**A-JACKS® CONCRETE ARMOR UNIT SPECIFICATION**

**24 in. A-Jacks Units**

**PART 1: GENERAL**

**A. Scope of Work**

The Contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of A-JACKS®concrete armor unitsin accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

**B. Submittal**

1. **Product Data**:Manufacturer's data sheets on each product to be used, including:
   * 1. Manufacturer’s hydraulic testing documentation and calculations supporting the following requirements for the concrete armor units:
        1. A minimum Dynamic Impact Factor of 1.75.
        2. Completed lateral load testing.
        3. Minimum FoS of 1.5, utilizing the factor of safety method detailed in section E of the specification.
     2. An appropriate geotextile, selected for the site being protected on the basis of the gradation and permeability of the surface soils.
     3. Manufacturer’s certifications for any ancillary materials used in conjunction with the system, including any cables, fittings, and any other materials needed for installation.
     4. Shop Drawings for the concrete armor units, installation, and safety instructions, and any recommendations, if applicable, that are specifically related to the project.
2. **Quality Assurance**
   * + - 1. Manufacturer Qualifications:

Suppliers must own and operate their own manufacturing facility.

Suppliers shall directly employ a minimum of five (5) registered Professional Engineers.

A list of five (5) comparable projects, in terms of size and applications, in the United States, where the satisfactory performance of the specific CAU system can be verified after a minimum of five (5) years of service life.

The names and contact information (phone numbers and e-mail addresses, at a minimum) for the suppliers’ representatives, for technical, production or logistics questions, at least one of whom must reside in the state where the project is located.

**PART 2: PRODUCTS**

**A. General**

The geometry of an A-JACKS® concrete armor unit consists of six arms extending from a central hub. A complete unit is made up of two identical halves, with each half consisting of a central core with three legs radiating outward at equal spacing. On each half, two fillets are located between adjacent arms. These fillets provide additional structural strength and aid in the proper placement of the armor units.

When the symmetrical halves are interlocked, the resultant unit will have geometry, which exhibits six equally spaced arms, with each arm spaced at 90 degrees from the four adjacent arms. When placed in the most stable configuration, each unit will rest on three of the six arms.

* 1. **Manufacturers**

The A-JACKS® concrete system shall have the following nominal characteristics:

**TABLE 2. STANDARD SIZES OF A-JACKS**®

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| A-JACK  Model | Total Length  (in) | Arm  Length  (in) | Fillet  Length  (in) | Arm  Width  (in) | Volume  (ft3) | Weight  (lbs) |
| AJ-24 | 24 | 8.30 | 1.85 | 4.00 | 0.59 | 76-82 |

* + 1. Acceptable Manufacturers:

A-Jacks® as manufactured and sold by:

ARMORTEC, a Contech Company

9025 Centre Pointe Dr., Suite 400

West Chester, OH 45069

P: 800-645-7000

F: 513-645-7241

* + 1. Substitutions:

Alternative materials may be considered. Full documentation consistent with the foregoing must be submitted in writing to the EOR a minimum of twenty (20) business days prior to bid date, and must be pre-approved in writing as an addendum to the bid documents and drawings by the EOR at least ten (10) business days prior to bid date.

**B. Concrete Armor Units**

1. **Materials**

The 2 ft. (AJ-24) A-Jacks® units will be produced on a pre-determined concrete block machine and will conform to ASTM D 6684-04, *Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems*.

Cementitious Materials - Materials shall conform to the following applicable ASTM specifications:

* + - Portland Cements - Specification C 150, for Portland Cement.
    - Blended Cements - Specification C 595, for Blended Hydraulic Cements.
    - Hydrated Lime Types - Specification C 207, for Hydrated Lime Types.
    - Pozzolans - Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.

Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

* Normal Weight - Specification C 33, for Concrete Aggregates.

1. **Casting**

The concrete units will be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product. Material and manufacture standards will be compliant with ASTM D6684-04.

1. **Physical Requirements**

At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 1 below.

|  |  |  |  |
| --- | --- | --- | --- |
| **TABLE 1. A-JACKS**® **PHYSICAL REQUIREMENTS** | | | |
| **Compressive Strength**  **Net Area**  **Min. psi** | | **Water Absorption**  **Max., lb/ft3** | |
| Avg. of  3 units | Individual Unit  (min. required) | Avg. of  3 units | Individual Unit |
| 4000 | 3,500 | 9.1 | 11.7 |

Units shall be sampled and tested in accordance with ASTM C 140, Standard Test Methods of Sampling and Testing Concrete Masonry Units.

1. **Visual Inspection**

All units shall be sound and free of defects that would interfere with either the proper placement of the unit or impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection.

Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be deemed grounds for rejection.

A-Jacks® rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. A-Jacks® rejected at the job site shall be repaired with structural grout or replaced at the expense of the contractor.

1. **Sampling and Testing**

The purchaser or their authorized representative shall be accorded proper access to facilities to inspect and sample the units at the place of manufacture from lots ready for delivery.

Field installation procedures shall comply with the procedures utilized during the hydraulic testing procedures of the recommended system. All system restraints and ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing. For example, if the hydraulic testing installations utilize a drainage layer then the field installation must utilize a drainage layer; an installation without the drainage layer would not be permitted.

Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.

**C. Filter Fabric**

The geotextile will meet the minimum physical requirements listed in Table No. 3 of these Specifications. Consultation with the manufacturer is recommended as AASHTO- M288 for permanent erosion control is assumed for the design.

## TABLE 3: PHYSICAL REQUIREMENTS

|  |  |  |
| --- | --- | --- |
| **Physical Property** | **Test Procedure** | **Minimum Value** |
| Grab Tensile Strength | ASTM D4632 | 205 Lbs. |
| (in any principal direction) | |
| Breaking Elongation | ASTM D4632 | 50% max. |
| (in any principal direction) | |
| Trapezoidal Tear | ASTM D4533 | 80 Lbs. |
| CBR Puncture Strength | ASTM D6241 | 525 Lbs. |
| A.O.S. | ASTM D4751 | *Specified by EOR* |

The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore fine soil particles will not be allowed to clog the filter fabric.

During all periods of shipment and storage, the filter fabric will be protected from direct sunlight, ultraviolet rays and temperatures greater than 140° Fahrenheit. To the extent possible, the fabric will be maintained wrapped in its protective covering. The geotextile will not be exposed to sunlight, ultraviolet rays until the installation process begins.

Soil characteristics such as grain size distribution and plasticity will be determined for every 200,000 square feet of geotextile installed or for each source of borrow material used during construction. Significant differences in soil characteristics will require further inspection at the discretion of the Engineer. The locations for which the material to be tested is extracted will be approved by the Engineer. The Contractor will provide the site-specific soil and modified proctor curves for the site-soil, at no expense to the manufacturer. Also, the contractor will be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test will be performed under the actual field soil conditions or as otherwise required by the Engineer.

The need and frequency of soil testing is explicitly at the discretion of the Engineer Record.

At the time of installation, the filter fabric will be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged area prior to placing the mats will repair a torn or punctured section of fabric. The patch will be large enough to overlap a minimum of three (3) feet in all directions.

**D. Field Cabling**

Termination or transition of the A-Jacks armoring, as identified in the submittal and contract drawings will require additional field cabling. Cable type will be minimum 3/16” or 1/4” galvanized steel or polyester, as approved by the Engineer.

Field cabling is done to mitigate unexpected local toe scour or to add redundancy at the termination and transition points. Cable will be placed around the mid-section of the selected units (recommended 3-unit minimum), hand tightened and connected using standard cable hardware supplied by the manufacturer.

Cable orientation of the recommended 3-unit minimum (i.e. perpendicular or parallel to a slope) will be identified and agreed upon in the field by the Contractor and Engineer’s representative. Ensure practical placement of additional cabling to minimize unreasonable effort by Contractor. Prior to field cabling work means and methods will be discussed to establish a typical configuration for the previously identified areas.

Ultimately, the number of units to be cabled as well as orientation is at the discretion of the Engineer of Record.

## E. Armor Unit Performance Specifications –Channel Bed and Bank Protection

The armor unit should provide sufficient hydraulic stability under the design conditions specified above.

The Factor-of-Safety (FOS) Method should be used in evaluating the hydraulic stability of the chosen armor units.

The FOS for shear stress, SFτ, should be greater than 1.5, where SFτ is defined in the following:

SFτ = τp/τo

where τp is the permissible stress for the armor unit accounting for the appropriate side slope correction factor, and τo is the maximum bed shear stress corresponding to the design condition.

The FOS for velocity, SFv, should be greater than 1.5, where SFv is defined in the following:

SFv = Vp/V

where Vp is the permissible velocity for the armor unit accounting for the appropriate side slope correction factor, and V is the design velocity.

**PART 3: FOUNDATION, GEOTEXTILE AND A-JACKS PREPARATION & PLACEMENT**

**A. Foundation Preparation**

**General.** All subgrade preparation should be performed in accordance with *ASTMD6884-03, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*.

Areas on which filter fabric and the Hard Armor Units are to be placed will be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.

**Grading.** The slope will be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric). All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. Where such areas are evident, they will be brought to grade by placing compacted homogeneous material. The slope and slope face will be uniformly compacted, and the depth of layers, homogeneity of soil and amount of compaction will be as required by the Engineer.

**Inspection.** Immediately prior to placing the filter fabric and remaining subgrade components, the prepared subgrade will be inspected by the Engineer as well as the owner's representative. No fabric, subgrade section or Hard Armor Unit will be placed thereon until that area has been approved by each of these parties. “Rules of thumb” may be established during the initial inspection of each product type with regard to foundation preparation to facilitate efficiency in future project preparation areas.

**B. Placement of Geotextile Filter Fabric**

**General.**

All placement and preparation should be performed in accordance with *ASTM D6884-03, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*. Filter Fabric, or filtration geotextile, as specified elsewhere, will be placed within the limits shown on the Contract Drawings.

**Placement.** The filtration geotextile will be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile will not be walked on or disturbed when the result is a loss of intimate contact between the geotextile and the subgrade. The geotextile filter fabric will be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints will be overlapped at least two (2) feet. The geotextile will extend at least one (1) foot beyond the top and bottom revetment termination points, or as required by the Engineer.

**C. Placement of A-Jacks System**

The proposed A-Jacks units, as specified in Part 2A of these specifications, will be constructed within the specified lines and grades shown on the Contract Drawings.

**Placement (No. 57 Stone) – 24” A-Jacks**

If applicable, to mitigate subgrade inconsistencies, a minimum thickness of 4” of No. 57 stone is required prior to installing the 24” units. The stone and desired thickness will be placed directly on the specified geotextile as directed and accepted by the Engineer of Record or representative.

**Bedding** **– 24” A-Jacks**

A bedding layer of clean stone is to be placed in conjunction with the subgrade section for backfilling purposes to achieve necessary bearing and/or setback tolerances. The recommended bedding layer size (D50) is 2-3”; alternate D50 size for bedding layer will be defined by local aggregate availability, approved by the Design Engineer.

**Placement – 24” A-Jacks**

A-Jacks can be installed individually or in bundles at the discretion of the Contractor.

Placed individually, A-Jacks will be placed with uniform spacing. For a specified area receiving the 24” units, standard spacing between unit center in both the x and y dimension is 12”, which represents a 0.5 packing ratio. Tighter placement tolerances are possible, such as a 0.4 packing ratio, but may become difficult to achieve while placing successive rows in a matrix. Standard installation includes placing the units in a consistent repeatable fashion to aid in efficiency. Recommended in-place orientation of the unit(s) emphasizes pointing exposed projecting unit arm (vertical or horizontal) downstream whenever practical during construction. Subsequent cabling of outer units is common, depending on the system embedment for the project.

Placed in bundles, A-Jacks are placed into a pre-determined matrix, spacing them as closely as possible, approximating the maximum packing ratio of 0.4 (9.6” center spacing in x and y directions). Cable will be placed around the pre-determined matrix (around mid-section) with cable; hand tightened and connected using standard cable hardware supplied by the manufacturer. Bundles are to be placed as closely as possible, with recommended tolerance requirement of 4” between bundles. If the bundling method is employed by the Contractor, tolerances between bundles will be discussed and agreed upon prior to commencing work. Spacing will be measured from center of bundle to middle of installed bundle, in the horizontal plane, before additional (stacked) units are placed.

Bedding stone material can be utilized for bridging interior voids and establishing consistent bedding layer for additional lifts of unit(s), whether hand placed or bundles. Vertical fluctuations occurring from unit to unit or bundle to bundle will be compensated for by utilizing bedding.

**Consultation.** The manufacturer of the hard armor units will provide design and construction advice during the design to the extent possible and initial installation phases of the project as necessary, by the discretion of the Engineer.