight metal. Straightedges shall be made available for use by USAID.

F. Curing:

1. All concrete bridge decks shall be kept wet with clean fresh water for a curing period of at least 14 days after placing of concrete. Curing shall begin by fog spraying during the placing and finishing operations. Fogging shall continue and shall be applied continuously, rather than intermittently, after the finishing operation until wet covering material has been placed over the concrete surface. Deck finishing machine mounted fogging systems shall be augmented by hand-held fogging equipment as needed.
2. All bridge decks, sidewalks, and barriers shall be water cured only and shall be kept continuously wet for the entire curing period by covering with one of the following systems:

    a. Two layers of wet burlap.
    b. One layer of wet burlap and either a polyethylene sheet or a polyethylene coated burlap blanket. Curing protection shall be applied within 15 minutes after the concrete is deposited and before the surface of the concrete has lost its surface "wetness" or "sheen" appearance. The burlap shall be completely saturated over its entire area by being submerged in water for at least 8 hours before the scheduled start of the placement. The burlap shall be drained of excess water prior to application. The burlap shall be free from cuts, tears, uneven weaving and contaminants. The burlap shall be placed such that the edges are lapped a minimum of 150 mm. Continuous burlap wetting shall commence 10 minutes from the time it is placed and shall be kept continuously wet and protected from displacement for the entire curing period in a manner acceptable to USAID.

3. The covering of bridge decks, sidewalks, and barriers shall be kept continuously wet for the entire curing period by the use of soaker hoses. The soaker hoses shall circulate water continuously and shall be located to insure a completely wet surface for the entire curing period.
4. The Contractor shall make sure that adequate personnel are available at the site to carry out the placement, screeding, finishing, fogging and curing operations simultaneously. To overcome shrinkage problems, the use of wind screens and sun shades shall be used as conditions require.
5. The application of impervious liquid membrane curing compounds shall not be considered a substitute for achieving the curing of the concrete required by these Specifications. Only in the event of an unavoidable delay during concrete placement shall two coats of an approved curing compound be sprayed on to the concrete that has been deposited and not screeded.
6. Curing compounds shall not be applied to the screeded surfaces of bridge decks. The Contractor shall limit the maximum concrete temperature to 20 deg C, and control the temperature of the concrete to ensure that it does not fall below 14 deg C. Heat control shall be accomplished through a combination of proper cement concrete ingredient selection to minimize heat generated, pre-placement cement concrete ingredient cooling, post-placement cooling, cement concrete placement rate control, cement concrete surface insulation to minimize heat loss, and providing supplemental heat to prevent heat loss.

7. The Contractor shall measure and record concrete and ambient air temperatures on an hourly basis for at least the first 72 hours after placement or longer during hot or cold weather conditions. In accordance with the Placement and Curing Plan. The Contractor shall furnish temperature log records of the temperatures that are recorded at a maximum frequency of once per hour. Temperature data shall be furnished to USAID as required, with a minimum frequency of once per day.

G. Cold Weather Requirements:

1. Cold weather is defined as any time during the concrete placement or curing period the ambient temperature at the work site drops below 5 deg C or the ambient temperature at the site drops below 10 deg C for a period of 12 hours or more. When cold weather is reasonably expected or has occurred within 7 days of anticipated concrete placement, the Contractor shall conform to the cold weather requirement of the Placement and Curing Plan. All material and equipment required for cold weather placement and curing protection shall be available at the project site before commencing concrete placement. All snow, ice, and frost shall be removed from the surfaces, including reinforcement, against which the concrete is to be placed. The temperature of any surface that will come into contact with fresh concrete shall be at least 2 deg C and shall be maintained at a temperature of 2 deg C or above during the placement of concrete.
2. During the curing period, the Contractor shall provide suitable measures to maintain the concrete surface temperature between 14 deg C and 30 deg C which shall be monitored by continuously recording surface temperature measuring devices that are accurate within 1 deg C. At least one temperature measuring device shall be randomly placed in an accessible location for every 140 square meters of concrete deck surface area being cured.
3. The minimum concrete surface temperature requirement shall be continuously maintained for the entire 14 day wet curing period. Any day during which the minimum concrete surface temperature requirement of 14 deg C is not continuously maintained shall not count as a day contributing to the curing period.
4. If the concrete surface temperature falls below 7 deg C during the curing period, the structure shall be enclosed and external heat shall be provided as directed by USAID. If external heat is required, the following shall apply:

    a. The time required for tenting shall not be counted as curing time.
    b. External heat shall be maintained on and below the structure for the entire curing period and then reduced gradually such that the uniform change in temperature does not exceed 3 deg C in one hour or 10 deg C in any 24 hour period. If at any time during the curing period the concrete surface temperature falls below 2 deg C, the concrete will be inspected by USAID for possible damage due to exposure to freezing temperatures. Concrete determined by USAID to be damaged due to exposure to freezing temperatures will be considered as being unsatisfactory and rejected.

5. Adequate precautions shall be taken to protect the concrete deck from any damages resulting from severe weather conditions during the curing process.

H. Surface Texturing:

1. Unless otherwise shown on the Drawings, the final finish required shall be as follows:

a. Bridge decks shall receive an artificial turf drag finish and shall be grooved using multi-bladed self-propelled saw cutting equipment. Transverse grooves shall be saw cut no sooner than completion of the 14 day wet curing operation provided that the concrete has reached a compressive strength of 23 MPa. The grooves shall be rectangular in shape, 3 mm wide (plus 1.5 mm, minus 0 mm) and 5 mm deep (plus or minus 1.5 mm). The grooves shall be cut at a variable spacing measured from the centerline of grooves as follows: 19, 29, 16, 25, 16, 29, and 19 mm in 150 millimeter repetitions across the width to be grooved in one pass of the mechanical saw device. One 150 mm sequence may be adjusted by one-quarter sequence increments to accommodate various cutting head widths provided the general pattern is carried out. The tolerance for the spacing of the grooves is plus or minus 1.5 mm.

b. The groove saw cutting equipment shall have a depth control device that will detect variations in the surface profile and adjust the cutting head height to maintain the depth of groove specified. The groove saw cutting equipment shall be provided with devices to control the alignment. Flailing type grooving that is uncontrolled and erratic will not be permitted. Grooves shall be cut continuously across the roadway, perpendicular to the centerline of the roadway, and shall stop 305 mm from the curb line. Grooves shall be continuous across construction joints. No un-grooved deck surface greater than 150 mm in width shall remain. A minimum clearance of 25 mm shall exist between the first groove and the end of deck or edge of metal bridge deck expansion joint. No overlapping or repeating of grooving in the same location by the grooving machine will be permitted. The pattern of grooving will be discussed and agreed upon with USAID before grooving begins. Debris and residue from the grooving operation shall be continuously removed and properly and legally disposed of off-site. Residue from grooving operations shall not be permitted to flow into gutters or drainage facilities. The surface of exposed concrete decks shall be left in a washed clean condition that is free from all slipperiness from the saw cutting slurry. A 305 mm wide margin shall be finished adjacent to curbs with a magnesium float.

I. Sidewalks on Bridges:

1. After being placed, the horizontal concrete surfaces shall be properly screeded and finished to true grade and surface. The finish shall be with an approved float, followed by light brushing with a fine brush but without the addition of any water to remove the cement film, leaving a fine grained, smooth but sanded texture. The surfaces shall then be cured as specified.

3.13 MISCELLANEOUS CONCRETE ITEMS

A. Weep Holes and Drains:

1. Weep holes shall be provided through all structures as indicated on the Drawings. Ends of weep holes that are to be covered by backfill shall be protected as shown on the Drawings and as follows:

a. Crushed stone shall conform to crushed stone No. 2 as specified in Division 31 Section “Earth Moving”.

b. Geotextile fabric shall conform to soil stabilization fabric (woven geotextile) as specified in Division 31 Section “Riprap”.
c. Geotextile fabric shall be installed as shown on the Drawings and in accordance with the manufacturer’s instructions.

B. Protection of Pipes and Conduits:

1. The Contractor shall care for and protect from injury all pipes, wires and conduits encountered in the work by furnishing and maintaining suitable supports, including steel bars, on the bridge during construction. The Contractor shall provide suitable openings in the abutments and walls as shown on the Drawings. If required, the opening shall be filled with concrete in a satisfactory manner.

3.14 CONCRETE PROTECTION AND CURING

A. Curing:

1. All concrete shall be kept fully saturated and protected against any drying action by methods of curing specified herein or as otherwise approved by USAID in the Curing Plan for Hot and Cold Weather Concrete in the Placement Plan, and in the Placement and Curing Plan for not less than 7 days after placing cement concrete. All surfaces of concrete which are to receive a rubbed surface finish or on which bituminous dampproofing is to be placed], and concrete at construction joints shall be cured in accordance with requirements below for water curing. All other concrete may be cured in accordance with requirements below for water curing or waterproof membrane curing.

B. Mass Concrete:

1. Concrete placements where all volumetric dimensions of the placement are 1.2 m or greater shall be considered mass cement concrete. Mass concrete shall also include concrete placements of other dimensions where measures must be taken to mitigate potential cracking caused by heat of hydration when such placements are specifically designated as mass cement on the Drawings. The Contractor shall perform the following to prevent cracking in mass concrete placements:

a. Limit the temperature differential between the internal (hottest) and external (coolest) temperature of the cement concrete to 21 deg C and limit the maximum concrete temperature to 20 deg C. Heat control shall be accomplished through a combination of proper cement concrete ingredient selection to minimize heat generated, pre-placement cement concrete ingredient cooling, post-placement cooling, cement concrete placement rate control, concrete surface insulation to minimize heat loss, and providing supplemental heat to prevent heat loss.
b. Measure and record concrete and ambient air temperatures on an hourly basis. Temperature data shall be furnished to USAID as required, with a minimum frequency of once per day.

C. Water Curing:

1. Curing of concrete shall begin by fog spraying immediately upon the disappearance of free bleed water on concrete surfaces not protected by forms. Fog spraying shall

continue until the burlap cover has been placed. The amount of fog spray shall be strictly controlled, so that accumulations of standing or flowing water on the surface of concrete shall not occur.

2. Should atmospheric conditions render the use of fog spray impractical, the Contractor shall use plastic covers of suitable weight and securely weighed down, but not directly in contact with the concrete. The covers shall be used only until the initial set has taken place. The burlap covers shall be placed immediately thereafter. On the windward side of the panel being cured, the Contractor shall erect canvas barriers of suitable height when necessary to protect the curing concrete from the direct force of the wind.
3. The area of concrete to be cured shall be covered by wet burlap blankets placed as soon after concrete finishing as USAID determines will not cause damage to the concrete surface. However, in no case will the foregoing time period exceed 1 hour after placing of concrete. Fog spray or covers shall be used continuously during this period. The burlap shall be completely saturated over its entire area by being submerged in water for at least 8 hours before the scheduled start of the placement. The burlap shall be drained of excess water prior to application. The burlap shall be free from cuts, tears, uneven weaving and contaminants. The burlap shall be placed such that the edges are lapped a minimum of 150 mm. Burlap shall be kept continuously wet and protected from displacement for the entire curing period in a manner acceptable to USAID.
4. The coverings shall be kept thoroughly wet by sprinkling with a fine spray of water until they may be removed. Wooden forms without liners, if left in place longer than 2 days after the placing of the concrete, shall be thoroughly wet down at least once each day for the remainder of the required curing period. Formed surfaces shall, after the removal of forms, be cured in like manner for the remainder of the required period, the entire surface of the concrete being thoroughly drenched with water and covered immediately after the forms are removed. Portions of the covering material may be removed temporarily when and as necessitated by any required finishing or waterproofing operation.

D. Impervious Liquid Membrane Curing:

1. Immediately after the free bleed water has disappeared on surfaces not protected by forms and immediately after the removal of forms, if such are removed before the end of the required curing period, the concrete shall be sealed by spraying as a fine mist a uniform application of the membrane curing material in a manner as to provide a continuous uniform, water impermeable film without marring or otherwise damaging the concrete.
2. The membrane curing shall be applied in one or more separate coats at the rate recommended by the manufacturer. If, in USAID's judgment, discontinuities or pinholes exist or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the material shall be applied immediately to those affected areas at the specified rate. If a slight delay in application shall occur, which permits the concrete surface to dry, the surface of the concrete shall be thoroughly moistened with water, immediately prior to the application of the membrane curing material. Application of membrane curing may be delayed for 12 hours if the concrete surface is protected and kept moist by the use of wetted burlap.
3. The membrane compound shall be thoroughly agitated immediately before application. The liquid shall be applied under pressure by means of an approved pressure spray which shall be held not more than 600 mm away from the concrete surface and the spray protected from any wind by suitable means as may be necessary, so as to apply the material directly onto the concrete surface.

4. The sprayed surface film shall be protected from abrasion or damage for the duration of the required curing period. The placing of materials or unnecessary walking on the surface will not be allowed until the film is at least 2 days old; and then only if no damage is caused to the surface film during the required curing time.

E. Curing by Other Methods

1. Other methods of curing may be used only when approved in writing by USAID prior to any use in the work.

3.15 CONCRETE SEALER

A. Concrete sealer shall be applied to cement concrete. Clear concrete sealers, after complete application, shall not stain or discolor the concrete. Application of the sealer shall not alter the surface texture and shall be compatible with the use of surface finish coatings and/or caulkings. The surface shall dry to a tack free condition. Application of the sealer shall be in accordance with the manufacturer's recommendations, including condition and preparation of surfaces to be treated and safety precautions.

B. The preparation process shall not cause any damage to the concrete surface, remove or alter the existing surface finish, or expose the coarse aggregate of the concrete. USAID shall approve the prepared surface prior to application of the sealer. The Contractor shall prevent the sealer from coming in contact with any joint sealers.

3.16 CRACK AND JOINT SEALING

A. Cement Concrete crack sealing requirements defined herein are for the repair and sealing of cast-in-place cement concrete to prevent water infiltration to the steel reinforcement bars, as noted on the Drawings or as directed by USAID. Concrete cracks shall be sealed in accordance with the sealant manufacturer's requirements. The Contractor shall be required to seal cracks even if the environmental conditions during placement and curing satisfied specification requirements.

B. Crack sealing materials shall be applied by skilled applicators under a supervisor with proven successful experience in applications with similar scope of work. Crack sealing materials shall be applied when the concrete and the ambient air temperatures are above 4 deg C. If a heated enclosure is used to accomplish this, the heating units shall be properly vented to the outside of the enclosure to prevent products of combustion from exhausting within the enclosure.

C. Before containers of sealing materials are opened, the labels shall be checked and the label information shall be documented. If multi-component systems are used, mixing shall be completed prior to application. Manufacturer's instructions shall be followed. An initial crack sealing application demonstration shall be satisfactorily made in the presence of USAID before the application is continued.

D. Before sealing, the concrete shall be clean, sound, and free of contaminants and surface moisture. Any curing compounds, sealers, oils, greases, coatings, or other impregnations shall be removed by sandblasting. Once any concrete surface contaminants are removed, the

concrete shall be swept clean and blown off using oil free compressed air immediately prior to applying the sealer.

E. Methacrylate crack sealing shall be performed in accordance with the manufacturer's instructions within the allowable ambient temperature range. The cracks shall be v-notched to a minimum depth of 12 mm and shall be cleaned with compressed air. The notch shall then be inspected to confirm that the crack was intercepted. If the crack was not intercepted, the notch shall be expanded to intercept the crack and shall then be re-cleaned with compressed air. Methacrylate shall then be poured into the crack. The crack shall then be observed for seepage of methacrylate and shall be refilled as necessary to ensure the crack is completely filled. If large quantities of methacrylate are used and the crack is not getting filled, the crack should be filled with pre-bagged dried silica sand filler and the crack shall then be re-filled with methacrylate.

F. Epoxy injection crack sealing shall be performed in accordance with the manufacturer's instructions within the allowable ambient temperature range. The cracks shall be cleaned with compressed air. Surface mounted injection ports shall then be installed over the centers of the cracks. The spacing of these ports shall be contingent upon the material and the injection equipment chosen. Socket porting shall be allowed provided that a hollow drill bit and vacuum system is used to prevent debris from entering the cracks. Surface ports shall be mounted with rapid setting epoxy material. The crack widths shall be noted during port installation. After the ports are installed, the crack surfaces shall be sealed with high modulus, 100 percent solids, moisture tolerant epoxy paste adhesive. This material shall be capped with fine sand before it is cured. After the capping material has cured, the cracks shall be injected with an epoxy resin compound. The injection pressure used to seal the cracks shall be based upon a number of factors including crack width, crack depth, and the epoxy material used. Injection shall be accomplished using a metered system. The system shall be equipped with a pressure gauge accurate for the pressures anticipated for this work. Injection shall start at the widest point of the crack and shall continue until the narrowest portions of the crack have been filled. Injection shall continue until refusal. If epoxy is observed at adjacent ports, the adjacent port shall be capped and injection shall continue until refusal occurs. Once refusal occurs, injection shall continue at the next wet port until refusal is reached.

G. The type of Cement Concrete crack sealing required shall be determined as a function of the surface type and maximum crack width as follows:

1. Bridge decks and other non-overhead surfaces sloped less than or equal to 15 percent:

    a. Cracks less than 0.15 mm wide shall be ignored.
    b. Cracks greater than or equal to 0.15 mm wide and less than 0.30 mm wide shall be sealed with an approved methacrylate.
    c. Cracks greater than or equal to 0.30 mm wide shall be sealed using either epoxy injection or methacrylate with a sand filler.

2. Overhead surfaces, vertical surfaces, and non-overhead surfaces sloped greater than 15 percent:

    a. Cracks less than 0.15 mm wide shall be ignored.
    b. Cracks greater than or equal to 0.15 mm wide and less than 0.41 mm wide shall be sealed with an approved silane sealer.

c. Cracks greater than or equal to 0.41 mm wide shall be sealed using epoxy injection.

3.17 BRIDGE JOINTS

A. Construction Joints:

1. Construction joints not shown on the Drawings will not be permitted except in case of emergency, when approved by USAID. Concrete in structures shall be placed in such a manner that all construction joints shall be exactly horizontal or vertical, as the case may be, and that they shall be straight and as inconspicuous as possible. All concrete placed between construction joints, shall be placed in a continuous operation. In order to allow for initial shrinkage, concrete shall not be placed against the second side of the construction joint for at least 3 days after that on the first side has been placed.
2. When making a horizontal construction joint, care shall be taken to have the concrete below the joint as dry as possible and any excess water or creamy material shall be removed before the concrete sets. Within 12 hours after the concrete below the joint has been placed, the top surface shall be thoroughly cleaned by the use of pressurized water blast and wire brushes and all laitance and loose material removed so as to expose clean, solid concrete. Care shall be taken not to loosen any of the coarse aggregate in the concrete. If for any reason this laitance is not removed before the concrete has hardened in place, it shall be removed using such tools and methods as may be necessary to secure the results specified above.
3. Immediately before placing concrete above the joint, the surface of the concrete below the joint that has been cleaned as specified above shall be thoroughly pre-wetted for a minimum duration of 12 hours. On all exposed surfaces, the line of the proposed joint shall be made truly straight by tacking a temporary horizontal straight edge on the inside of the form with its lower edge on the line of the joint and then placing the concrete sufficiently higher than this edge to allow for settlement. Immediately before placing the new concrete, the forms shall be drawn tightly against the concrete already in place. In construction joints, approved waterstops of plastic material shall be placed not less than 75 mm from the face of concrete and shall extend a minimum of 65 mm into the concrete unless otherwise shown on Drawings. Prior to the use of plastic waterstops, the manufacturer's installation instructions shall be furnished to USAID.

3.18 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by USAID. Remove and replace concrete that cannot be repaired and patched to USAID's approval.

B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 13 mm in any dimension to solid concrete. Limit cut depth to 19 mm. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with repair mortar before bonding agent

has dried. Fill form-tie voids with repair mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, repair mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by USAID.

3.19 FIELD QUALITY CONTROL

A. Testing and Inspecting: USAID will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports, except where noted.

1. The Contractor shall provide safe and convenient access to all areas of the Work that are reasonably required by testing and inspecting agency in the performance of their work.
2. Contractor to supply all batch tickets to USAID's testing agency. Batch tickets to note w/c ratio and amount of water allowed to be added at Project site.
3. Inspections:

    a. Steel reinforcement placement.

B. Concrete Tests: Testing of composite samples of fresh concrete shall be performed according to the following requirements:

1. Procedures for obtaining representative samples of fresh concrete for testing shall be in accordance with the following, as a minimum:

    a. Elapsed time shall be 15 minutes, maximum, between obtaining first and last composite samples. Sample size shall be approximately 28 L. Ensure that enough concrete is taken for the sample so that all of the tests required can be performed.
    b. Move samples to testing location. Samples shall be combined and remixed with a shovel to provide uniformity and consistency. Do not over remixed samples when combining into one sample.
    c. Tests for slump, temperature and air content shall be started within 5 minutes of obtaining the last composite sample. Complete these tests within 10 minutes of starting tests.
    d. Cylinders for compressive strength tests shall be made immediately upon completion of the other tests.
    e. Do not reuse the same concrete for different tests.

        1) Testing Frequency: Obtain at least one composite sample for each 76 cu. m or fraction thereof of each concrete mixture placed each day, nor less than once per each 465 square meters of surface area of walls or slabs.

2. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

a. Include corresponding concrete mix batch tickets and design mix with each test report.
b. Indicate amount of water added to batch at Project site.
c. Slump: Perform a slump test in accordance with ASTM C 143/C 143M; "Slump of Hydraulic Cement Concrete" or equivalent industry standard, one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change. Measure after slump adjustment.
d. Air Content: Perform an air content test in accordance with ASTM C 231, "Air Content of Freshly Mixed Concrete by the Pressure Method" or equivalent industry standard pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
e. Concrete Temperature: Determine concrete temperature in accordance with ASTM C 1064/C 1064M, "Temperature of Freshly Mixed Hydraulic Cement Concrete" or equivalent industry standard; one test hourly when air temperature is 4.4 deg C and below and when 27 deg C and above, and one test for each composite sample.
f. Density (Unit Weight): Perform a unit weight test in accordance with ASTM C 138/C 138M, "Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete" or equivalent industry standard, fresh unit weight of concrete. Two tests per 7 cubic meters batch or less, one at beginning of pour and one near end of pour.
g. Unit Weight: Perform a unit weight test in accordance with ASTM C 567, "Determining Density of Structural Lightweight Concrete" or equivalent industry standard, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
h. Compression Test Specimens: Make and cure compression test specimens in accordance with ASTM C 31/C 31M, "Making and Curing Concrete Test Specimens in the Field" or equivalent industry standard.

3. Cast and standard cure six cylinders for each composite sample.

    a. Standard curing:

        1) Storage: Place cylinders on a firm level surface. Surface slope shall be no greater than 20 mm per meter. Protect cylinders from damage.
        2) Initial Curing: For first 48 hours, store cylinders at a temperature range of 16 deg C to 27 deg C. Prevent cylinder moisture loss. When cardboard molds are used, protect the cardboard molds from contact with wet items.
        3) Final curing: After 48 hours, remove the molds. Within 30 minutes of mold removal, immerse concrete cylinders in 21 deg C to 25 deg C water.

4. Cast and field cure two standard cylinders for each composite sample.

    a. Field curing:

        1) Storage: Place cylinders on a firm level surface. Surface slope shall be no greater than 20 mm per meter. Protect cylinders from damage.

2) Curing: Place the cylinders near the pour from which the sample was taken and used to make the cylinders. Cure the cylinders within the curing envelope of the pour so that the cylinders receive the same curing environment as the concrete they represent.

3) Compressive Strength Tests: Perform compressive strength tests in accordance with ASTM C 39/C 39M, or equivalent industry standard. The test method requires the application of a compressive axial load to molded cylinders at a predetermined rate until failure of the cylinder. The compressive strength of the cylinder is determined by dividing the load at the time of failure by the cross sectional area of the cylinder.

5. Test two standard cured cylinders at 7 days, three cylinders at 28 days, and retain one cylinder for testing at 56 days as deemed necessary by USAID.
6. Test two field cured cylinders at 28 days.
7. A compressive strength test shall be the average compressive strength from a set of two cylinders obtained from same composite sample and tested at age indicated.
8. If one cylinder in the test shows evidence of improper sampling, molding or testing, discard the cylinder and consider the strength of the remaining cylinders to be the test result. If more than one cylinder in a test shows any defects, discard the entire test.

a. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
b. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive strength tests equals or exceeds specified compressive strength and no compressive strength test value falls below specified compressive strength by more than 3.4 MPa.
c. Test results shall be reported in writing to USAID and Contractor within 48 hours of testing. Reports of compressive strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
d. Nondestructive Testing: Impact-echo, ultrasonic methods, or other nondestructive methods may be permitted by USAID but will not be used as sole basis for approval or rejection of concrete.
e. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by USAID. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M, “Obtaining and Testing Drilled Cores and Sawed Beams of Concrete” or equivalent industry standard, or by other methods as directed USIAD.
f. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. The Contractor shall correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents, at no additional cost to USAID.

END OF SECTION 03 30 00

SECTION 07 11 13 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cutback asphalt bituminous dampproofing applied to the back faces of the abutments and walls, and top of approach slabs.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

a. Cutback asphalt dampproofing.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit bituminous dampproofing to be performed according to manufacturers' written instructions.

B. Concrete surfaces shall be allowed to dry for a period of at least 5 days, after removal of forms, before applying bituminous dampproofing.

C. Sand mortar patches shall be allowed to dry a minimum of 2 days before applying bituminous dampproofing.

D. Dampproofing shall not be done during wet weather, nor when application temperature is outside the manufacturer’s recommended application temperature range.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain bituminous dampproofing materials from single source and from single manufacturer. Provide auxiliary materials, including primer if required, recommended in writing by manufacturer of bituminous dampproofing materials.

2.2 BITUMINOUS DAMPPROOFING

A. Bituminous dampproofing material shall be rapid curing type or medium curing type conforming to the following:

1. Cutback Asphalt Rapid Curing Type: Homogeneous blend of asphalt cements and suitable solvents free from water and conforming to the requirements of AASHTO M 81, "Cutback Asphalt (Rapid-Curing Type), or equivalent industry standard.
2. Cutback Asphalt Medium Curing Type: Homogeneous blend of asphalt cements and suitable solvents free from water and conforming to the requirements of AASHTO M 82, "Cutback Asphalt (Medium-Curing Type), or equivalent industry standard.

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Sand Mortar Patching Mix: Sand mortar patching mix shall consist of 1 part cement to 2 parts sand. Mix with water to produce a consistency suitable for application.

1. Cement shall be of the same type as used in the structure to which sand mortar patching mix is applied.
2. Sand shall be clean and contain no unsuitable material and shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
4.75 mm	100
2.36 mm	95 to 100
1.18 mm	70 to 100
600 um	40 to 75
300 um	10 to 35
150 um	2 to 15
75 um	0 to 5

3. Water: Potable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

B. Proceed with application only after structure construction work has been completed and unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor’s acceptance of surfaces and conditions.

3.2 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with bituminous dampproofing. Prevent bituminous dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the bituminous dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by the bituminous dampproofing manufacturer.

C. Apply sand mortar patching mix to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for bituminous dampproofing application, cure time between coats, and drying time before backfilling.

1. Apply bituminous dampproofing to provide continuous plane of protection.

B. Concrete surface preparation shall be in accordance with bituminous dampproofing manufacturer’s instructions and as specified.

C. Surfaces to be bituminous dampproofed shall be made reasonably smooth and free from all projections and holes. All holes in concrete surfaces shall be filled with sand mortar patching mix before bituminous dampproofing is applied and allowed to dry.

D. Surfaces to receive bituminous dampproofing shall be dry and immediately before the application of the bituminous dampproofing shall be cleaned of dust and all loose material.

E. The bituminous dampproofing shall be mopped or sprayed in accordance with the manufacturer’s instructions on the designated surfaces shown on the Drawings, and in amounts necessary to obtain a two coat coverage of not less than 2 liters of bituminous dampproofing material per 10 square meters of surface.

F. The initial coat of bituminous dampproofing material shall be allowed to dry thoroughly before the second coat is applied.

G. The final coat shall be thoroughly dry before backfill is placed against it.

3.4 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction and in accordance with bituminous dampproofing manufacturer's instructions.

END OF SECTION 07 11 13

SECTION 07 13 54 - MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Membrane waterproofing applied to the concrete bridge deck prior to installation of the roadway wearing course. Membrane waterproofing shall consist of a preformed sheet system comprised of an impregnated woven fiberglass high strength inner mat sandwiched between layers of a modified polymer bitumen, with a spun-bonded polyester top mat, or approved equivalent.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, forecasted weather conditions, special details, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

PART 2 - PRODUCTS

2.1 SHEET WATERPROOFING

A. Sheet Membrane Waterproofing: 0.15 cm (+/- 0.0127 cm) thick flexible sheet meeting the physical properties tabulated below:

PHYSICAL PROPERTIES	**TEST METHOD**	**PERFORMANCE**
Rubberized Asphalt Compound Elongation	ASTM D 1000	1000% Min.
Tensile Strength	ASTM D 1000	4.46 kg/cm
Permeance	ASTM E 96 Method B	.05 US Perms (max)
Rubberized Asphalt Compound Softening Point	ASTM D 36	97.8deg C (min)
Rubberized Asphalt Compound Penetration	ASTM D 5	40-60 @ 77deg F 5 sec @ 100g Neddle
Puncture Resistance	ASTM E 154	11 kg
Low Temperature Pliability	ASTM D 146 1” Mandrel @ -31deg C	No cracks or splints @ 180deg bend
Cycling Shear Strength	RTM 30 – 5.08 cm min @ 0degC with 0cm opening & .3175 cm displacement	1.76 kg/cm^2 (min)
Cycling Shear Strength Recovery	RTM 30 - .635 cm recovery @ 0degC	Constant load @ 1000 cycles no damage
Resistance to Hydrostatic Head	RTM 29	45.75 m (min)
Water Absorption	ASTM D 1228 – 72 hours	.25% (max)
Peel Adhesion	180deg peel after 1 hour primed steel	1.784 kg/cm (min)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 SURFACE PREPARATION

A. All concrete surfaces which are to be waterproofed shall be screeded true to the section. Depressions shall be filled to a smooth flush surface with 1:2 mortar (1 part cement to two parts sand) or an approved rapid setting patching mortar. Other surfaces shall be trimmed of rough spots, projects or other defects which may cause puncture of the membrane.

B. The membrane waterproofing on bridge decks shall not be placed unless the Contractor is ready to follow within 24 hours with the wearing surface, a longer period of time will be allowed only with the approval of the Engineer.

C. Immediately prior to the membrane application, the concrete surface shall be thoroughly swept and blown clean to remove and loose debris.

D. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

3.3 FULLY ADHERED SHEET INSTALLATION

A. Install fully adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions.

B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.

C. Apply bonding adhesive to substrates at required rate and allow it to partially dry.

D. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.

3.4 WEARING SURFACE PROTECTIVE COURSE

A. The wearing surface shall serve as the protective course, placed within 24 hours after the membrane has been installed.

B. The use of rubber tired mechanical pavers and trucks on the membrane will be permitted provided workmanship is satisfactory to the Engineer. If work is judged unsatisfactory, placement shall be by hand.

C. After the mixture has been properly places, it shall be rolled. Delays in initial rolling of the fresh placed mixture will not be permitted.

D. The wearing surface shall be placed such that the number of joints required shall be reduced to a minimum.

E. No wearing surface work shall be performed during rainy weather or when weather conditions as to temperature or otherwise are, in the Engineer's judgment, unsuitable for obtaining satisfactory results.

3.5 FIELD QUALITY CONTROL

A. Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation; membrane application, protection, and to furnish daily reports to Engineer.

3.6 PROTECTION, REPAIR, AND CLEANING

A. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates and reapply waterproofing.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 53

SECTION 07 95 63 – ELASTOMERIC BRIDGE BEARINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Furnishing and installing elastomeric bridge bearing pads and associated plates and anchors.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Shop Drawings:

a. Elastomeric bridge bearing pads.

2. Product Data:

a. Elastomeric bridge bearing pads.
b. Steel plates.
c. Anchor bolts, nuts and washers.
d. Base plate threaded studs, nuts and washers.

3. Other Submittals:

a. Written Notification: Written notification shall be provided as required in "Quality Assurance" Article.
b. Certificates: Certificate from manufacturer stating that elastomeric bridge bearing pads, as furnished for this Project, conform to AASHTO M 251, "Plain and Laminated Elastomeric Bridge Bearings", or equivalent industry standard.

1) Submit a minimum of 30 days before scheduled date of beam erection.

c. Shop Test Report: Submit copy of shop test results of testing as required by AASHTO M 251, "Plain and Laminated Elastomeric Bridge Bearings" or equivalent industry standard.

1) Submit a minimum of 30 days before scheduled date of beam erection.

1.4 QUALITY ASSURANCE

A. The Contractor shall provide USAID with written notification 30 days prior to the start of bearing production. The notification shall include the contract number, quantity, type, and size of bearing being produced, manufacturer's name, and the representative who will coordinate production, inspection, sampling, and testing with USAID.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle elastomeric bridge bearing pads to prevent bending and damage.

1.6 SCHEDULING

A. At least 30 days prior to the scheduled date of beam erection, the Contractor shall deliver to the Project site all elastomeric bridge bearing pads shown on the Drawings.

PART 2 - PRODUCTS

2.1 ELASTOMERIC BRIDGE BEARING PADS

A. Elastomeric bearing pads shall consist of laminated bearings (consisting of layers of elastomers restrained at their interfaces by bonded metal laminates). The elastomeric compound shall be composed of 100 percent low temperature Grade 3 (low temperature of minus 34.4 deg C), virgin crystallization resistant polychloroprene (neoprene) meeting the requirements of AASHTO M 251, "Plain and Laminated Elastomeric Bridge Bearings", and Division II, Section 18, "Bearings" of the AASHTO Standard Specifications for Highway Bridges, or equivalent industry standards. The type of bearing, hardness, dimensions, design compressive load, design compressive stress, and whether the bearings are subject to shear deformation shall be as shown on the Drawings.

B. All components of the elastomeric bearing pad shall be molded together as an integral unit and all surfaces of the steel laminations shall be covered with a minimum of 5 mm of elastomer.

C. The finished pads shall be free of cuts, blemishes, and molding defects. All imperfections or exposed laminations that result in either less than 5 mm of elastomer cover over any surface of the steel laminations shall be repaired by the manufacturer at the point of manufacture.

1. The repair shall consist of sealing the imperfections flush on the finished pad with a bonded vulcanized patch material compatible with the elastomeric bearing pad. Repairs employing caulking type materials or repairing the bearings in the field shall not be permitted.

D. All bearings that are delivered to the job site with exposed steel laminations will be rejected.

2.2 STEEL PLATES

A. Steel plates shall conform to ASTM A 36/A 36M (minimum yield strength of 250 MPa), or equivalent industry standard.

2.3 ANCHOR BOLTS, NUTS AND WASHERS

A. Anchor bolts shall conform to ASTM A 449, (minimum tensile strength of 558 MPa), or equivalent industry standard.

B. Nuts shall conform to ASTM A 563/A 563M, Grade A, Hex Style, or equivalent industry standard.

C. Washers shall conform to ASTM F 436/F 436M, or equivalent industry standard.

D. Galvanize all anchor bolts, nuts and washers in accordance with ASTM A 123/A 123M, or equivalent industry standard.

2.4 BASE PLATE THREADED STUDS, NUTS AND WASHERS

A. Base plate threaded studs shall conform to ASTM A 36/A 36M, (minimum tensile strength of 250 MPa), or equivalent industry standard.

B. Nuts shall conform to ASTM A 563/A 563M, Grade A, hex nuts, or equivalent industry standard.

C. Washers shall conform to ASTM F 436/F 436M or equivalent industry standard.

D. Galvanize all base plate threaded studs, nuts and washers in accordance with ASTM A 123/A 123M, or equivalent industry standard.

2.5 SOURCE QUALITY CONTROL

A. All elastomeric bridge bearing pads shall be tested by the manufacturer before shipment to ensure compliance with all applicable requirements of AASHTO M 251, “Plain and Laminated Elastomeric Bridge Bearings” or equivalent industry standard.

1. The manufacturer shall issue and submit a certificate stating that the elastomeric bridge bearing pads meet the requirements of AASHTO M 251, “Plain and Laminated Elastomeric Bridge Bearings” or equivalent industry standard.
2. Factory test results shall be submitted.

PART 3 - EXECUTION

3.1 GENERAL

A. Anchor bolts and base plate threaded studs shall be set accurately by a secured template prior to placing concrete.

B. No elastomeric bridge bearing pads shall be installed until source testing results have been accepted by USAID. Install the elastomeric bridge bearing pads in accordance with the manufacturer's instructions and as shown on the Drawings.

C. Elastomeric bridge bearing pads shall not be placed upon bridge seat bearing areas that are improperly finished, deformed or irregular. Elastomeric bridge bearing pads shall be set to the required grade in the exact positions called for on the Drawings and shall have full and even bearing upon the bridge seat concrete.

D. Preparation of concrete areas for elastomeric bridge bearing pad seats shall be as specified Division 03 Section "Cast-In-Place Concrete".

END OF SECTION 07 95 63

SECTION 07 95 65 – ASPHALTIC BRIDGE JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Furnishing and installation of a polymeric binder and backer rod placed into a prepared joint as shown on the Drawings. The system shall provide a flexible waterproof bridge joint capable of accommodating a total movement of up to 50 mm from maximum expansion to maximum contraction. Incidental to this system shall be the placement of the non-sag joint sealer and backing rod through the sidewalk and barrier joint as shown on the Drawings.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

a. For each type of product indicated.

2. Other Submittals:

a. Certified Reports/Certificates of Compliance/Material Certificates:

1) Certified Test reports, Materials Certificates and Certificates of Compliance for the asphaltic polymeric binder and the joint sealer.
2) Certificates of Compliance for the backer rod.

b. Quality Assurance Documentation:

1) Installer documentation showing experience on the work required by this Section.

1.4 QUALITY ASSURANCE

A. The Installer shall have previously demonstrated the ability to have successfully produced a joint of similar nature and shall provide documentation of a working joint to USAID.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyurethane Joint Sealer, Non-Sag, ASTM C 920, or equivalent industry standard.

1. A cold applied, single component elastomeric joint sealing compound for sealing, caulking vertical joints on bridges.

B. Asphaltic Binder for Asphaltic Bridge Joint System:

1. The thermoplastic polymeric modified asphalt binder shall conform to the following physical properties based on the designated ASTM testing methods:

TEST	ASTM TEST METHOD **	REQUIRED PROPERTIES
Softening Point	D 36	82.2ºC minimum
Tensile Adhesion	D 5329	700 % minimum
Ductility, @ 25ºC	D 113	400 mm minimum
Penetration @ 25ºC, 150g, 5 seconds maximum	D 3407	7.0 mm
Flow, 5 hours @ 60ºC	D 3407	3.0 mm maximum
Resiliency, @ 25ºC	D 3407	70% maximum
Asphalt Compatibility	D 3407	Pass
Low Temperature Penetration @ -17.8ºC, 200g, 60 seconds D5 with cone*minimum		1.0 mm
Flexibility, @ -23.3ºC	D 5329	Pass
Bond 3 Cycles @ -28.9ºC, 50% Elongation	D 3405	Pass
Bond 3 Cycles @ -17.8ºC, 100% Elongation	D 3405	Pass
Recommend Installation Range		182.2ºC to 198.9ºC
Safe Heating Temperature Range		198.9ºC to 215.6ºC

*Use Method D5, however replace the standard penetration needle with a penetration cone conforming to the requirements given in Test Method D 217, except the interior construction may be modified as desired. The total moving weight of the cone and attachments shall be 150.0 g ± 0.10.

** or equivalent industry standard.

C. Backer Rod:

1. The backer rod shall be closed cell foam expansion joint filler, compatible with polymeric binder and the elevated temperatures of the polymeric binder application. The size of the backer rod shall be in accordance with the manufacturer's recommendations for the gap width.

2. The backer rod shall meet ASTM D 1752, or equivalent industry standard, and have the following typical physical properties using a 12 mm specimen and the test method ASTM D 545, or equivalent industry standard:

   a. Compression, 50%: 91.7 kPa
   b. Extrusion: 2.54 mm
   c. Recovery: 99.21 percent
   d. Water Absorption, Volume: 0.246 percent

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Installer present, for compliance with requirements for surface conditions, and other conditions affecting performance of asphaltic bridge joint work.

B. Proceed with installation only after concrete construction work has been completed and unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor's acceptance of surfaces and conditions.

3.2 INSTALLATION, GENERAL

A. A qualified installer approved by USAID shall be at the job site prior to the beginning of the joint construction process to instruct the work crews in proper joint construction procedures and shall remain on the job site for the duration of the joint installation.

B. The Contractor shall produce uniform and parallel surfaces in the forming of the bridge joint gap as detailed on the Drawings. The joint area shall be protected by the Contractor to prevent any edge damage by any site equipment throughout the on-going construction process.

C. The Contractor shall produce the required gap width within the full depth of the joint as dimensioned on the Drawings. Immediately prior to placing any binder, the joint gap shall be inspected full depth and any debris shall be removed. The backer rod shall be installed in the sidewalk and safety curb gap to the proper depth to ensure a correct width/depth ratio as specified by the manufacturer. The backer rod shall be set in accordance with the Drawings. Splicing of the backer rod at the curb lines will not be permitted.

D. The binder shall be melted and heated to the application temperature in a double jacketed, hot oil, heat transfer kettle, or as recommended by the manufacturer. The kettle shall be equipped with a continuous agitation system and temperature controls that can accurately maintain the material temperatures. The binder shall be poured into the joint gap. For sidewalk and curb joint gaps a non-sag polyurethane joint sealer compatible with the asphaltic binder shall be used.

3.3 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction and in accordance with asphaltic bridge joint materials manufactures' instructions.

END OF SECTION 07 95 65

SECTION 31 10 00 - SITE CLEARING AND PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above and below grade site improvements.
6. Temporary erosion and sedimentation control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil and/or subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Excess cleared materials generated from clearing and/or excavation related activities not meeting Project specifications shall become Contractor's property and shall be removed from Project site.

1.5 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Other Submittals:

a. Documentation of existing trees or shrubs and plantings, adjoining structures and/or site features that establishes preconstruction conditions of work area.
b. Sufficiently photograph and videotape work area and adjacent structures, vegetation and features prior to beginning work. Provide USAID with digital copies of all photos and/or video(s) related to this task.

1.6 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct a preconstruction conference at Project site.

1.7 PROJECT CONDITIONS

A. Traffic: Maintain traffic at all times.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from USAID.
2. Provide alternate routes around closed or obstructed travel ways meeting the approval of USAID.

B. Do not commence site clearing operations until erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

1. When satisfactory soil material(s) is not available on-site secure a source of off-site borrow material(s) for approval by USAID.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to USAID.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil bearing water runoff or airborne dust to adjacent properties and walkways, as directed by USAID.

B. Inspect, maintain, and repair erosion and sedimentation control measures during construction.

C. Remove erosion and sedimentation controls and restore areas disturbed upon removal.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation, including stumps and roots, to permit installation of new construction.

1. Remove stumps, roots, obstructions, and debris to a depth of 450 m below exposed subgrade.
2. Dispose of all debris off-site.

B. Remove non-hazardous trash and debris.

1. If suspected hazardous trash and debris are encountered. Do not disturb, immediately notify USAID.

    a. Contractor shall move his operations to Project areas where there is no suspected hazardous trash or debris and continue working.
    b. Contractor shall return to area where suspected hazardous trash and debris was encountered only upon written direction from the USAID and complete site clearing operations.

C. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 200 mm, and compact each layer to a density equal to adjacent original ground.

3.4 TOPSOIL STRIPPING

A. Strip topsoil to depth of 150 mm in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Dispose of topsoil.

3.5 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut full depth along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Project site.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Excavating and backfilling for structures.
2. Preparing subgrades for foundations, approach slabs, and roadways.
3. Select Fill: For roadway fills.
4. Gravel Borrow: For backfill under or around foundations, and on embankments.
5. Processed Gravel: For roadway base course material and on embankments.
6. Crushed stone.
7. Geotextiles.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed in a trench.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Borrow Soil: Any aggregate soil used on the Project.

C. Subbase: Granular aggregate layer supporting the slab-on-grade and pavement that also minimizes upward capillary flow of pore water.

D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

E. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 2.0 cubic meter for bulk excavation or for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 1050 mm wide, maximum, short-tip-radius rock bucket; rated at not less than 102907 watts flywheel power with bucket-curling force of not less than 127664 N and stick-crowd force of not less than 81847 N with extra-long reach boom; measured according to SAE J-1179. (Ratings are based on: Caterpillar's "Model No. 320CL".)

2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 171511 watts flywheel power and developing a minimum of 213479 N breakout force with a general-purpose bare bucket; measured according to SAE J-732. (Ratings are based on Caterpillar's "Model No. 973C".)

F. Structures: Footings, foundations, retaining walls, approach slabs, curbs, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, structural fill, drainage fill, or topsoil materials.

1.4 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Samples:

a. Samples for Verification: For the following products, in sizes or quantities indicated below:

1) Borrow Soil: Two liters by volume of material in sturdy container of each type of off-site and/or on-site borrow soil material, naming source for each material.
2) Geotextiles: 300 mm by 300 mm.

2. Other Submittals:

a. Material Test Reports: For each on site and off site borrow soil material used on the Project.

1) Classification according to ASTM D 2487.
2) Laboratory compaction curve according to ASTM D 1557 (Not required for crushed stone No.1 and No.2).

b. Dewatering Plan:

1) The Contractor shall submit a dewatering plan.
2) The Contractor shall submit a dewatering/water control plan for the proposed drainage culvert installation.

c. Qualification Data: For Contractor's qualified testing agency.

1) United States Army Corps of Engineers Review: Submit a copy of the independent testing agency's latest review documentation showing a satisfactory or better rating, or similar rating status.

a) Independent testing agency performing soil classification, laboratory compaction curves and sieve analysis.

d. Pre-excavation photographs or video to sufficiently document existing conditions of Project area and adjoining areas; noting site improvements, including finish

surfaces, and/or other site features. Provide USAID with digital copies of all photos and/or videos related to this task.

1.5 QUALITY ASSURANCE

A. Contractor's Soil Testing Agency:

1. Soil classification, laboratory compaction curves and sieve analyses shall be performed by an independent testing agency for both off-site and on-site soil materials.
2. The independent testing agency shall have been reviewed within the last 6 months by the United States Army Corps of Engineers (USACE) and have received a satisfactory or better rating, or similar rating status.

1.6 PROJECT CONDITIONS

A. Traffic: Maintain vehicle and pedestrian traffic at all times.

1. Do not close or obstruct roadways, streets, walks, or other adjacent occupied or used facilities without permission from USAID.
2. Provide alternate routes around closed or obstructed traffic ways meeting the approval of USAID.
3. Do not proceed with work on adjoining private property until directed by USAID.

B. Do not commence earth moving operations until erosion and sedimentation control measures, specified in Division 31 Section "Erosion and Sedimentation Controls" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide imported soil materials when sufficient satisfactory soil materials are not available from onsite excavations.

B. Hazardous Materials:

1. Provide materials that are not contaminated with petroleum product, hazardous waste, chemical waste, industrial waste, construction waste, sanitary waste, commercial/office waste or general household waste.
2. Materials with a visible sheen or petroleum odor shall be rejected.

C. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups. Satisfactory soils are to meet the additional requirements noted below and to be free of topsoil, asphalt, concrete rubble, wood, debris, clay, overburden and other deleterious materials.

1. General descriptions (Group Name) for satisfactory soils Soil Classification Groups are as follows:

Soil Classification Group	General Description (Group Name)
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand

D. Unsuitable Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsuitable soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
2. General descriptions (Group Name) for unsuitable soils Soil Classification Groups are as follows:

Soil Classification Group	General Description (Group Name)
GC	Clayey gravel
SC	Clayey sand
CL	Lean clay
ML	Silt
OL	Organic silt
CH	Fat clay
MH	Elastic silt
OH	Organic clay
PT	Peat

E. Select Fill: Provide materials consisting of rock, stone, cobbles or gravel, free of organic matter, and substantially free of shale or other soft, poor durability particles having no particles greater than 100 mm in maximum dimension. Of the portion passing the 100 mm square sieve, the material shall have a gradation in accordance with the following Table.

SELECT FILL GRADATION	
Sieve Designation	Percentage Passing by Weight
425 um	0-70
75 um	0-15

F. Processed Gravel: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand meeting the gradation shown below.

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
75 mm	100
37.5 mm	70 to 100
19 mm	50 to 85
4.75 mm	30 to 60
75 um	3 to 10

G. Gravel Borrow: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone and natural crushed sand meeting the gradiation shown below.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
75 mm	100
12.5 mm	50 to 85
4.25 mm	40 to 75
75 um	0 to 10

H. Crushed Stone: Where indicated, provide the following fill materials, consisting of sound stone, free of slag, which is the product of mechanical crushing, having clean, durable, sharp angled fragments of stone of uniform quality complying with following requirements:

1. No. 1 (37.5 mm) Crushed Stone Gradation Requirements:

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
37.5 mm	100
31.5 mm	85 to 100
19 mm	10 to 40
12.5 mm	0 to 8

2. No. 2 (19.0 mm) Crushed Stone Gradation Requirements:

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
25 mm	100
19 mm	90 to 100
12.5 mm	10 to 50
9.5 mm	0 to 20
4.75 mm	0 to 5

2.2 GEOTEXTILES

A. Geotextile fabric at weep holes shall be as specified in Division 03 Section “Cast-In-Place Concrete”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished. Notify USAID in writing of any deviations and/or conditions not consistent with the Drawings. Do not proceed with earthwork until USAID has confirmed the reported deviations and/or inconsistencies in writing which would impact the project and has provided written direction to the Contractor.

3.2 PREPARATION

A. Protect structures and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

1. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.3 DEWATERING/CONTROL OF WATER

A. Refer to Division 31 Section “Cofferdams” for control of water by cofferdams.

B. Provide a written dewatering and/or water control plan.

C. Furnish and install all dewatering pumps, wells points, sumps, suction and discharge lines and other dewatering systems as stated in the approved dewatering and/or water control plan. Maintain dewatering systems until completion of the permanent construction.

D. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

E. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.4 EXPLOSIVES

A. Explosives: Do not use explosives.

3.5 EXCAVATION, GENERAL

A. Excavation: Excavate to subgrade elevations.

1. Unclassified excavation includes excavating all soil, boulders (less than 2 cm), pavements, stonewalls, masonry walls and other obstructions visible on surface; underground structures, and other items indicated to be removed.

a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is unclassified excavation.

2. Rock excavation includes removal and disposal of rock (refer to Definitions Article for definition of: "Rock"). Rock excavation beyond the specified dimensions will be considered for the Contractor's convenience and will not be paid for separately. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 610 mm outside of concrete forms other than at footings.
    b. 300 mm outside of concrete forms at footings.
    c. 150 mm outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 150 mm beneath bottom of concrete slabs-on-grade.
    f. Rock

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

    a. See Structural Drawings for specific removal and replacement instructions if required.

3.7 SUBGRADE INSPECTION

A. Notify USAID when excavations have reached required subgrade.

B. If USAID determines that unsuitable soil is present, continue excavation and replace with compacted backfill or other fill materials as directed.

C. Prior to excavation for foundations but after topsoil is stripped, proof-roll subgrade below structures, foundations and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 14 metric tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction and repeating proof-rolling in direction perpendicular to first direction with a minimum of six overlapping passes. Limit vehicle speed to 5 kmph.
2. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as directed by USAID, and replace with compacted backfill or other fill materials as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices (if applicable) or changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Replace materials removed during unauthorized excavations using gravel borrow, unless otherwise directed by USAID. Placement of the material shall be in 150 mm lifts with 95 percent of maximum dry density compaction. Compaction shall be as specified in this Section.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage and dampproofing.
2. Removing concrete formwork.
3. Removing trash and debris.
4. Removing excess water and allowing material to dry.
5. Removing temporary shoring and bracing, and sheeting.
6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows. Refer to Part 2 for material requirements and specific conditions for the use of each type of soil material. All fill materials to be approved by USAID and shall conform to requirements specified in Part 2.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 200 mm in loose depth for material compacted by heavy compaction equipment, and not more than 150 mm in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, foundations, roadway and roadway shoulders: Scarify and recompact top 300 mm of existing subgrade and each layer of backfill or fill soil material to obtain 95 percent.
2. Under unpaved areas, scarify and recompact top 150 mm below subgrade and compact each layer of backfill or fill soil material to obtain 85 percent. (Compact all beneath the upper 610 mm to obtain at least 95percent of maximum dry density).

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Unpaved Areas: Plus or minus 25 mm.
2. Roadway Surfaces: Plus or minus 25 mm.

3.15 ROADWAY BASE COURSE AND SHOULDERS

A. Place processed gravel base course on subgrades or select fill as indicated on the Drawings free of mud, frost, snow, or ice.

1. Shape base course to required crown elevations and cross-slope grades.
2. Place base course 200 mm or less in compacted thickness in a single layer.

3. Compact processed gravel base course at optimum moisture content (plus or minus 2 percent) to required grades, lines, cross sections, and thickness to obtain not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.16 SUBBASE FOR CONCRETE FOUNDATIONS, FOOTINGS AND SLABS-ON-GRADE

A. Place subbase granular materials as indicated on the Drawings on subgrades free of mud, frost, snow, or ice.

1. Place subbase 200 mm or less in compacted thickness in a single layer.
2. Compact each layer of subbase to required cross sections and thicknesses to obtain not less than 95 percent of the maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: USAID will engage a qualified testing agency to perform tests and inspections, and prepare test reports unless otherwise noted.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Inspections and tests:

1. Geotechnical observations: Proof rolling procedures, site preparation, unsuitable soils removal, excavations, footing/foundation bearing, fill and roadway base material placement.
2. Field Density Testing:

    a. Footing/Foundation Subgrade: At footing/foundation subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by USAID.
    b. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 1557, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
        1) Fill Under Footings/Foundations: In each compacted fill layer, one compaction test for every 10 meters of wall. Two compaction tests under each individual footing.
        2) Roadway Areas, Roadway Embankment Areas and Wall Backfill Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 200 square meters or less of area, but in no case fewer than three tests per work area.

    c. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3. Laboratory testing for on-site and off-site borrow materials:

a. ASTM D 1557 Modified Proctor compaction curve including sieve analysis.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them outside the limits of the Project.

END OF SECTION 31 20 00

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes construction dewatering as required to perform general site work. Control of water for bridge foundation work is included in Section 31 52 00 – Cofferdams.

1.3 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Verify availability of Contractor's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered including coordination with erosion and sedimentation control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified dewatering system engineer.

    a. Include plans, elevations, sections, and details.
    b. Show arrangement and locations of pumps and discharge lines; and means of discharge, control of sediment, and disposal of water.
    c. Include written plan for dewatering operations including coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

2. Other Submittals:

    a. Qualification Data: For Installer.

        1) Installer: Submit list of projects showing a minimum of 5 dewatering systems of the size and extent proposed for this Project..

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in the installation of dewatering systems and has installed a minimum of 5 dewatering systems of the size and extent proposed for this Project.

1.6 PROJECT CONDITIONS

A. Project Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. USAID is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing structures, and site improvements adjacent to excavation.
4. Remove dewatering system when no longer required for construction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads and other adjacent facilities.

1. Do not close or obstruct roads or other adjacent facilities without permission from USAID. Provide alternate routes around closed or obstructed traffic ways if required by USAID.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain erosion and sedimentation controls as directed by the Engineer during dewatering operations.

1. Erosion and sedimentation controls shall be as directed by the Engineer and as shown on the Drawings.
2. Erosion and sedimentation controls shall conform to Division 31 Section "Erosion and Sedimentation Controls".

3.2 INSTALLATION

A. Install dewatering system complete with pump equipment, standby power and pumps, filter material gradation, water disposal, and surface water controls.
1. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground water level.

C. Provide standby equipment on site, available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until work has been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water bearing strata above and below bottom of foundations and other excavations.

1. Do not permit open sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water bearing strata below subgrade elevations of foundations and other excavations.
3. Maintain piezometric water level a minimum of 600 mm below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering.

3.4 FIELD QUALITY CONTROL

A. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages caused by dewatering.

END OF SECTION 31 23 19

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Erosion, sediment and pollution controls as directed by USAID.
2. Erosion, sediment and pollution control includes, but is not limited to, the following:

a. Silt fence.
b. Crushed stone check dams.
c. Clean up.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

a. Silt fence.

2. Other Submittals:

a. Erosion, sediment and pollution control plan.
b. Inspection reports.

1.4 QUALITY ASSURANCE

A. Contractor shall develop and submit an erosion, sediment and pollution control plan showing dewatering ponds/devices, stockpile areas and related erosion control measures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store products according to manufacturer's written instructions.

1.6 NOTICES

A. When the site has been finally stabilized, Contractor shall notify USAID, in writing, that a final inspection be performed.

1.7 INSPECTIONS AND MAINTENANCE

A. The Contractor shall inspect disturbed areas of the construction site and provide USAID a written report of the inspection including recommended repairs or improvements. Review inspection report with USAID for concurrence. Special attention shall be focused on areas not finally stabilized, structural control measures, and locations where vehicles enter or exit the site. Disturbed areas shall be inspected for pollutants entering the adjacent river and/or drainage culvert. Structural control measures shall be reviewed for effectiveness in preventing significant impacts to receiving waters.

B. Provide timely maintenance of vegetation erosion and sediment control measures, and other protective measures, during construction.

C. Perform corrective measures within two calendar days of the Contractor's report at no cost to the USAID. Failure by the Contractor to perform corrective work within this schedule automatically authorizes the USAID to hire others and deduct from the Contract Sum the costs incurred by the USAID for the performance of this Work.

PART 2 - PRODUCTS

2.1 SILT FENCE

A. Meet the following criteria unless specific type is shown on the Drawings or USAID accepts the change in criteria.

1. Silt Fence: Polypropylene filter fabric supported by non pressure treated hardwood posts meeting the following requirements.

Property	Unit	Test Method	Value
Grab Strength	kN	ASTM D 4632	0.53 min
Grab Elongation	%	ASTM D 4632	30 max
Trapezoid Tear	kN	ASTM D 4533	0.27 min
Mullen Burst	kN	ASTM D 3786	1932) min
Coeff of Permeability	CM/Sec	ASTM D 4491	0.005min
Water Flow Rate	$l/min/m^2$	ASTM D 4491	489 min

2. Basis of Design Product: Subject to compliance with requirements provide Tencate Geosynthetics Mirafi 100X fabric.
3. Reinforced fence: Fabric backed with 2.1 mm diameter (14 gauge-Birmingham) by 150 mm square mesh woven wire. See plans for specific locations.

B. Manufacturers: Subject to compliance with requirements. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Tencate Geosynthetics (Mirafi).
2. Approved equal.

2.2 STAKES

A. One of the following

1. 50 mm by 50 mm by 1.2 m non pressure treated hardwood.

2.3 STONE FILTERS

A. Size shown on the Drawings and meeting the following requirements.

1. Crushed stone No. 1 or No. 2 as specified in Division 31 Section “Earth Moving”.

2.4 CRUSHED STONE CHECK DAMS

A. Crushed stone check dams shall be constructed from either crushed stone No.1 and/or No. 2 as specified in Division 31 Section “Earth Moving” and as directed by USAID.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which soil erosion and sediment control is to be installed. Notify USAID in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Beginning installation constitutes Contractor’s acceptance of substrate and conditions.

3.2 GENERAL EROSION CONTROL

A. Install initial construction erosion control features, as indicated on the Drawings and Specifications or as directed by USAID, prior to topsoil stripping, earthwork, and removal of existing vegetation and indicated in the Contractor’s erosion, sediment and pollution control plan. Keep the disturbance to a minimum. Install other features as described in the sequence of erosion, sediment and pollution control shown on the Drawings.

B. Until a disturbed area is stabilized, trap runoff sediment by the use of debris basins, sediment basins, silt traps, or other methods acceptable to USAID.

C. Place check dams as directed by USAID. If check dams become plugged or partially plugged, remove and replace the stone. Cleaning of stone will not be permitted.

D. Provide temporary erosion controls on slopes and swales traversing, bordering, or leaving the site. Limit the water flow to a non-erosive velocity.

E. Do not store fill materials within 15 meters of the banks of any streams, wadis, channels or water bodies, intermittent or perennial.

F. Inspect erosion and sediment control measures immediately after each rainfall and at least daily during prolonged rainfall. Make required repairs immediately.

G. Remove sediment deposits when they reach approximately one-half of the height of the barrier.

H. Remove all temporary measures at completion of construction.

3.3 SILT FENCE

A. Locate in accordance with the Drawings and details and/or as directed by USAID. Excavate trench along the lower perimeter(s) of site, along the contract limit line, and as indicated on the Drawings. The placement of silt fence shall consider drainage paths and intercept drainage prior to leaving site or entering storm system. Place excavated material on uphill side of trench for backfilling.

B. Drive stakes securely into the downhill side of the trench. When prefabricated silt fence with fabric attached to stakes is used, drive stakes so that fabric is buried in the ground as detailed.

C. Backfill trench with excavated material, so that fabric is securely buried in the ground to prevent undermining. Tamp soil.

D. Join sections by overlapping fabric between two stakes. Set stakes simultaneously. Overlap by minimum 150 mm, fold, and staple to prevent sediment bypass.

E. Attach silt fence securely to stakes spaced no more than 2.45 meters on center. Secure fence fabric to stake with minimum three 25 mm staples.

F. Provide silt fence dikes perpendicular to swale center lines in swales one and one half percent and steeper. Locate dikes at a maximum interval of 15 meters on center unless otherwise shown on Drawings.

G. Removal of silt and replacement of silt fence shall be on going throughout the duration of the project to maintain an effective silt removing barrier.

3.4 CLEANING

A. During the Contract and at intervals as directed by USAID and as erosion, sediment and pollution control procedures are completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well draining, and neat condition.

B. Clean storm ponding areas. Clean out contaminants, sediment, rubbish, construction debris, foreign objects and accumulated floatables from chambers and ponding areas thoroughly, immediately prior to final acceptance.

END OF SECTION 31 25 00

SECTION 31 37 00 – RIPRAP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Furnishing and installing woven geotextile fabric, bedding material, riprap and grout where shown on the Drawings.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

a. Geotextile fabric.

2. Other Submittals:

a. Written description of the procedures and a list of equipment to be used for the riprap placement.
b. Material Source: Name and address of local riprap source.

PART 2 - PRODUCTS

2.1 SOIL STABILIZATION FABRIC (WOVEN GEOTEXTILE)

A. Soil Stabilization Fabric (Woven Geotextile): Heavy duty, commercially manufactured woven polypropylene geotextile meeting the following properties:

Property	Unit	Test Method	Value
Grab Strength	kN	ASTM D 4632	1.40 min
Tensile Strength	kN	ASTM D 4595	30.6 min
Grab Elongation	%	ASTM D 4632	15 max
Trapezoid Tear	kN	ASTM D 4533	0.53 min
Mullen Burst	kN	ASTM D 3786	4134 min
Permittivity	/Sec	ASTM D 4491	0.05 min
Water Flow Rate	$l/min/m^2$	ASTM D 4491	163 min

1. Manufacturers: Subject to compliance with requirements. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Tencate Mirafi – 600X.
   b. Approved equal.

2.2 BEDDING MATERIAL

A. Bed course material shall consist of crushed stone No. 1 as specified in Division 31 Section "Earth Moving".

2.3 ANGULAR RIPRAP

A. Riprap shall be rough stone, fractured to sub angular, and have a specific gravity of at least 2.65.

B. Riprap shall consist of individual crushed angular stone fragments which shall be unweathered, dense, hard, sound, and resistant to abrasion; shall be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost actions. Riprap shall be nearly cubical as possible, with neither breadth nor thickness of a single piece less than one-third of its length. Slab type stones, flaking stones, rounded stones, asphalt, broken concrete, concrete slabs, or other materials not classified as stone will not be allowed for use as riprap. Riprap shall be clean, free of fines, and shall meet the following requirements:

CLASSIFICATION AND GRADATION OF RIPRAP

Riprap Designation	% Smaller Than Given Size by Weight	Intermediate Riprap Dimension (mm)	D_{50}* (mm)
300 mm	70 – 100	530	
	50 – 70	460	
	35 – 50	300	300
	2 – 10	100	

D_{50} = Particle size.

C. Stone crushed to produce riprap shall come from a local source, and shall be of the type, material, and quality typically found in that region.

   1. Stone shall not be taken from a waterway (river, stream or wadi) bed or bank.

2.4 ROUNDED RIPRAP

A. If boulders or rounded cobbles are to be used as riprap, the layer shall be 50 percent thicker than shown on the Drawings. The rounded stones shall be at least 25 percent larger in diameter than angular stones. No rounded stone shall have a length on any one axis greater than 3 times the length on any other axis.

PART 3 - EXECUTION

3.1 GENERAL

A. No geotextile fabric, bedding material, and riprap shall be placed until the subgrade has been prepared, dewatered and properly compacted, or otherwise prepared in accordance with the provisions of the Specifications and as specified on the Drawings and has been checked and approved by USAID.

3.2 GEOTEXTILE FABRIC PLACEMENT

A. Place the geotextile in a manner recommended by the manufacturer. At the time of installation, replace any geotextile that has defects, rips, holes, flaws, deterioration, or damage. Place the geotextile with the long dimension parallel to the centerline of the channel, and lay it smooth and free of tension, stress, folds, wrinkles, or creases. Place the strips to provide a minimum width of 1 meter of overlap for each joint. The Contractor shall secure the geotextile to the embankment or foundation soil by pins or other methods to prevent movement prior to placement of revetment materials. Securing pins shall be inserted through both strips of overlapped geotextile along the line passing through midpoints of the overlap. Securing pins shall be removed as revetment materials are placed to prevent tearing of geotextile or enlarging holes. The maximum pin spacing shall be 600 mm or less. When windy conditions prevail at the construction site, the number of pins shall be increased as directed by USAID. The Contractor shall anchor terminal ends of the geotextile with key trench or apron at crest, toe of the slope, and upstream and downstream limits of installation as recommended by the manufacturer.

B. Trimming shall be performed in such a manner that the geotextile is not damaged in any way.

C. The Contractor shall secure the geotextile to the embankment or foundation soil by pins or other methods as recommended by the manufacturer.

3.3 BEDDING MATERIAL PLACEMENT

A. Bedding material (crushed stone No. 1) shall be placed uniformly to the grades and elevations shown on the Drawings. Care shall be taken to keep the bedding material thickness uniform. Excessive rutting of the finished bedding surface shall be avoided. Bedding material shall be kept clean and free of other soils. If the bedding material is contaminated with other soils or unsuitable material, it shall be removed and replaced by the Contractor immediately.

3.4 RIPRAP PLACEMENT

A. The Contractor shall submit a written description of the procedures and a list of the equipment to be used for riprap placement.

B. Riprap shall be placed with a maximum drop height of 1 meter to reduce segregation of particle sizes. Placing in layers or by dumping into chutes or similar methods which may cause segregation will not be permitted. The riprap shall be placed, in one preparation, to the line,

grade, and thickness as shown on the Drawings, without undue displacement of the granular filter bedding underneath.

C. Riprap shall be placed to grade in a manner such that the larger riprap fragments are uniformly distributed and the smaller riprap fragments serve to fill the spaces between the larger riprap fragments in such a manner as will result in a well-keyed, densely placed, uniform layer of riprap of the specified thickness. Consolidation of the riprap by backhoe or other means will be necessary to insure interlocking of riprap fragments. Placed riprap shall be uniform and free from bulges, humps, or cavities. Hand placing will be required only to the extent necessary to secure the results specified above.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: USAID will engage a qualified testing and inspection agency to perform tests and prepare test reports.

B. Tests:

1. Relative Density Testing of Bedding Material: Perform in accordance with ASTM D 4253, "Maximum Index Density and Unit Weight of Soils Using a Vibratory Table", or equivalent industry standard.

C. Field Test for Riprap Gradation

1. The Contractor shall provide personnel, tools and equipment as necessary to assist the Testing Agency, at no additional cost to USAID.
2. The field test for riprap gradation shall be performed after the first 5000 square meters of riprap is placed. Riprap placement shall not continue until after this test has been performed. The test area shall be marked for easy identification and shall be used as a reference for remaining riprap work.
3. Testing Frequency: One field test for riprap gradation shall be performed.
4. Develop detailed test procedures based on the following:

    a. From a constructed section of riprap not exceeding 5,000 square meters of 0.5 meters thickness, designate an area 2 m by 2 m for testing.

        1) The field test for riprap gradation shall be performed on the first 5000 square meters of riprap placed. Riprap placement shall not continue until after the riprap gradation test has been performed.

    b. Weight and record each stone individually in the test area. For stones that are greater than the capacity of the scale or too heavy to be managed safely, estimate the volume of the stone and calculate a weight based on a known unit weight or specific gravity supplied by the quarry. After weighting, set aside the stones weight in 10 kilograms (8% size) or less.
    c. Individually number all stones. The set-aside 8% size stones are collectively number 1.
    d. Prepare a table with the individual weight for each stone. The collective weight of the 8% size stones must be the first entry on the table.
    e. Arrange the table in size order, keeping the accumulated 8% size weight as the first entry on the table. See example below.

Stone No.	Individual Weight (Kg)	Accumulated Weight (Kg)	Accumulated % Weight
33-41	51.2 (accumulated 8% size weight)	51.2	3.9*
16	10.9	62.1	4.8
27	10.9	73.0	5.6

14	51.7	618.2	47.6**
24	52.6	670.9	51.6**

3	108.9	1060.0	81.6***
5	112.0	1172.1	90.2***
4	127.0	1299.1 (W, Step g below)	100.0

f. Calculate the collective weight (W) of all stones on the table.

g. Calculate the 90% (0.9*W) and the 50% (0.5*W) values. For the table above: 90%= 1169.4 kg, 50% = 649.5 kg.

h. Calculate the 8% size: (Accumulated 8% size weight ÷ W)

i. Acceptance criteria:

1) * The accumulated percent weight of stones weighing less than 10 kg shall be less than 8%.

2) ** The stone at the 50% size shall be between 50-100 kg.

3) *** The stone at the 90% size shall be between 130-215 kg.

4) The maximum weight of any individual stone shall be less than 240 kg.

D. Field Test Reports:

1. Submit field test results of riprap gradation.

END OF SECTION 31 37 00

SECTION 31 52 13 - COFFERDAMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Designing, furnishing, and installing cofferdams and water control systems, and maintaining and operating water control systems, and removing cofferdam structures and water control systems.

1.3 SYSTEM DESCRIPTION

A. General:

1. Based on depth of water variations and the depth of excavations required, a cofferdam may be required for the proposed construction. The Contractor has the option to propose alternative methods for providing dry conditions for the pier and abutment construction.
2. The Contractor may submit alternate temporary methods for providing pier and abutment construction in the dry.
3. Methods for the control of water are to be included in the selection and design of the temporary excavation system.
4. The Contractor shall submit drawings and design calculations showing the Contractor's proposed method of cofferdam construction or alternate temporary methods. The submittal of such drawings, methods and calculations shall not serve to relieve the Contractor of any of his responsibility for the safety of the work or the responsibility for the successful completion of the project.
5. Approval of the cofferdam / temporary excavation system will be general in character and shall not relieve the Contractor from the responsibility for the adequacy of the design, materials and workmanship to safely support the excavation.

B. Design Requirements:

1. The Contractor shall submit drawings and calculations of the proposed method for approval, stamped and signed by a qualified structural engineer. The cofferdam / temporary excavation system shall be designed according to the following criteria:

    a. Soil properties to be used in the design shall be consistent with the Geotechnical Report.
    b. The Contractor shall make their own evaluation of existing conditions and facilities, and of the effects of the proposed cofferdam / temporary excavation system and construction methods, and shall provide in their design for all loads

and methods necessary to permit construction of the proposed pier and abutments while maintaining public safety and protecting completed work (and all third party property) from damage caused by their operations.

c. The Contractor should be aware that ledge/bedrock may be encountered during excavation.
d. Steel sheet piling, if used, shall continuously interlock with adjacent sheet piling.
e. No element of the support system shall be spliced unless approved by USAID.
f. The Contractor shall submit a manufacturer's sworn statement, in lieu of mill inspection, for the material furnished. Costs involved in furnishing the statement (certificate) shall be borne by the Contractor. The statement shall include the following as a minimum:

    1) Contract Number, Project Name, Project Location, USAID Number.
    2) Name of the Contractor to which the material is furnished.
    3) Kind of material supplied.
    4) Quantity of material represented by the certificate.
    5) Means of identifying the consignment, such as label, marking, seal number, etc.
    6) Date and method of shipment.
    7) Statement to the effect that the material has been tested and found in conformity with the pertinent parts of these specifications.
    8) Results of all required tests including the chemical analysis in the case of metal, or a statement that results of all required tests pertinent to the certificate are satisfactory.
    9) Signature of a person having legal authority to bind the supplier.

C. Performance Requirements:

1. Cofferdams for foundation construction shall be carried to adequate depths and heights, shall be safely designed as watertight as necessary for the proper performance of the work which must be done inside them. Sheeting shall be driven to a sufficient depth below the proposed foundation grade to permit reasonable change in depth of the proposed foundation to a maximum of 750 mm except where solid rock is encountered. The interior dimensions shall be sufficient for the unobstructed and satisfactory completion of such construction work as form building, inspection and pumping. Cofferdams which become tilted or are displaced during the process of building the substructure shall be righted, reset or enlarged as may be necessary to provide the necessary clearances and this shall be at the sole expense of the Contractor. Cofferdams shall be dewatered and the proposed work placed in the dry.
2. Cofferdams shall be constructed so as to permit excavation and construction to proceed on dry, stable subgrades, and to protect the work against damage from sudden rising of water and to prevent damage to the work by erosion. No part of the cofferdam shall be left in such a way as to extend into the work, without written permission of USAID.

D. Control of Water:

1. The Contractor shall not restrict the flow of water in the waterway beyond the impacts of the cofferdam when flow conditions exist in the waterway.
2. A water control system within the cofferdam structure may be required for the construction of the proposed piers and abutments in the dry. The water control system

shall be capable of lowering the water table to an elevation below the bottom of foundation as determined by USAID.

3. A temporary cofferdam may be utilized to create a dry environment within the waterway for construction to occur. Documentation shall be provided which demonstrates the suitability of the proposed cofferdam design for the particular site conditions (e.g. channel bed, surficial geology and hydrology) of the crossing. Sediment laden water will be pumped to an enclosure which shall be used to filter the water prior to its return to the water course. Sedimentation enclosures shall be located in upland areas and shall be properly sized in order to provide adequate filtration so as not to impair the water quality of the receiving water.
4. Water removed from within the work area shall be routed through either sedimentation tanks or temporary filter bags to remove suspended solids including sand, silt and other materials before being discharged into the waterway. The sedimentation tanks or filter bags shall be located outside the wetlands and discharge shall be directed to a stabilized area. Discharge into the waterway shall be visibly clear of suspended solids, and shall be performed such that discharge does not result in erosion of the ground surface. The Contractor shall submit a dewatering plan. All plans, procedures and calculations shall be prepared and signed by a qualified structural engineer.
5. If filter bags are used, they are to be constructed of non-woven geotextile fabric and have a maximum of one 300 mm discharge hose per filter bag. Flow to each bag should not exceed 5680 liters per minute. To help prevent punctures, geotextile fabric may be placed below the filter bag. Hose clamps are to be used to secure the discharge hose to the bag.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project site.

1.5 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Shop Drawings:

    a. For cofferdam system, prepared by or under the supervision of a qualified structural engineer. Shop drawings shall be signed and dated by the qualified structural engineer.

        1) Method of cofferdam construction. Include plans, elevations, sections, and details.
        2) Alternate temporary methods for providing pier and abutment construction in the dry.
        3) Dewatering plan.
        4) Water control system.

2. Other Submittals:

    a. Design Data: For cofferdam system, prepared by or under the supervision of a qualified structural engineer. Drawings and calculations shall be signed and dated by the qualified structural engineer.

1) Drawings and calculations.

b. Certificates: For steel sheeting and structural steel, if used.

1) Manufacturer's sworn statement.

c. Qualification Data: For Installer and cofferdam structural engineer.

1) Installer: Submit list of projects showing a minimum of 5 cofferdam systems of the size and extent proposed for this Project.
2) Cofferdam Structural Engineer: Submit list of projects showing a minimum of 5 cofferdam systems of the size and extent proposed for this Project.

1.6 QUALITY ASSURANCE

A. Cofferdam Structural Engineer Qualifications: An experienced structural engineer that has designed a minimum of 5 cofferdam systems of the size and extent proposed for this Project.

B. Installer Qualifications: An experienced installer that has installed a minimum of 5 cofferdam systems of the size and extent proposed for this Project.

1.7 FIELD CONDITIONS

A. Project-Site Information: A Geotechnical Report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. The Contractor shall verify the actual subsurface conditions are consistent with the Geotechnical Report.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.

B. Survey Work: Engage a qualified land surveyor or engineer to set benchmarks and locate cofferdam perimeter for each pier and abutment location.

1. Clearly identify benchmarks and record existing elevations.

C. The water level in the waterway is influenced by the amount of precipitation during a storm event in the watershed at any time of year (dry season or rainy season) and snow melt in the spring. The water level may rise rapidly, and for extended periods of time be at high levels including top of bank and higher as a result of these rains, snow melt and other events.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials used for the cofferdam, whether new or used, shall be sound and free from strength impairing defects.

2.2 STEEL SHEETING

A. Steel sheeting shall be a standard section, either new or used, weighting not less than 110 kg/sm and shall conform to ASTM A 328/A 328M, “Steel Sheet Piling”, (minimum yield strength of 270 MPa) or equivalent industry standard.

2.3 STRUCTURAL STEEL

A. All structural steel shall conform to ASTM A 709/A 709M, “Structural Steel for Bridges” or equivalent industry standard. Minimum yield strength shall be as required for the design.

2.4 TIMBER

A. Timber for sheeting and structural members shall be locally available wood species suitable for the intended use. Lumber and wood sheeting shall be planed on one side and either tongue and grooved or splined. Lumber sheeting shall not be less than nominal 100 mm thick. Wood sheeting shall not be less than nominal 50 mm thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The cofferdam shall be securely and satisfactorily braced to withstand all pressures to which it may be subjected and be sufficiently tight to prevent any flow of water or material into the space in which work is to be performed. The bottom of each piece of lumber and wood sheeting shall be so sharpened to lead the toe of the sheeting away from the excavation. Jetting maybe be done only with the approval of USAID, but it will not be permitted when excess of water may endanger other structures or work.

B. Where sheeting is to be used as a form for placing concrete the sheeting shall be driven entirely outside the neat lines shown on the plans for the concrete.

C. If in USAID’s opinion a tremie seal is necessary, USAID may require the placing of underwater concrete of such dimensions as necessary below the footing to safely dewater the foundation and place the footing concrete in the dry.

1. All tremie concrete seals shall be placed as directed by USAID.

D. Before placing the underwater concrete, the inside walls of the cofferdam shall be thoroughly cleaned and the walls made sufficiently tight to reduce the velocity of water to less than 3 meters per minute. The elevation of the water inside the cofferdam shall be controlled during the placing and the curing of the concrete. No pumping of water shall be permitted while concrete is being placed nor until the concrete has cured a minimum of 24 hours. Once concreting has started the tremie, if required, shall not be moved laterally through the deposited concrete. When necessary to move the tremie it shall be lifted out of the concrete and moved to the new position. Unless otherwise directed by USAID, spacing of the triemies shall be at the Contractor's option.

E. After each excavation is completed, the Contractor shall notify USAID and no construction shall be started until USAID has approved the depth of the excavation and the character of the foundation material.

F. Unless otherwise provided, all parts of the cofferdams shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished work.

G. Sheetpiling used in the construction of cofferdams may be left in place at the option of the Contractor, provided it is cut off at an elevation as may be directed by USAID. All cut offs will become the property of the Contractor and the cut off portions removed from the site. No cut off shall be allowed to float away or left in such a manner as to obstruct the flow of water. No sheeting may be left so as to create a possible obstruction to flow of water or a hindrance to traffic of any kind.

H. Guide wales or other devices may be used to ensure accurate driving and aligning of the sheeting. Any movement which would prevent work from being performed in a proper manner shall be corrected at the expense of the Contractor.

END OF SECTION 31 52 13

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Pavement marking paint.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

   a. For each type of product indicated. Include technical data and tested physical and performance properties.

2. Other Submittals:

   a. Job-Mix Designs: For each job mix (hot-mix asphalt) proposed for the Work.
   b. Copy of industry procedures used to develop hot-mix asphalt design, if Asphalt Institute (AI), MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types" is not used.
   c. Qualification Data:

      1) Manufacturer: Submit list of completed projects using products proposed for this Project demonstrating compliance with applicable requirements specified in “Quality Assurance” article.
      2) Asphalt Paving Installer Experience Listing: Submit list of completed projects using products proposed for this Project demonstrating compliance with applicable requirements specified in “Quality Assurance” article.

   d. Material Certificates:
      1) Manufacturer’s Certificates: Certify that hot mix asphalt products and other products specified meet or exceed the requirements specified.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer that has designed and produced mixes for asphalt paving projects of similar size and scope to the application shown on the Drawings with a record of successful in-service performance on a minimum of 5 prior projects.

B. Asphalt Paving Installer: Company specializing in performing the work specified in this Section with a minimum of 3 years experience on asphalt paving projects of similar size and scope to the application shown on the Drawings with a record of successful in-service performance on a minimum of 5 prior projects.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 15.6 deg C.
2. Tack Coat: Minimum surface temperature of 15.6 deg C.
3. Slurry Coat: Comply with the following weather limitations:

    a. Do not apply if pavement or ambient temperature is 13 deg C or below and falling.
    b. Apply when ambient temperature is 7 deg C or above and rising, and pavement temperature is 7 deg C or above and rising.
    c. If high relative humidity (65 percent and above) is present, the slurry coat shall not be applied due to prolonged curing time.

4. Asphalt Base Course: Minimum surface temperature of 4.4 deg C and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 15.6 deg C at time of placement.
6. Pavement Marking Paint: Proceed with pavement marking at minimum ambient and surface temperature as recommended by manufacturer.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING MIX AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692/D 692M, or equivalent industry standard, sound; angular crushed stone, or crushed gravel.

1. The gradation shall be based upon the design mix specifications as determined by the asphalt batch plant for each course or type to be provided. Also see ASTM D 448, or equivalent industry standard.

C. Fine Aggregate: ASTM D 1073, or equivalent industry standard, sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof.

1. The gradation shall be based upon the asphalt batch plant's standard mix design for each course or type to be provided.
2. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242/D242M, or equivalent industry standard, rock dust or hydraulic cement, or other inert material.

1. The gradation shall be based upon the design mix specifications as determined by the asphalt batch plant for each course or type to be provided.
2. Mineral filler shall be dry enough so that it flows freely and does not clump.
3. Mineral filler shall contain no organic material or harmful material.
4. Mineral filler that is from rock dust shall have a plasticity index not greater than 4.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22, or equivalent industry standard.

1. The asphalt binder shall be an asphalt based cement.
2. The asphalt binder shall be the asphalt batch plant's standard product that is equivalent to the performance grade (PG) specified.

B. Asphalt Cement:

1. ASTM D 3381/D 3381M, or equivalent industry standard, for viscosity-graded material

   a. Asphalt cement graded by viscosity at 60 deg C shall be the asphalt batch plant's standard product that is equivalent to the product specified.

2. ASTM D 946/D 946M, or equivalent industry standard, for penetration-graded material].

   a. Asphalt cements graded by penetration shall be the asphalt batch plant's standard product that is equivalent to the material specified.

C. Emulsified Asphalt Prime Coat: ASTM D 977, or equivalent industry standard, emulsified asphalt, or ASTM D 2397, or equivalent industry standard, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

1. Material shall be manufacturer's standard product that is equivalent to the material specified.

D. Tack Coat: ASTM D 977, or equivalent industry standard, emulsified asphalt, or ASTM D 2397, or equivalent industry standard, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

1. Material shall be manufacturer's standard product that is equivalent to the material specified.

E. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Sand: Sand for use as blotter material over unabsorbed prime coat and filling depressions in subgrade after proof rolling and prior to paving shall be natural sand or processed fine aggregate from crushed stone or crushed gravel. The sand shall consist of hard, tough grains and shall be free of organic material, clay, loan and other harmful materials. The sand shall conform to the following gradation:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
4.75 mm	100
2.36 mm	75 to 100
1.18mm	50 to 74
600 um	28 to 52
300 um	8 to 30
150 um	0 to 12
75 um	0 to 5

B. Joint Sealant: ASTM D 6690, Type II or III, or equivalent industry standard, hot applied, single-component, polymer-modified bituminous sealant.

a.

2.4 PAVEMENT MARKING PAINT

A. Pavement-Marking Paint: Alkyd-resin type for use on asphalt pavement and concrete pavement, lead and chromate free, ready mixed, complying with AASHTO M 248, Type F, or equivalent industry standard; colors complying with FS TT-P-1952 and Fed. Std. 595, or equivalent industry standards.

1. Color: As indicated

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, or equivalent industry standard, with drying time of less than 45 minutes.

1. Color: As indicated

C. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint. Color shall be black.

2.5 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes**;** designed according to procedures in Asphalt Institute, MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", or equivalent industry standard, and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 5 km/h.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 13.6 tonnes.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Engineer, and replace with compacted backfill or fill as directed.
4. After rolling, test course with a 5 meter long straight edge. Fill depressions over 6 mm in depth with sand.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Beginning asphalt paving operations constitutes the Contractor's acceptance of subgrade and conditions.

3.2 SAWCUTTING

A. Saw cut existing pavement perpendicular to the roadway surface in straight lines. Pavement shall be saw cut through its full thickness. If the pavement breaks irregularly along the cut line during removal, saw cut the entire length of pavement again to achieve one uniform and straight line.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 50 mm.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 25 mm after milling, before wearing course is laid.
7. Keep milled pavement surface free of loose material and dust.
8. Do not allow milled materials to accumulate on-site.

3.4 TACK COAT APPLICATION

A. The tack coat contained in the distributor tank shall be homogenous. The tack coat shall be sufficiently agitated or circulated to ensure a homogeneous emulsion prior to application. The tack coat shall be applied to a prepared clean pavement and in a manner to offer the least inconvenience to traffic and to reduce pickup or tracking of the bituminous material. Upon application the material shall be uniformly spread across the width of the designated area.

B. The tack coat shall not be applied on a wet pavement surface or when the pavement surface temperature is below 7 deg C. The Engineer will approve the temperature and areas to be tack coated prior to application. To avoid "boil-off" of the water, the asphalt emulsion shall not be heated above 90 deg C.

C. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

D. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

E. Coat surfaces of manhole frames and covers, and catchbasin frames and grates with oil to prevent asphalt adherence to surfaces. Do not tack coat manhole frames and covers, and catchbasin frames and grates.

3.5 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate saw cut pavement section to sound base.

1. Saw cut rectangular or trapezoidal patches, extending 300 mm into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically for full depth of pavement.
2. Remove saw cut pavement material.
3. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.2 to 0.7 L/sq. m.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

D. **Placing Patch Material**: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

E. Use hot applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.6 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 25 mm in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 75 mm thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 6 mm.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 6 mm wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 6 mm wide. Fill flush with surface of existing pavement and remove excess.

3.7 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces at a rate of 0.2 to 0.7 L/sq. m.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.8 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course and asphalt binder course in one lift each according to the thickeness indicated on the Drawings.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 121 deg C.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 3 m wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 25 to 38 mm from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.9 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 150 mm.
3. Offset transverse joints, in successive courses, a minimum of 600 mm.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints in accordance with Asphalt Institute MS-22, “Construction of Hot Mix Asphalt Pavements” requirements or equivalent industry standard.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.
7. Use hot applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.10 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 85 deg C.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 13 mm.
2. Binder course: 6 mm
3. Surface Course: Plus 6 mm, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 3 m straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 6 mm.
2. Binder Course: 6 mm
3. Surface Course: 3 mm
4. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 6 mm.

C. Pavement Surface Drainage: Pavement is to drain to catch basin, swale or other storm drainage control measure as indicated on Drawings or, if not indicated on Drawings, to nearest storm drainage control measure.

D. Pavement Remediation: If pavement surface smoothness and drainage requirements above are not met, correct to meet tolerance and performance requirements. If remediation is not acceptable to Engineer, removal and replacement of area will be required. Feather and smooth edges of correction measure so that joint is invisible.

3.12 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Perform work in accordance with the following requirements:

1. When necessary, the Contractor shall establish marking line points at 9 meter intervals, maximum, throughout the length of the pavement or pavement area to provide straight and uniform line work. Arc lines shall be laid out with a chalk string line.

2. Pavement markings shall only be applied during conditions of dry weather and on dry pavement surfaces.
3. At the time of installation the pavement surface temperature shall be a minimum of 10 deg C and the ambient temperature shall be a minimum of 10 deg C and rising.
4. Asphalt pavement shall have been in place for 48 hours prior to the application of pavement markings.

C. Sweep and clean surface to eliminate loose material and dust.

D. At the time of application, all pavement surfaces and existing durable markings shall be free of oil, dirt, dust, grease and similar foreign materials.

E. The Contractor shall be responsible for removing, to the satisfaction of the Engineer, all tracking marks, spilled paint, and paint markings applied in unauthorized areas.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform field tests and inspections, and prepare field and inspection reports.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 836 sq. m or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.14 FLOOD TESTING

A. Perform a flood test, using a water tank truck, in the presence of the Engineerto confirm that pavement surface smoothness and surface storm drainage requirements are met.

3.15 WASTE MATERIAL REMOVAL AND DISPOSAL

A. Remove pavement materials that are the result of removal of existing pavement from the Project site and legally dispose of them.

END OF SECTION 32 12 16

SECTION 32 32 40 – STONE MASONRY WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stone masonry walls, laid in full cement mortar bed, in close conformity with the lines and grades shown on the Drawings. All walls shall be fully grouted with cement mortar.
2. Stone walls shall be used for the approach roadway barriers, and as indicated on the Drawings.

1.3 REQUIRED SUBMITTALS

A. Provide the following submittals:

1. Product Data:

   a. Cement mortar.

2. Other Submittals:

   a. Material Source: Name and address of local stone source.

1.4 QUALITY ASSURANCE

A. Sample Wall: Build a sample wall to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build the sample wall of full-thickness sections to demonstrate typical joints; surface finish, texture, and color; and standard of workmanship in the location where directed by USAID. Size shall be full height and a minimum of 3 meters in length.
2. The sample wall shall be built of materials and by methods to be used in the construction of the permanent wall. Do not start construction of the permanent wall until approval of the sample wall by USAID.
3. The sample wall may be included as part of the permanent wall, when approved by USAID.

PART 2 - PRODUCTS

2.1 STONE

A. Stone shall come from a local source, and shall be of the type, material, and quality typically found in that region.

1. Stone shall not be taken from a waterway bed or bank.
2. Pieces of concrete will not be permitted.

B. Stone for field stone masonry shall consist of sound durable blasted or field stone free from seams, cracks and other structural defects and of satisfactory quality and shape.

C. The stone may consist of angular blasted or field stones having straight edges, but with flat faces not necessarily rectangular in shape.

D. Individual stone shall have, when set in the wall, no face dimension less than 100 millimeters. Stretchers shall have a depth in the wall at least 1-1/2 times the rise, and a length on the face at least twice the rise. Headers shall have a length on the face at least equal to the rise. Headers shall hold in the heart of the wall the same size as shown on the face and shall extend at least 300 millimeters more than the stretchers into the backing.

2.2 CEMENT MORTAR

A. Cement mortar shall be cement-lime mortar type and shall meet the requirements of ASTM C 270, Type S (12.4 MPa), or equivalent industry standard.

1. Proportions shall be 1 part cement, 1/2 part lime and 2-1/2 parts aggregate. Mix with water to produce a consistency suitable for application.
2. Aggregate shall be clean and contain no unsuitable material, and shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
4.75 mm	100
2.36mm	95 to 100
1.18 mm	70 to 100
600 um	40 to 75
300 um	10 to 35
150 um	2 to 15
75 um	0 to 5

3. Water: Potable.

PART 3 - EXECUTION

3.1 SHAPING STONES

A. Selected stone, roughly shaped to provide suitable exposed faces, shall be used at all angles and ends of walls.

B. All shaping of stone shall be done before the stone is laid in the wall. If a stone is loosened after the cement mortar has set, it shall be removed, the cement mortar cleaned off and the stone re-laid in fresh cement mortar.

3.2 TOP OF WALL SURFACE

A. Top of wall surface shall receive a smooth mortar surface.

3.3 LAYING STONE

A. The masonry shall be laid and the face pattern shall be of uniform appearance throughout.

B. Each stone to be set in cement mortar shall be cleaned and thoroughly wetted before being set. They shall be set on full beds of cement mortar, and cement mortar joints shall be full and the stones settled in place before the cement mortar has set.

C. The wall shall be compactly laid having all interior joints completely filled with suitable stones or spalls thoroughly bedded in cement mortar. Voids shall be filled with cement mortar.

D. Vertical joints shall be provided at 10 meter intervals.

END OF SECTION 32 32 40

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