



ACE Geosynthetics

ACEFormer™ Installation Manual

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Introduction

ACEFormer™ is a soft and flexible formwork or mattress formed by two layers of high strength PP and/or PET woven geotextile. Its flexibility enables the formwork to accommodate different landforms for the construction of a surface protection structure. It is mainly used for the purpose of erosion control in shoreline protection, riverbank protection, slope protection, submarine pipeline protection, and etc.

Different type of ACEFormer™ satisfies different engineering consideration. However, all ACEFormer™ system provides an effective shield and medium to against erosion, and to reduce the wave energy and flow velocity on the applied surface.

A. Equipment and Material Preparation

1. Main Equipment

- Concrete pump
- Filling pipe (2" to 4" diameter is recommended)
- Portable bag closer (electric or pneumatic)

2. Tools and Accessories

- | | |
|----------------|------------------|
| ➤ Tape measure | ➤ Plastic boots |
| ➤ Shovel | ➤ Plastic gloves |
| ➤ Rake | ➤ Bucket |
| ➤ Hammer | ➤ Trowel |
| ➤ Wooden peg | ➤ Scissor |
| ➤ Rope | |

3. Filling Material

a. General Application

The filling material should flow and fill ACEFormer™ easily. And it should also be strong and durable enough for the application after completion.

Cement mortar is the ideal filling material for ACEFormer™. And Portland cement is recommended for the cement mortar mix. The M type cement specified in ASTM C270 is recommended as the filling material. Below are the mix ratios:

- The Portland cement to sand ratio = 1:3
- The water-cement ratio = 0.65 to 0.7



This testing sample of cement mixture is able to achieve the compressive strength of 175 kg/cm^2 (or 2500 psi) at 28 days. This result satisfies the compressive strength requirement of ASTM C109, C31, and C39. However, depending on the structural requirement of the application, one can adjust the water-cement ratio to get a higher or lower compressive strength of the cement mortar. Make sure the mix is free of grease, chemical substances, and organic materials.

b. Underwater Application

For case, especially in marine structure projects, that requires underwater concrete (or tremie concrete) as filling material, the underwater concrete should be able to resist erosion during construction process. The guideline to follow for this case is *Chapter 8 Concrete Placed under Water* of “ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete”.

Below is the general information about the concrete mixture:

- Basic Ratios: the cement content should at least be 356 kg/m^3 , or use the water-cement ratio of 0.45.
- Slump: 150 to 230 mm (6 to 9 in)
- Aggregate: aggregate used should be less than 38 mm, and the fine aggregate content should be 45 to 55% of the total aggregate volume.
- Volcanic Ash: the use of volcanic ash normally takes 15% of the cement by weight to improve the flowability of the concrete mixture.
- Air Content: normally 5%.
- Chemical Additive: air-entraining admixture, water-reducing admixture, retarding admixture, and anti-washout admixture are usually used with underwater concrete to improve properties like flowability and cohesiveness, and to reduce the washout of cement and/or fine aggregate during casting. ASTM C494 provides the specification and guideline for the use of chemical additives.

The above mentioned ratios and materials are general recommendations of the American Concrete Institute (ACI). The actual ratios and materials to be used should consider the type of structure to be constructed and its expected service life. And then follow the specific standard to design the mix ratio of the underwater concrete.



There are things to know for using underwater concrete. The condition of the working environment may affect the workability of the underwater concrete. Hence one should pay attention to the following:

1. The water temperature should not be less than 1.7°C (35°F).
2. The temperature of the underwater concrete should be between 15.5°C (60°F) and 48°C (120°F).
3. Build a temporary cofferdam to reduce the flow velocity, if the water has a greater flow velocity.
4. Do not compact underwater concrete in any manner.
5. Remove the cofferdam after the concrete becomes stiff.
6. Clean the foam on the surface with high-pressure water.

B. Installation Process

1. Site Preparation

- a. Clean the site and remove any sharp objects that may tear or puncture ACEFormer™ and affect its functionality as formwork.
- b. Shape the slope (angle and dimension) as designed. (See picture 1)



Picture 1. Site preparation

- c. Prepare the toe of slope to receive ACEFormer™ as well, for the toe of slope is subject to erosion and should be protected. Consult professional hydraulic engineer for related calculation and design. Illustration of the extended length of ACEFormer™ at the toe is shown in figure 1.

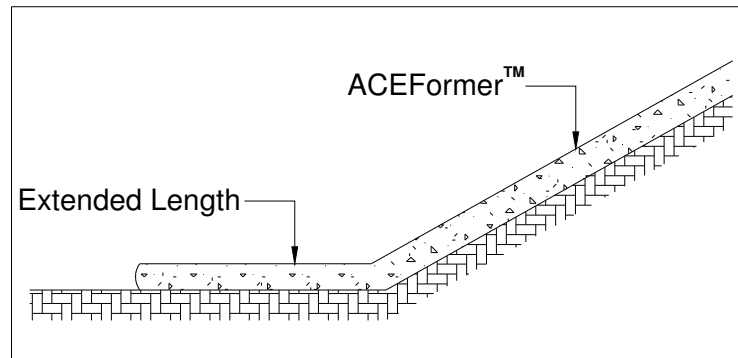


Figure 1. Illustration of protection at the toe of slope

2. Anchor Trench Excavation

- a. Excavate an anchor trench at the top and on both sides of the prepared area. Picture 2 shows the excavation of the anchor trench at the top of slope. Anchored ACEFormer™ will enhance the stability of revetment. Illustration of anchor trench positions is shown in figure 2.



Picture 2. Excavation of the anchor trench at the top of slope

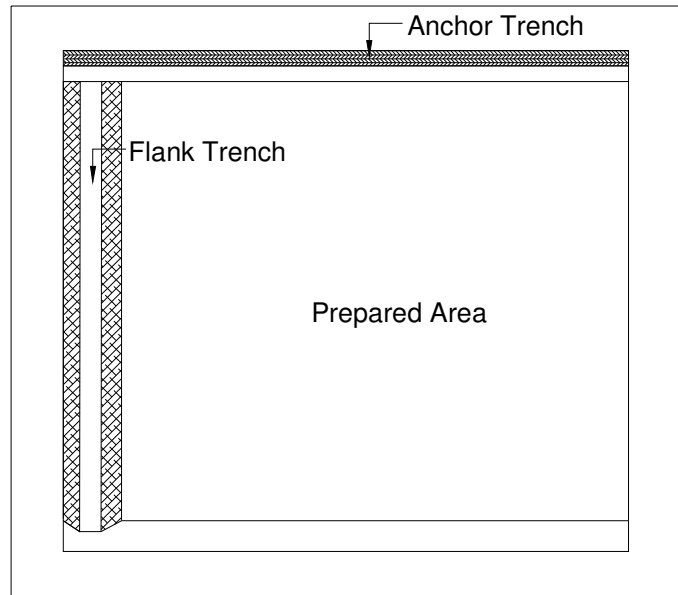


Figure 2. Positions of anchor trench

- b. Leave a horizontal flat surface of at least 60 cm between the anchor trench and the slope at the top to get a better anchorage after filling. Note the minimum depth required for top anchor trench is 50 cm for applications at river bank and channel, and 60 cm for marine structural applications. Illustration of the anchorage at the top of the slope is shown in Figure 3.

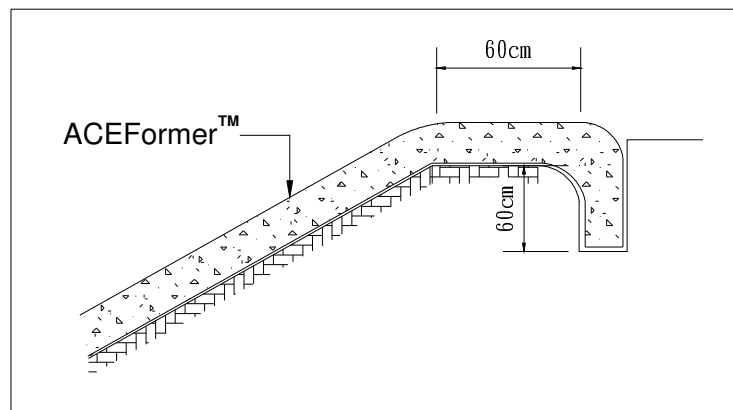


Figure 3. Illustration of anchorage at the top of slope

- c. Excavate the flank trench with a minimum depth of 60 cm. (Later, after the laying and filling of ACEFormer™, backfill with soil and compact it properly to hold ACEFormer™ in place as shown in figure 4.)

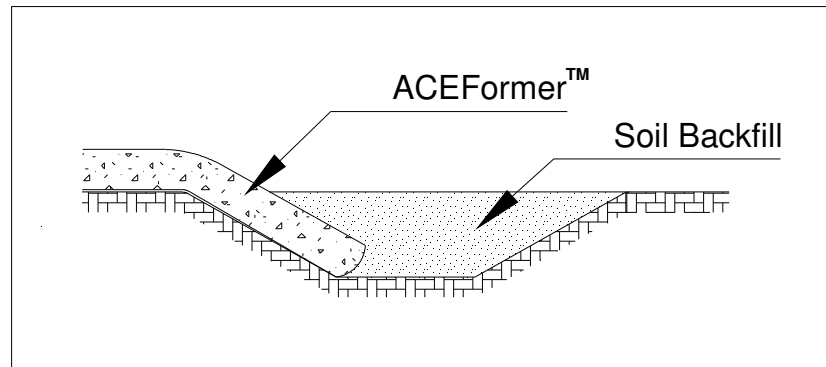


Figure 4. Illustration of the function of flank trench

3. ACEFormer™ Installation

- a. Lay ACEFormer™ from the anchor trench at the top and the adjacent flank trench (see figure 5). And lay in the direction from upstream to downstream; consult ACE technical staff for recommendation. Control the flow velocity to 1.5m/sec or slower if the work site is underwater.

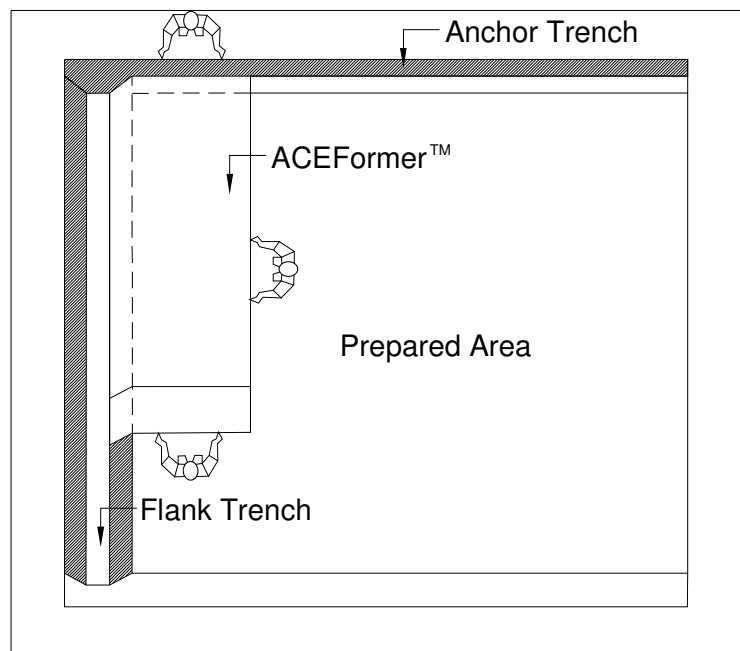
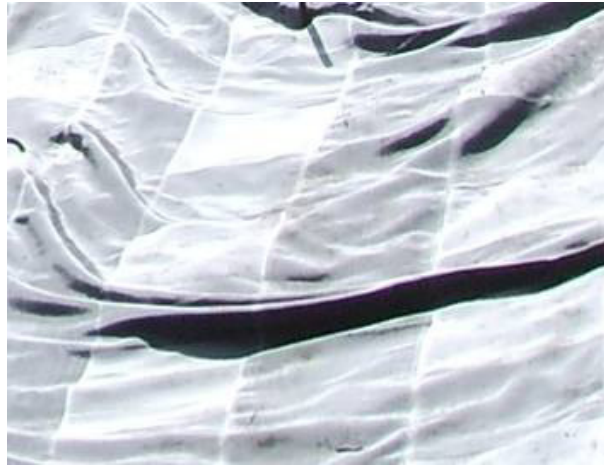


Figure 5. Illustration of laying the first piece of ACEFormer™

- b. Fold ACEFormer™ (as shown in picture 3 and figure 6) to provide space for contraction and expansion during the filling and forming process. Do not lay and fix ACEFormer™ tightly to the work surface, for damage may occur during the filling process and the filling may not achieve the required height. The width of folding varies with the type of ACEFormer™. Consult ACE technical staff for the detail.



Picture 3. Fold the ACEFormer™

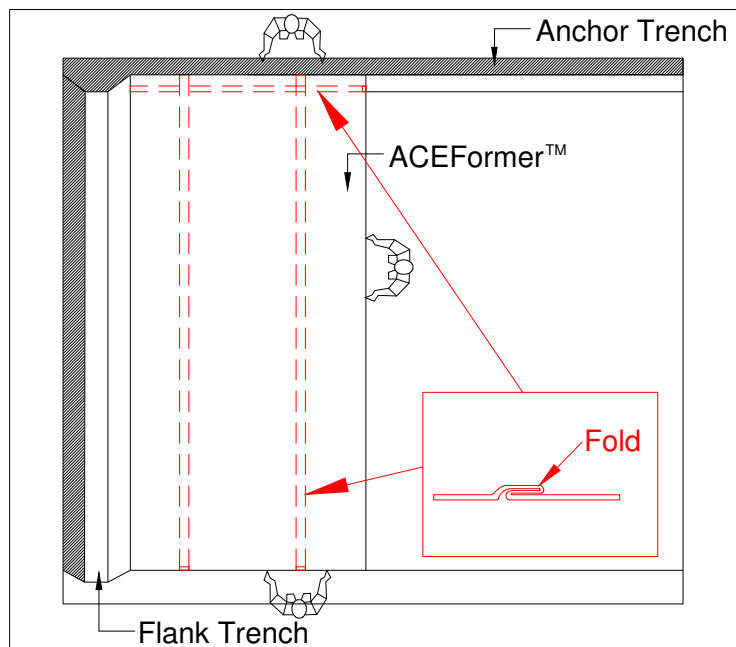


Figure 6. Recommended folding positions

4. Connecting of ACEFormer™

The varied method for ACEFormer™ panels connect, easiest way is overlapping. Lap the ACEFormer™ on the upstream side over the ACEFormer™ on the downstream for the simplest connection. Keep the overlapping area at least 0.5 m in width for general condition, and at least 1 m for underwater construction. The overlapping of ACEFormer™ is shown in figure 7 and 8.

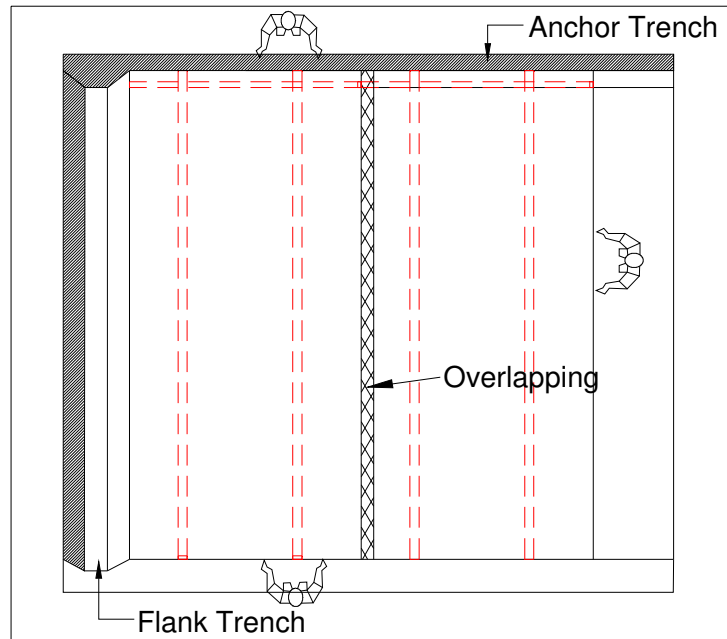


Figure 7. The overlapping arrangement

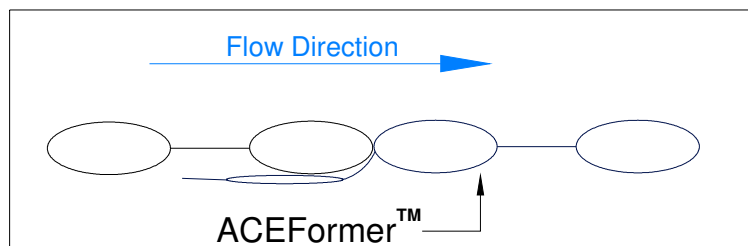


Figure 8. Illustration of overlapping ACEFormer™

Another common method is sewn method. Sew two close together by using portable bag closer, as picture 4.



Picture 4. Sew two panels together



5. Laying ACEFormer™ along a curve

Lay and align the ACEFormer™ along the upper edge of the curve. ACEFormer™ may overlap as illustrated in figure 9.

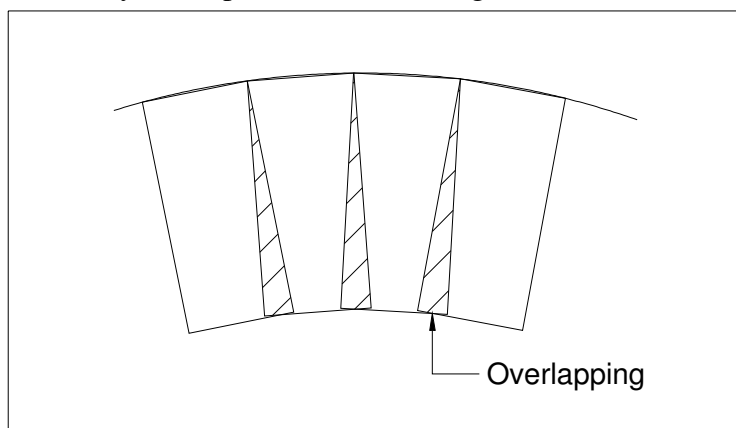


Figure 9. Overlapping at the curve

Fill the ACEFormer™ if protrusion at the overlapping area after filling is acceptable. Otherwise, cut and sew the overlapping section (the triangular section) of the ACEFormer™ beneath to get an even arrangement.

Illustration of the cutting section is shown in figure 10.

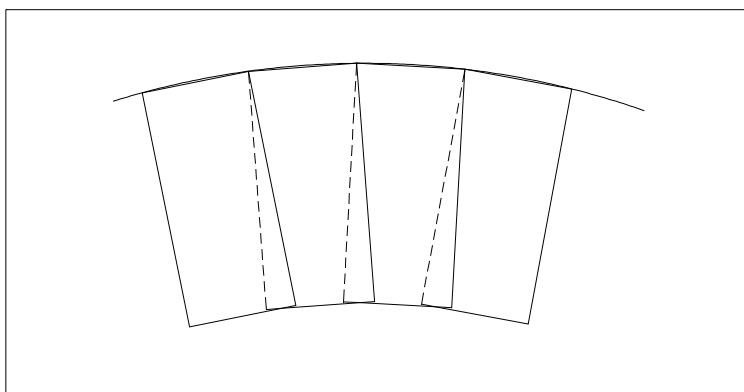


Figure 10. Illustration of the overlapping section to be cut

6. Filling ACEFormer™

- a. Cut an appropriate opening at the top to insert the filling pipe (see picture 5). Insert the pipe to the bottom of the ACEFormer™ and fill from there. Pull the filling pipe outward gradually while filling the ACEFormer™, to get an even filling distribution. Apply pressure and/or vibration externally on the ACEFormer™, when the filling material is stuck in half way. Repeat the process to fill all ACEFormer™.



Picture 5. Inserting filling pipe

- b. Do not fill the entire ACEFormer™ at once, in case of long slope. Excess pressure may occur at the toe of slope, and fail to achieve an even distribution of the filling. In this case, divide ACEFormer™ into 2 or 3 sections (depending on the length of the ACEFormer™) vertically. Fill the lowest section of ACEFormer™ in a row firstly. And then fill the next upper section of ACEFormer™ after the initial setting of the lowest section. Repeat the process until the entire ACEFormer™ is filled (see figure 11).

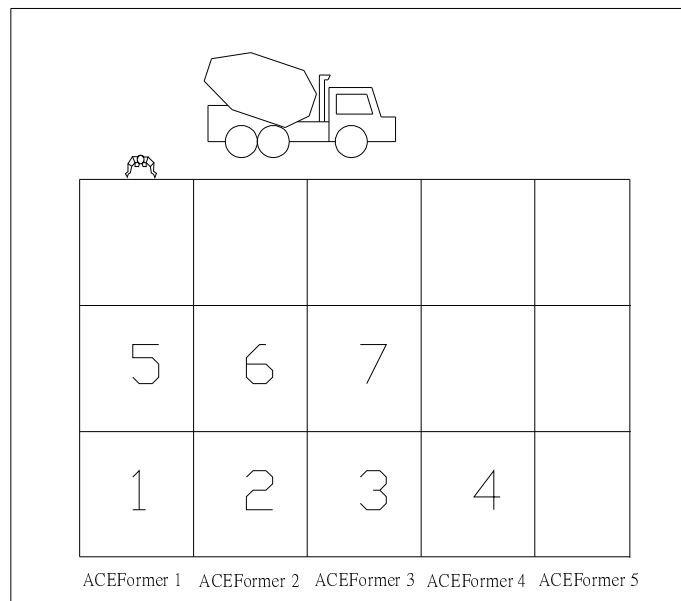


Figure 11. Filling order on long slope