TECHNICAL SPECIFICATIONS
FOR HILFIKER M. S. E. SYSTEM
ArtWeld Gabion-Faced Wall
(Brite Basic / Non-Galvanized Soil Reinforcements)

1.0 DESCRIPTION

This work shall consist of Hilfiker ArtWeld Gabion facing, combined with welded wire soil reinforcement mats, creating an integral Mechanically Stabilized Earth (M.S.E.) Retaining Wall structure constructed in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans or established by the Owner's Engineer.

2.0 MATERIALS

The Contractor shall make his own arrangements to purchase all Gabion-Faced M.S.E. materials, including wire mesh reinforcement mats, ArtWeld gabion baskets, and all necessary incidental accessories from Hilfiker Retaining Walls, 1902 Hilfiker Lane, Eureka, CA 95503-5711, ph. 707/443-5093; www.hilfiker.com; info@hilfiker.com.

2.1 Gabion Baskets

Gabions shall be of a single unit construction. The base, ends, sides, and lid shall be either welded into a single unit or shall be connected in such a manner that strength and flexibility at the connection are at least equal to that of the wire mesh. The gabions shall be fabricated in such a manner that they can be assembled at the construction site with Spiral Binders and pre-formed stiffeners into rectangular baskets of the specified size.

The height, length, and width of the gabions shall not vary more than 5 percent from the dimensions shown on the plans.

Gabions shall be divided into cells of equal length, not more than 3 feet long, by diaphragms made of 9 gauge minimum non-galvanized welded wire mesh. Each gabion shall be fabricated with the necessary diaphragm(s) secured in proper position.

Wire for the manufacture and assembly of gabions shall ***meet or exceed*** any combination of the following requirements:

Description	**Requirement**
3"x3" (7.62 cm x 7.62 cm), 9 Ga. - 0.144 in. min. (3.66 mm) Welded Wire Fabric	ASTM A1064, A370 *Exception: Weld Shear at 800 lbs of force min.*
9 Ga. Pre-Formed Stiffener	N/A
9 Ga. Spiral Binder - min. 0.144 in. (3.66 mm)	ASTM A641, A90

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2.2 Welded Wire Reinforcement Mesh

Welded wire fabric for reinforcing mesh shall be shop fabricated of cold drawn steel wire and shall be welded into the finished mesh fabric conforming to the minimum requirements of ASTM A-1064, with a yield strength minimum of 450 MPa [65 ksi]. Welded Wire Mesh for the Gabion-Faced M.S.E. Wall shall be as per project specifications and will be brite basic / non-galvanized.

2.3 Filter Fabric

Where required, as shown on the plans, geotextile filter fabric shall be utilized between the back of the gabion and the backfill to prevent migration of the soil fill.

3.0 BACKFILL MATERIALS

3.1 Select Granular Backfill **for Soil Reinforcement Zone**

As shown on the plans, select granular backfill materials for the Gabion-Faced M.S.E. Wall structure shall be reasonably free from organic and otherwise deleterious materials and shall conform to the following gradation limits as determined by ASTM D-422:

Sieve Designation	Percent by Weight Passing Standard Sieves (AASHTO T 27 & T 11)
6 inches (152.4 mm)	100
3 inches (76.2 mm)	100 - 75
No. 200 (75 µm)	0 - 15

The backfill shall conform to all of the following additional requirements:

A. The Plasticity Index (P.I.), as determined by ASTM D-4318 (AASHTO T 90), shall not exceed 6.

B. The fraction finer than 15 microns (0.015 mm), as determined by ASTM D-422 (AASHTO T-88) shall not exceed 15 percent.

C. The material shall exhibit an angle of internal friction of not less than 34 degrees, as determined by the standard direct shear test ASTM D-3080-72 (AASHTO T-236), utilizing a sample of the material compacted to 90% percent of ASTM D-1557-92. No testing is required for backfill where 80 percent of the material is greater than ¾ inch (19 mm). Before construction begins, the borrow selected shall be subject to show conformance with this frictional requirement.

In addition, backfill materials shall also meet the following corrosion requirements:

Resistivity	$\geq$ 3000 OHM-cm (min)	AASHTO T 288
pH	5.0 to 10.0, inclusive	AASHTO T 289
Chlorides	$\leq$ 100 mg/kg (ppm)	AASHTO T 291
Sulfates	$\leq$ 200 mg/kg (ppm)	AASHTO T 290
Organic Content	<1%	AASHTO T267-86

If the resistivity is greater than or equal to 5,000 ohm-cm, the chlorides and sulfates requirements may be waived.

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3.1.1 Acceptance of Material

Testing should be performed by the Contractor to assure compliance with the specifications. The Contractor shall furnish to the Owner's Engineer a Certificate of Compliance certifying that the select granular backfill material complies with this section of the specifications.

The frequency of sampling of Select Granular Backfill necessary to assure the above-mentioned requirements shall be directed by the Owner's Engineer.

Backfill not conforming to this specification shall not be used without written consent of the Engineer.

3.1.2 Free Draining, Permeable Backfill

If the M. S. E. will be subject to water inundation, the following permeable, free-draining backfill material shall be used:

Sieve Designation	Percent by Weight Passing Standard Sieves (AASHTO T 11 and T 27)
6" (76 mm)	100
¾ " (19 mm)	50 - 90
No. 4 (4.75 mm)	20 – 50
No. 200 (75 µm)	0 - 2

3.2 Rock **for Gabion Facing**

Rock for filling the gabions shall be as listed:

100% passing 8 inches (20.3 cm), 0-5% passing 4 inches (10.2 cm)

4.0 CONSTRUCTION REQUIREMENTS

4.1 Wall Excavation

Wall excavation shall be in accordance with the requirements of the Project specifications and in reasonably close conformity with the limits and construction stages shown on the plans. All excavation cuts and slopes shall be in accordance with governing safety regulations.

4.2 Foundation Preparation

The foundation for the structure shall be graded level for a width equal to or exceeding the length of the reinforcement mat or as shown on the plans. Prior to wall construction, the foundation, if not in rock, shall be compacted, as directed by the Owner's Engineer.

Any unsuitable foundation material below the reinforced soil volume, as determined by the Owner's Engineer, shall be excavated for the full length of mat reinforcements, and to a depth as directed by the Owner's Engineer. Excavated unsuitable material shall be replaced as directed by the Owner's Engineer.

The maximum calculated applied bearing pressure at the foundation level is in the design submittal for each wall. It is the responsibility of the Owner's Engineer to determine that this calculated applied bearing pressure is allowable for that location.

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4.3 Gabion-Faced M.S.E. Wall Erection

Welded wire mesh reinforcement mats, and applicable ArtWeld Gabion facing baskets, shall be placed in 36" maximum successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds.

4.4 ArtWeld Gabion Basket Assembly

Gabions shall first be assembled individually as empty units. Each gabion shall be manufactured with the necessary panels, properly spaced and secured, so they can be rotated into position at the construction site with no additional tying of the rotation joint. The panels and diaphragms shall be rotated into position and joined along vertical edges.

When 13.5-gauge tie wire is used as the joint material, all vertical edges of each gabion panel shall first be constructed to form individual empty gabions. Simple spiraling (looping without locking) of 13.5-gauge tie wire is not permitted. For welded-mesh, the joint shall be constructed using alternating single and double half hitches (locked loops) in every mesh opening along the joint.

When 9-gauge spiral binders are used, the spiral shall be screwed into position such that it passes through each mesh opening along the joint. Both ends of all 9-gauge spiral binders shall be crimped to secure the spiral in place.

Temporary fasteners may be used to hold panels wherever gabion-to-gabion joints will be constructed.

4.4.1 Assembly of Successive Gabions (Gabion-to-Gabion Joints)

Empty gabions shall be set in place. Individually constructed empty gabions shall be joined successively to the next empty gabion with 13.5-gauge tie wire or 9-gauge spirals, before filling with rock begins. The 13.5-gauge tie wire or 9-gauge spiral binders shall secure, in one pass, all selvage or end wires of panels of all the adjacent gabions along the joint. Once successive gabions are joined together, they can be pulled taught and staked before backfilling.

4.4.2 Modified Geometry

To match the geometry of the planned gabion configuration, or to meet specific conditions panels shall be folded, cut, and/or re-tied to dimensions shown on the plans or as approved by the Engineer.

4.4.3 Stiffener Placement

When constructing with 1.5-foot high or 3-foot high gabions, pre-formed stiffeners shall be used to produce a flat, smooth external surface.

Pre-formed Stiffeners shall be installed on the exposed face of the gabion prior to rock placement, two rows at 1/3 points on 3' high gabions, one row at 1/2 point in 1.5' high gabions.

4.5 Filter Fabric Placement

Install geotextile filter fabric against the back of the gabions as shown in the plans, prior to backfilling.

4.6 Backfill Placement **for Soil Reinforcement Zone**

Backfill placement shall closely follow erection of each course of reinforcement mats. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing. Any wall materials, which become damaged or disturbed during backfill placement, shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Owner's Engineer. The Contractor, at their expense, shall correct any misalignment or distortion of the wall facing due to placement of backfill outside the limits of this specification.

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Backfill shall be compacted to 95 percent of AASHTO T 99 method C or D, with oversize correction, at optimum moisture content (±2%).

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill material shall have a placement moisture content equal to or within two percentage points of optimum moisture content (W_{opt} ±2%). Backfill material with placement moisture content in excess or less than W_{opt} ±2% shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The Contractor shall decrease the percentage of deviation from optimum moisture, if necessary, to obtain the specified density. The optimum moisture content shall be determined in accordance with AASHTO T 99 Standard Proctor Method A, with coarse particle correction according to AASHTO T 224.

Backfill shall be placed in complete horizontal lifts. The maximum lift thickness after compaction shall not exceed twelve (12) inches (305 mm). The Contractor shall decrease this lift thickness, if necessary, to obtain the desired density.

Place and compact a lift of backfill over the mats prior to placing the gabion rock. Do not backfill against the back of an empty basket.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct run-off of rainwater away from the wall face. In addition, the Contractor shall not allow surface run-off from adjacent areas to enter the wall construction.

4.7 Rock Placement **for Gabion Facing**

Rock shall be placed in gabions to insure proper alignment, avoid bulges, and provide a minimum of voids. All exposed rock surfaces shall have a smooth and neat appearance. No sharp edges shall project through the wire mesh.

When filling 3-foot high gabions, rock shall be placed in 3 nominal 12-inch layers; when filling 1.5-foot high gabions, rock shall be placed in two 9-inch layers.

The last layer of rock shall fill flush or slightly overfill the gabions such that the lid will rest on rock when it is closed.

4.8 Closure of Lids

Lids shall be tied along the front, ends, and diaphragms of individual gabions and to successive gabions with 9-gauge spiral binders in the same manner as specified elsewhere in this specification.

• End of Section •

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