

Installation of HYDROCAST Armor Units

Equipment and Tools

Because of the simple installation procedure for HYDROCAST Armor Units, a nominal amount of tools and equipment are required. We suggest that the contractor have on hand the following:

Tools:

Surveyor's level and rod	Shovels
Rakes	Hammers
Stakes	String line
Rubber boots and gloves	Pail
Safety glasses or goggles	Scissors
Trowels	

Equipment:

- Small line concrete pump
- Concrete pump hose - 2 inch (50 mm) diameter
- Injection pipe - 2 inch (50 mm) diameter
- Hand-held sewing machine (electric or air powered) with speed control
- Extension cord (if electrical equipment is used)
- Electric generator with ground fault circuit breaker
- Air compressor (for air powered sewing machine)
- Small, walk-behind flat or vibratory compactor for soil compaction

A list of equipment manufacturers is provided in the appendices. However, Synthetex, LLC makes no warranty nor guarantees the performance of equipment provided by another manufacturer.

Sequence of Armor Unit Installation

Once the area to be protected has been excavated, graded and compacted to the lines and grades specified in the Contract Drawings and Specifications, an installation crew, filter fabric (if required), fabric forms, and the tools and equipment listed above should be mobilized to the job site. Freshly excavated and graded slopes are highly subject to erosion and should be protected from water runoff, flowing water and waves.

Depending on the location of the area, dimensions, and the rate of subgrade preparation, installation rates of as much as 15 yd³ (11.5 m³) of fine aggregate concrete per hour can be achieved by a crew of 3 or 4 laborers, a concrete pump operator and a supervisor.

Establish the starting point.

The first step in the installation of fabric-formed concrete armor units is to establish a starting point. If a working point and direction of placement are shown on the Contract Drawings this should be the starting point. If this is not the case, it is the customary practice for channels, streams and rivers to work from the upstream end of the project to the downstream end. In this manner the flow of the water will tend to spread

the fabric forms out ahead of the finished work and the finished concrete armor unit is protected from undercutting. For inland and coastal shorelines it is customary practice to install the first course of armor units then proceed to succeeding courses. Fabric form armor unit layout drawings, available from Synthetex will recommend starting points and directions of placement for the project.

Establish the alignment lines

Once a starting point has been established a surveyor's level should be used to determine the longitudinal and slope alignment lines of the fabric-formed concrete armor units. String lines should then be placed along the respective alignment lines and staked. Generally, the alignment lines are offset, by a measured distance, to the opposite side of any trench or a minimum of 5 feet (1.5 m) in order not to interfere with the work area. The method of establishing reference points and lines should be left to the discretion of the contractor.

Placement of the filter fabric, if required

Under certain soil conditions or if called for in the Contract Drawings and Specifications, it will be necessary to place filter fabric and/or a granular sublayer under the fabric forms to guarantee that soil is not piped through any spaces between the armor units. Filter fabric should be selected and placed in accordance with the Contract Drawings and Specifications or in the absence of such directions in accordance with the manufacturer's guidelines. Filter fabrics and their installation are discussed, in brief, earlier in this manual (page 7).

Placement of the first course of armor unit fabric forms

The prefabricated armor unit forms are folded and marked with the appropriate form numbers and dimensions at the factory for easy identification, location and installation.

The first armor unit fabric form, in the first course, should be carefully placed at the designated starting point and unfolded into position (Fig 62). Special care should be taken to assure that the sides and ends of the form are exactly parallel to their respective alignment lines.

Armor unit fabric forms should be placed loosely, but without folds, to allow for proper filling with fine aggregate concrete. The extra fabric provided for form contraction should be extended. Forms that are stretched or taut will not permit the required form contraction, therefore the fabric forms will not fill to their required thicknesses. For example, a 72 inch by 120 inch (183 cm x 305 cm) form is to be filled to a thickness of 30 inches (76 cm). When filled with fine aggregate concrete to this thickness, the width and length of the form will contract by approximately 57% of the thickness, giving a finished armor unit dimension of 55 inches x 103 inches (139 cm x 261 cm). Adjacent armor units (of the same dimensions

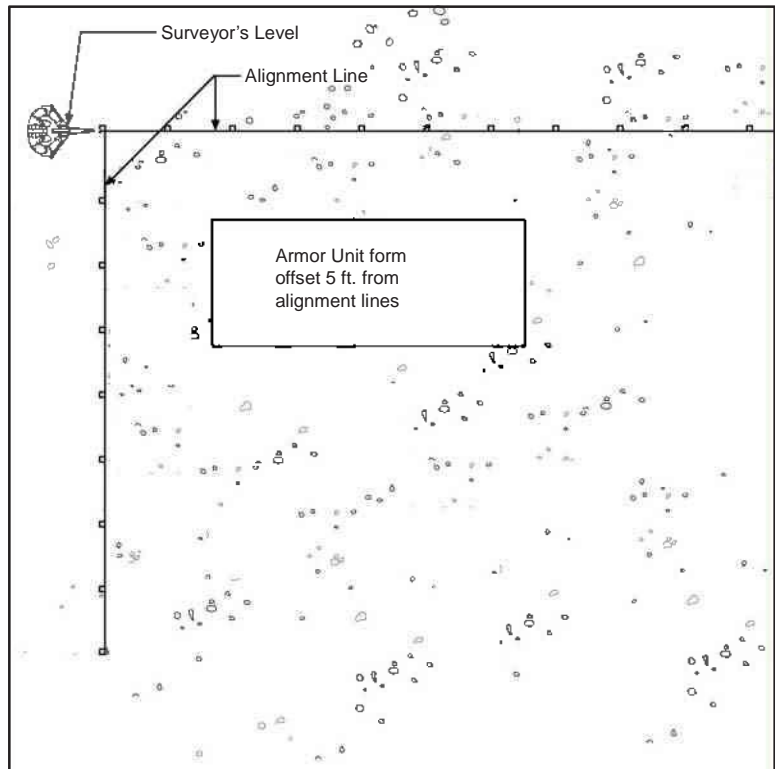


Figure 62

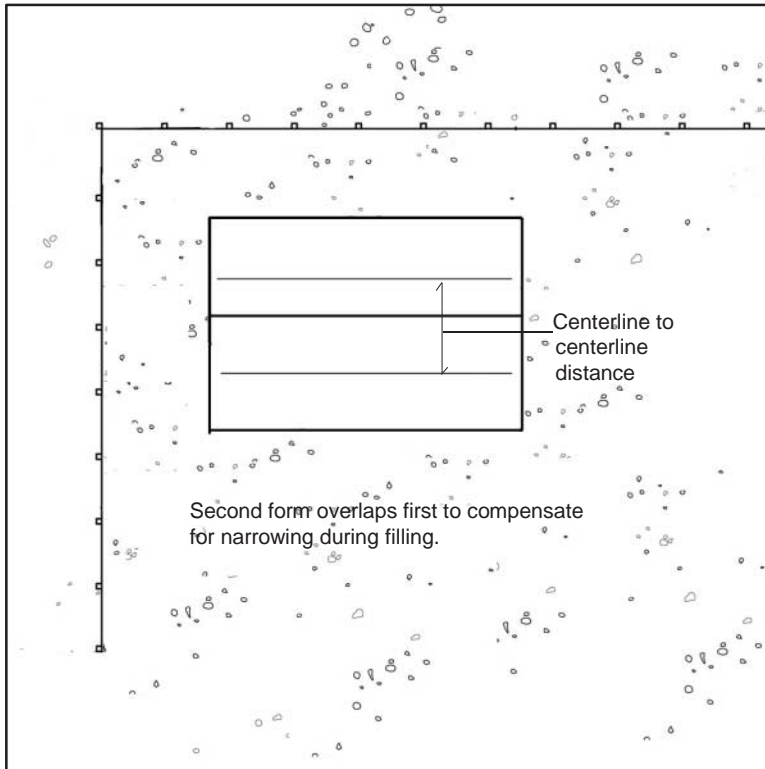


Figure 63

used in this example) should therefore be placed with their centers 17 inches (43 cm) closer together than called for by the unfilled form dimensions.

The second armor unit form in the first course should be placed alongside the first form so that the centerline to centerline distance equals that of the calculated armor unit width after contraction, as shown in Figure 63. After the second armor unit form has been positioned, the alignment of the forms should be checked.

The remaining armor unit forms in the first course should be placed side-by-side in the same manner. The alignment of the forms should be checked periodically since small errors in alignment can progress in severity. Armor unit form alignment is important in providing a uniform and attractive appearance in the finished installation.

Armor unit form placement should precede concrete filling by no more than the distance that can be completed in one day. Where the forms may be exposed to flowing water or wave action, each form should be filled with fine aggregate concrete prior to placement of the adjacent form.

Placement of the second course of armor unit fabric forms

The second course of armor unit forms should be placed atop the fine aggregate concrete filled first course. (See Sequence of Fine Aggregate Concrete Pumping.) The center line of the first form in the second course is positioned directly over the abutting edges of the first two armor units in the first course, as shown in Figure 64. The staggering of the centerlines of the armor units in vertically adjacent courses encourages “nesting” of armor units and facilitates alignment. The remaining forms in the second course should be placed side-by-side in the same manner as the first course. Once again, check alignment periodically since small errors can progress in severity.

When constructing structures subject to wave action, the armor units should be aligned with their long axis facing the principal direction of wave attack.

Underwater placement of fabric-formed armor units may require the use of divers. The divers can prepare the finished grading, inspect the area to be protected, and position and secure the filter fabric and fabric forms. The securing of the forms may require sand bags or weights.

A small quantity of bulk (uncut and unassembled) form fabric should be ordered for each project. The fabric can be used for special field tailoring. At least one half a roll, about 900 ft² (84 m²) of bulk fabric, is recommended.

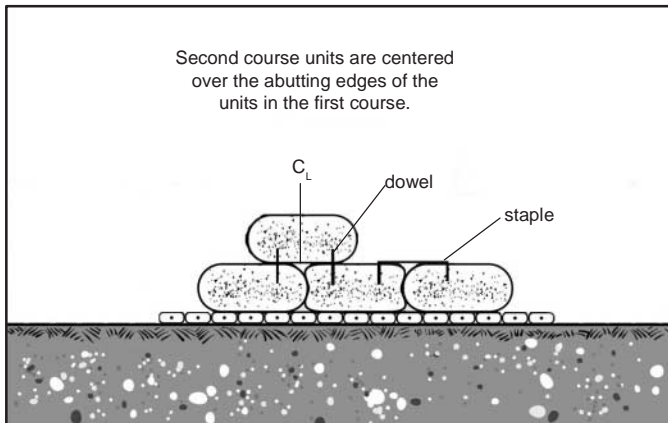


Figure 64

Sequence of Fine Aggregate Concrete Pumping

Ordering fine aggregate concrete

Fine aggregate concrete is generally delivered to the job site in ready-mix trucks. The order for concrete should be placed a least one day prior to its scheduled delivery to the job site. The concrete supplier should be instructed to fill the water tank of each truck with mix water. It is common that the first few loads delivered to the job site will not be fluid enough for pumping and will require the addition of mix water. In order to avoid presetting of the fine aggregate concrete it is recommended that the concrete be delivered in loads of no more than 8 yd³ (6 m³). At a minimum, the first load of each day should be checked with a standard flow cone for consistency, in accordance with ASTM D 6449. The addition of pea gravel to the mix may reduce the cost of materials with a slight increase in labor costs. When pumping concrete with pea gravel, the diameter of the pump hose should be increased.

Securing the armor unit forms

Beginning at the designated starting point the installation crew should check and adjust the armor unit forms to assure that they are in alignment. After the forms have been properly adjusted, fine aggregate concrete is pumped into forms. It must be emphasized that care should be exercised in the alignment and securing of the first course of armor units. This will ensure the aesthetics of the concrete armor units and also hasten the installation of subsequent courses.

Inserting the fine aggregate concrete injection pipe

Fine aggregate concrete should be pumped into the fabric form armor unit by inserting the injection pipe through a self-closing "pocket type" filling valve in the upper layer of the fabric. A tight seal is made when the injection pipe is inserted into the valve. When the pipe is withdrawn, the valve shuts.

Filling the first fabric form armor unit with fine aggregate concrete

Starting at the first fabric form armor unit, the injection pipe should be inserted into the self closing filling valve. The form should be filled by pumping fine aggregate concrete into the form. The fine aggregate concrete should fill the center and corners of the form, proceeding gradually to the specified armor unit thickness. Pressure from the concrete fill helps close the filling valve.

The injection pipe should then be moved to the adjacent armor unit form and inserted into the filling valve. Once again, the previous pumping procedure should be repeated until this form has been filled to its specified thickness.

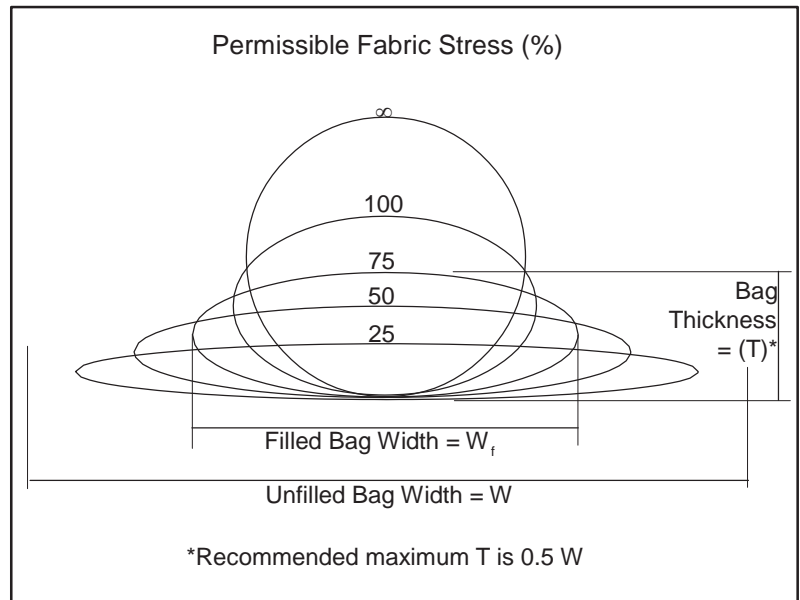


Figure 65

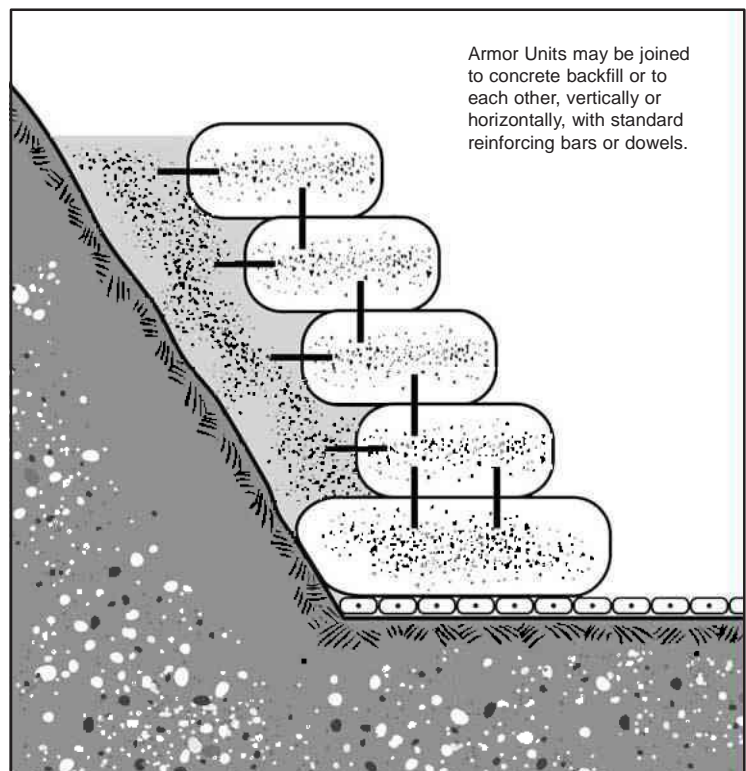


Figure 66

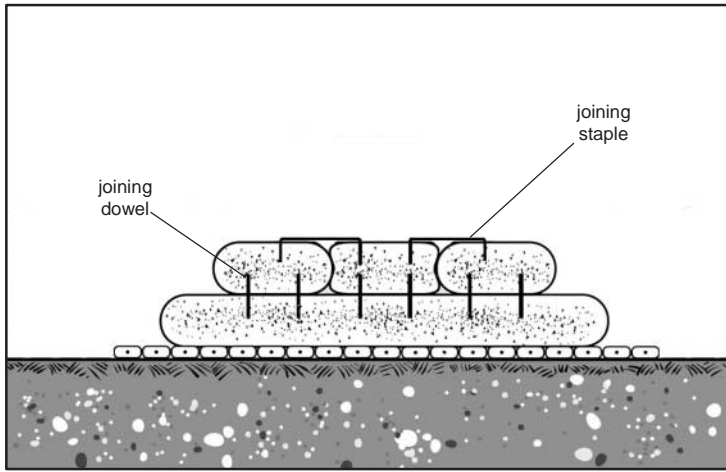


Figure 67- Typical cross section

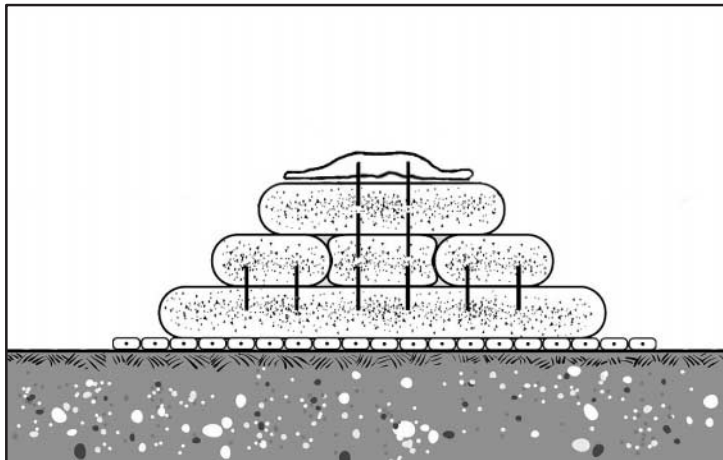


Figure 68- Armor Unit form ready for filling

Overpressuring of fabric forms

Care must be taken when pumping fabric forms to assure that the fabric is not over pressurized. Over pressurization may cause bursting of seams. Please refer to Table 12.0 for recommended filling thicknesses per width. See also Figure 65 for fabric stress at differing fill geometries.

Connecting fine aggregate concrete armor units

Armor units are easily joined by inserting steel reinforcement bars, "dowels" or "staples" as suggested in Figures 66 and 67. When connecting vertically adjacent courses of armor units by inserting dowels, first force the pointed ends of the reinforcement bars through the fabric and into the fresh concrete of the filled armor units. Dowels or staples shall be inserted into the filled unit(s) not less than one half hour and not more than one hour after filling of the unit, unless directed otherwise by the Engineer. The forms in the succeeding course are then threaded over the exposed reinforcement bar ends. The dowels are then forced through the bottom layer of the vertically adjacent fabric form (Fig. 68), and the form is then filled with fine aggregate concrete.

Armor units may be connected side-by-side by inserting staples; bend the reinforcement bars into an elongated "U" shape and force the pointed ends of the reinforcement bars through the fabric and into the fresh concrete of the filled armor units. The dowels and staples assist in holding the forms in place during filling and maintaining the alignment of the armor unit structure. Abutting armor units, if placed laterally, may be installed immediately after placement of the preceding unit(s). If an armor unit is to bear on previously installed units, the lower units must be allotted a minimum of four hours of cure time before beginning installation of a succeeding, vertically adjacent course of armor units.

Where required, reinforcement bar cages are installed in the forms through openings in the forms. The form opening is closed before filling by means of a zipper or a portable sewing machine. Reinforcement bar cages are suspended by tie wires from the upper side of the form to assure centering.

Circumferential straps may be attached to armor unit forms as thickness indicators to facilitate the filling of forms underwater. Slight depressions formed by the straps in the surface of the armor unit indicate to the diver, working by touch, that the form has been filled to the specified thickness.

Circumferential straps of predetermined circumferences and spacing, with or without external restraining reinforcement bars, permit the casting of tapering or irregularly shaped armor units.

Filling remaining fabric form armor units with fine aggregate concrete

If care has been taken in positioning the forms and in concrete filling the first course of armor unit forms, little, if any, adjustment of subsequent courses should be required. However, form alignment should be checked periodically since small errors in alignment can progress in severity. Periodically check the location of the forms with an instrument to assure that proper alignment is being maintained.

Special Considerations

Pipes, piles, culverts, trees, and other appurtenances

Armor unit forms should be tailored in the field to fit around pipes, culverts, trees, and other appurtenances. A form may be field cut and sewn or bulk fabric may be fabricated to fit snugly around the object.

Backfilling and compaction of trenches

The backfilling and compaction of open excavations should not begin until at least one hour after filling the adjacent concrete armor unit. Backfill material may be either select bedding materials or fine aggregate concrete. The excavations should be backfilled as shown on the Contract Drawings. The open excavations behind completed sections of armor units should be backfilled and compacted by the end of the work day.

Foot traffic

Foot traffic on the freshly pumped fine aggregate concrete armor unit should be avoided for a period of not less than one hour after concrete injection or until the concrete is resistant to indentation. Should traffic be unavoidable, the contractor should place board walks along the finished filled concrete areas. This will reduce the amount of objectionable indentation. Footprints will leave permanent impressions in the installed fabric-formed concrete armor units.

Cleanup

Any fine aggregate concrete that may spill on top of the fabric-formed concrete armor unit should be picked up by hand or trowel and the surface smoothed by cloth or broom. Such unnecessary spillage of concrete will cause an unsightly appearance. This is particularly important along the top of the final course of armor units.

The installation crew should be instructed to carefully "kink" the concrete pump hose when it is moved from one injection point to another or to place the end of the concrete injection pipe in a pail when moving the concrete pump hose.

The freshly pumped fabric-formed concrete units should never be washed (sprayed) under pressure with water in an effort to clean or remove spills from its surface. A wet cloth should be used for clean up and spill removal.

The cement film that impregnates the fabric forms provides a bond between the fabric form and the concrete fill and a degree of protection against ultraviolet degradation of the fabric. Should this film be removed by washing the uncured concrete armor units, cement may be also washed out from beneath the layer of fabric. The result would be a loss of concrete-to-fabric bond, a sandy, low strength outer surface of concrete and a concrete armor units which will exhibit low abrasion resistance and durability.