WELDED WIRE (WWW) and
EUREKA REINFORCED SOIL (ERS)
M.S.E RETAINING WALLS

Construction Guide

HILFIKER RETAINING WALLS
1902 Hilfiker Lane
Eureka, California 95503-5711
Local 707.443.5093    Fax 707.443.2891
Toll-Free 800.762.8962

Web: http://www.hilfiker.com    email: info@hilfiker.com

Hilfiker M.S.E. Systems are covered by the following patents:
Patent no. 4,117,686; 4,329,089; 4,505,621 and others
The Hilfiker MSE System is a composite mechanically stabilized earth structure, designed for strength, durability and ease of construction. The welded wire mats reinforce the backfill, providing the tensile strength to make the compacted soil a stable structure. The superior pullout resistance of the wire mesh potentially allows a wide range of backfill soils. Properly installed, the Hilfiker MSE System is exceptionally strong, resilient and economical.

Backfill should preferably be select granular material with a high frictional strength.

ALWAYS FOLLOW YOUR PROJECT SPECIFICATIONS!

Compaction of the backfill is very important to prevent unanticipated settlement of the wall. Ninety to ninety-five percent compaction is recommended for walls supporting paved roadways, railroads, buildings, mining equipment and other significant loads. If the backfill is not compacted as recommended, settlement will occur, and may distort the wall face.

In addition, the moisture content of the backfill prior to and during construction shall be uniformly distributed throughout each lift.

The contractor must provide positive drainage and encapsulation of the backfill to insure that it is not saturated with surface and sub-surface moisture. If rain is expected, protect the backfill from getting wet. If it does get wet, remove the wet portion and replace it with dry backfill.

Under no circumstances should the use of saturated backfill ever be permitted within the M.S.E. structure. This includes the placement of future landscape irrigation.

Hilfiker MSE Systems can be designed as battered, vertical or cantilever structures. The welded wire mats are easily trimmed or bent, adapting to curves, angles and steps. A Welded Wire Wall can be designed to fit nearly any special site application.

If you have any questions about design, construction or suitability of application, contact Hilfiker Retaining Walls. We will be happy to answer your questions, or design a retaining wall for your project.

ABOVE ALL, PLEASE REMEMBER, THIS BOOKLET IS A GUIDE ONLY. FIELD CONDITIONS NATURALLY VARY. THE OWNER'S DISCRETION AND EXPERIENCE MAY NECESSITATE MODIFICATIONS WITHIN REASON. HILFIKER ASSUMES NO LIABILITY FOR COMPLIANCE, OR LACK THEREOF.

April 2009
HAND TOOLS NECESSARY
TO BUILD YOUR WALL
(NOT PART OF HILFIKER SUPPLIED COMPONENTS)

24" BOLT CUTTER

TIN SNIPS

LIGHT-WEIGHT COMPACTOR FOR FRONT FACE, ENDS AND CORNER COMPACTION

SHOVEL

24" LEVEL

STRING LINE AND GRADE STAKES

6' BAR 2 EACH

24" = 610MM
6' = 1.83 M
I think you'll find Hilfiker's Wall Systems to be the easiest retaining walls you'll ever build. The wire mats are designed to give the proper strength. It's up to you to make the backfill strong. Be sure it's the right density and compaction. Keep it dry! Questions? Just call us!

Suggested Unloading Procedure

When you unload the mats at the job site, hook the chains as shown.

Important!

✓ Check off "wall parts" from your bill of lading as you unload.
**SUPPLIED WALL PARTS**

- Cap Mat
- Prongless Mat
- Hog Ringer with Rings
- Backing Mat
- Fabric (Filter Fabric or Hardware Cloth)
- Standard Mat
- Varies

**EXCAVATION**

1. The foundation must be solid and able to support the weight of the wall.

   Excavate according to your plans and specifications.

   If fill is required, place it as directed by the soils engineer.
2. Make sure the wall foundation is to line and grade. A little time spent now will save a lot of time later!

3. Bench the ends of the wall into solid ground. This prevents settling and erosion of the foundation layer.

START YOUR WALL!

4. Accuracy of the first lift is essential! Take extra care to prepare the foundation grade and place the first lift accurately.

Survey to string line for grade and alignment.

First lift mat 3" offset to grade stake

Fine grade this area

3" = 76mm
6" = 152mm
3' = 914mm
5  BE SURE YOU HAVE THE REQUIRED BERM IN FRONT OF THE WALL. SEE YOUR PROJECT PLANS FOR THE MINIMUM WIDTH. IF FIELD CONDITIONS DO NOT GIVE YOU THE MINIMUM WIDTH, CONTACT THE PROJECT ENGINEER.

BERM WIDTH

6  YOU MAY CUT THE MATS TO FIT YOUR EXCAVATION IF NEEDED.
DO NOT SHORTEN THE BASE DEPTH

CUT TRANSVERSE WIRES ONLY!

7  FOLLOW YOUR PLANS CAREFULLY FOR LOCATING THE MATS BY BASE DEPTHS AND WIRE SIZES. EACH MAT BUNDLE WILL BE TAGGED!

THE SPACE BETWEEN THE MATS SHALL EQUAL THE SPACE BETWEEN THE LONGITUDINAL WIRES.
8
BERM
SEE STEP 5
WALL FACE
TO FORM A CONCAVE CURVE, SPREAD THE BACK OF THE MATS
FOR A CONVEX CURVE, OVERLAP THE BACK OF THE MATS
FOR A SMOOTHER CURVE, YOU CAN SPLIT THE MAT BASES AND BEND THE FACES.
OVERLAP BACK OF MATS
OVERLAP BACKING MATS AND FABRIC IF NECESSARY
1.5' MIN. ON EACH SIDE OF ANGLE
TO FORM ANGLES AT MID-MAT, CUT THE TRANSVERSE WIRES IN THE MATS.
BACKING MATS AND HARDWARE CLOTH MUST BE CONTINUOUS AT THE ANGLE!
BEND THEM TO FIT.
IF THEY ARE NOT CONTINUOUS, THEY MAY BE OVERLAPPED AS SHOWN.

9a
BEGIN BACKING MAT INSTALLATION.
MATS ARE INSTALLED WITH THE WIDER TRANSVERSE SPACING AT THE TOP
TOP WIRE
BACKING MAT
3.5"
3"
TYP.

3" = 76MM
3 1/2" = 89MM
9. INSTALL THE BACKING MATS INSIDE THE FIRST LIFT
   IMPORTANT! CHECK STANDARD MAT MESH SIZE!

8"x21" MESH
HOG RING
SECOND TRANSVERSE WIRE ON BACKING MAT SPACE
3-1/2" TOP SPACE ONLY

8"x12" MESH
HOG RING
TOP TRANSVERSE WIRE ON BACKING MAT SPACE
TOP WIRE ON MAT FACE

10. HALF BACKING MAT
    SPAN OPEN VERTICAL SPACES WITH BACKING MATS.

CUT A BACKING MAT IN HALF AND USE HALF AT THE BEGINNING AND ENDING OF EACH LIFT

8' WIDE BACKING MAT
BACKING MATS SPAN THE SPACE BETWEEN THE STANDARD MAT FACES

11. CLIP THE VERTICAL EDGES OF THE SOIL REINFORCEMENT MATS TO THE VERTICAL WIRES ON THE BACKING MATS

NO SPACE BETWEEN BACKING MATS. (OVERLAP IS NOT REQUIRED)

THIS WILL INSURE A UNIFORM SPACING BETWEEN THE REINFORCEMENT MATS

\[
\begin{align*}
3\frac{1}{2}" &= 89\text{mm} \\
8" &= 203\text{mm} \\
24" &= 610\text{mm} \\
12" &= 305\text{mm} \\
8' &= 2.438\text{m}
\end{align*}
\]
12 UNROLL THE FABRIC AGAINST THE BACKING MATS. KEEP IT AS TIGHT AS POSSIBLE.

13 PLACE AND COMPACT BACKFILL IN LAYERS AND DENSITIES SPECIFIED IN YOUR PROJECT PLANS.

   THIS IS WRONG
   FUTURE BULGING CAN BE CAUSED BY UNDER-FILLING OR UNDER-COMPACITION

   THIS IS RIGHT!
   0" TO 1" ABOVE THE TOP WIRE ON THE BACKING MAT

14 BACKFILL AND COMPACT UP TO THE FACE OF THE WALL. STOP COMPACTING AT FACE WHEN THE MAT FACE ROTATES TO THE CORRECT BATTER

   IF A VOID IS LEFT HERE, YOU WILL FILL IT WHEN YOU FILL THE NEXT LIFT.

16" = 406MM
1" = 25MM
15  BEGIN THE NEXT LIFT OF REINFORCEMENT MATS. MAKE THE SPACES BETWEEN THE MATS LINE UP WITH THE SPACES IN THE PREVIOUS LIFT.

16  INSTALL THE NEXT LEVEL OF BACKING MATS.

   HOOK THE BOTTOM TRANSVERSE WIRE OF THE BACKING MAT OVER THE VERTICAL PRONGS ON THE LOWER REINFORCEMENT MAT

   ROTATE THE BACKING MAT TO VERTICAL AND HOG RING IT TO THE STANDARD MAT FACE AS SHOWN IN STEP 9

17  ADJUST THE BATTER IN THE LOWER LIFT BY SLIDING THE UPPER MAT FORWARD OR BACK.

   THE LEVEL IS HELD AGAINST THE BOTTOM OF THE VERTICAL WIRES.

   WHEN THE BATTER IS RIGHT, ANCHOR THE MATS AS SHOWN IN STEP 18

1:48 = 1/4 INCH PER VERTICAL FOOT
1:10 = 1.2 INCH PER VERTICAL FOOT
1:6 = 2 INCHES PER VERTICAL FOOT
BE SURE TO CONTROL ALIGNMENT ON EVERY LIFT. A LEVEL IS USED ON A RADIUS. USE A STRINGLINE ON STRAIGHT RUNS.

STRINGLINE MAY BE PLACED BEHIND THE WALL FACE ABOVE THE FIRST LIFT.

USE 2 STAKES OR PLACE BACKFILL TO ANCHOR THE END MATS.

ANCHOR THE STRING ON ONE END, SET THE DESIRED OFFSET, MOVE TO THE OTHER END AND DO THE SAME.

BEGIN INSTALLING THE FABRIC. CLIP IT WITH HOG RINGS TO THE TOP WIRE ON THE BACKING MAT. CUT A VERTICAL SLIT IN THE BOTTOM OF THE FABRIC AT EACH LONGITUDINAL WIRE AS SHOWN.

PUSH THE FABRIC DOWN AROUND THE LONGITUDINAL WIRES, CREATING AN OVERLAP INTO THE PREVIOUS LIFT.

3'' TO 6'' = 76MM TO 152MM
20 BEGIN BACKFILLING AGAIN. **DO NOT OPERATE HEAVY EQUIPMENT ON THE BARE WIRE!**

When the mats are weighted with fill, you can remove the stakes.

Install fabric as shown in Step 12.

21 FILL THE VOID, IF ANY, IN THE FACE OF THE LIFT BELOW

Face of wall

Place the fill so falls through the base wires into the void below.

Use fill that will pass through the mesh.

22 USE A HAND COMPACTOR TO COMPACT THE FILL IN THE FACE OF THE WALL.

Keep a 2" to 3" cushion of fill under the tamper to protect the wire.

2" to 3" = 51MM TO 76MM
23 COMPLETE THE BACKFILL AS SHOWN IN STEPS 13 AND 14

24 PLACE THE FILL FOR THE TOE BURY WHEN YOU ARE AT OR ABOVE THE THIRD LIFT.

IMPORTANT! COMPACT CAREFULLY

CONTINUE STEPS 15 THRU 22 TO THE TOP LIFTS OF YOUR WALL
TOP OF WALL DETAILS

25. The ends of the top lifts need return backing mats to contain the fill.

Make a return backing mat by bending an 8’ backing mat in half as shown.

Important! In the 8” x 12” lifts only, hog ring the top wire on the backing mat to the top wire on the prongless mat. (See Step 9, similar)

26. If your wall steps at the top, use a return backing mat to close the end of each step.

8” = 203mm 4’ = 1.22m
12” = 305mm 8’ = 2.44m
2 BACKFILL TO THE TOP OF THE TOP LIFT. BEFORE YOU PUT THE CAP ON, COMPACT AND ALIGN THE PRONGLESS MAT.

THIS LAYER IS IMPORTANT! THIS IS THE FINAL MAT LAYER, AND WILL BE THE TOP OF THE WALL.

28 COMPLETE THE FINAL LIFT. TILT THE CAP AND CATCH THE FRONT HOOK UNDER THE MIDDLE WIRE ON THE PRONGLESS MAT.

LAY THE CAP ONTO THE FILL. CHECK THE ALIGNMENT, SET THE BATTER, AND ANCHOR. BEGIN THE COVER BACKFILL.

29 FILL THE VOID, IF ANY, IN THE FACE OF THE LIFT BELOW.

COMPACT THE BACKFILL AS SHOWN IN STEPS 21 AND 22.

BACKFILL TO THE TOP OF THE FINAL GRADE PER YOUR PROJECT PLANS.

1'-6" = 457MM
PROJECT-SPECIFIC DETAILS
ROCK FACING INSIDE THE WALL FACE

30 Some projects call for rock facing. In these applications, the hardware cloth is omitted. Rock larger than the openings in the backing mat mesh is placed at the face of the wall. Filter fabric may be installed directly behind the rock. This encapsulates the backfill and prevents any fines from migrating into the rock zone.

SLOPED CAP ON TOP OF WALL

31 Some walls require a sloped cap to maintain a minimum shoulder width above the wall. Install the backing mat and fabric in the top lift. Place and compact the backfill on slope to the level of the top of the wall shown in your plans. Mark the prongless mats and backing mats, and cut them to follow the slope. Install the cap mats and hog ring to the face. Place and compact the final layer of fill.
WOOD GUARDRAIL PENETRATION

IF THE PLANS CALL FOR GUARDRAIL POSTS NEAR THE FACE OF THE WALL, IT MAY BE NECESSARY TO CUT HOLES IN THE CAP MATS.

MARK THE MAT AT THE PROPER SPACING ALONG THE FACE OF THE WALL. CHECK AND MARK THE OFFSET TO THE FACE OF THE WALL.

MARK FOR FUTURE POST LOCATION

IF DISTANCE "A" IS LESS THAN 5′, CUT A HOLE IN THE CAP MAT FOR POST PENETRATION

CULVERT THROUGH WALL

IF A CULVERT OR LARGE PIPE PASSES THROUGH THE FACE OF THE WALL, THE MATS ARE CUT TO FIT AROUND IT.

AT THE LOWER SURFACE OF THE CULVERT, CUT THE TRANSVERSE WIRES ON THE MAT FACE, THEN BEND THE LONGITUDINAL WIRES BACK TO FIT AGAINST THE CULVERT.

LONGITUDINAL WIRE

TRANSVERSE WIRE

5′ = 1.524M
34 AT THE UPPER SURFACE OF THE CULVERT, THE TRANSVERSE WIRES IN THE BASE OF THE MATS ARE CUT AND BENT AGAINST THE CULVERT AS SHOWN.

**DO NOT**
CUT OFF THE LONGITUDINAL WIRES!

**CUT THE TRANSVERSE WIRES ONLY.**

LIFT AND BEND THE LONGITUDINAL WIRES TO FIT AGAINST THE CULVERT.

35 THERE MAY BE A LARGE GAP IN THE FACE OF THE WALL AT THE TOP OF THE CULVERT.

**CUT A BACKING MAT AND FABRIC TO FIT**

**CUT DOWN A STANDARD MAT, AND BEND IT AS SHOWN TO FIT AGAINST THE CULVERT AT THE TOP**
EUREKA REINFORCED SOIL
M.S.E. WALL DETAILS

THE HILFiker E.R.S. WALL BEGINS AS A WELDED WIRE WALL. AFTER COMPLETION AND ANY POTENTIAL SETTLEMENT, PERMANENT FACING IS INSTALLED. THIS MAY CONSIST OF CAST-IN-PLACE CONCRETE, OR FULL-HEIGHT PRECAST CONCRETE PANELS. THE PROJECT CONSTRUCTION PLANS WILL GIVE MORE SPECIFIC DETAILS.

A LEVELING COURSE IS CAST AGAINST THE TOE OF THE WELDED WIRE WALL. THIS WILL SERVE TO SUPPORT AND ALIGN THE FORMS FOR THE C.I.P. FACING, OR WILL HAVE A KEYWAY FOR ALIGNMENT AND CONTROL OF THE TOE OF THE PRECAST FULL-HEIGHT PANELS.
ANCHORS FOR C.I.P. FORMS
ANCHORAGE BOLTS ARE INSTALLED AS THE WELDED WIRE WALL IS BUILT. THE DESIGN MAY VARY FROM THAT SHOWN HERE. SPACING, SIZE AND PROJECT-SPECIFIC DETAILS OF THE ANCHORS WILL BE SHOWN IN THE CONSTRUCTION PLANS.

ANCHORS FOR FULL-HEIGHT PRECAST PANELS
ANCHORAGE BOLTS ARE INSTALLED ONLY NEAR THE TOP OF THE WALL. THE DESIGN MAY VARY FROM THAT SHOWN HERE. SPACING, SIZE AND PROJECT-SPECIFIC DETAILS OF THE ANCHORS WILL BE SHOWN IN THE CONSTRUCTION PLANS.
FINISHING THE E.R.S. C.I.P. FACING

ATTACH THE FORMS TO THE ANCHORAGE BOLTS AND CAST THE CONCRETE FACING.

STRIP THE FORMS

BACKFILL AT THE TOE TO THE FINAL GRADE.

FINISH THE TOP OF THE WALL PER THE PROJECT PLANS

LEVELING COURSE

FINISHING THE E.R.S. PRECAST FACING

PLACE THE BOTTOM OF THE PRECAST FULL-HEIGHT PANELS INTO THE CHANNELS ON THE LEVELING COURSE.

RAISE THE PRECAST PANEL TO VERTICAL AND ATTACH IT TO THE ANCHORAGE BOLTS

BACKFILL AT THE TOE

FINISH THE TOP OF THE WALL PER THE PROJECT PLANS.

CLOSURE MAT

ANCHORAGE BOLT

LEVELING COURSE

STAND BACK AND ADMIRE YOUR WORK OF ART! SEND PHOTOGRAPHS TO HILFIKER RETAINING WALLS FOR POTENTIAL PUBLICATION (WITH YOUR APPROVAL, OF COURSE!)
## Wire Size Comparison Table

<table>
<thead>
<tr>
<th>&quot;W&quot; Size Number</th>
<th>Nominal Diameter (Inches)</th>
<th>Nominal Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W12.0</td>
<td>.391</td>
<td>9.9</td>
</tr>
<tr>
<td>W9.5</td>
<td>.348</td>
<td>8.8</td>
</tr>
<tr>
<td>W7.0</td>
<td>.299</td>
<td>7.6</td>
</tr>
<tr>
<td>W4.5</td>
<td>.239</td>
<td>6.1</td>
</tr>
<tr>
<td>W4.0</td>
<td>.226</td>
<td>5.7</td>
</tr>
<tr>
<td>W3.5</td>
<td>.211</td>
<td>5.4</td>
</tr>
</tbody>
</table>

## Wire Specifications

<table>
<thead>
<tr>
<th>ASTM Specification</th>
<th>AASHTO Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 82</td>
<td>M 32</td>
<td>Cold-Drawn Steel Wire for Concrete Reinforcement</td>
</tr>
<tr>
<td>A 185</td>
<td>M 55</td>
<td>Welded Steel Wire Fabric for Concrete Reinforcement</td>
</tr>
<tr>
<td>A 123</td>
<td>M 113</td>
<td>Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products</td>
</tr>
</tbody>
</table>

## Welded Smooth Wire Fabric

### ASTM A 185

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Tensile Strength (PSI)</th>
<th>Yield Strength (PSI)</th>
<th>Weld Shear Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1.2 &amp; Over</td>
<td>75,000 (520 MPA)</td>
<td>65,000 (450 MPA)</td>
<td>35,000 (240 MPA)</td>
</tr>
</tbody>
</table>

For more information on welded wire reinforcement (WWR) check the website for the Wire Reinforcement Institute: [http://www.wirereinforcementinstitute.org/](http://www.wirereinforcementinstitute.org/)
ArtWeld Gabions are factory-assembled of galvanized 9 or 11 ga Welded Wire Mesh, and are shipped folded flat. Standard sizes are available, and non-standard sizes can be supplied. The mesh can be field-cut to any size or shape without losing structural strength. In comparison to conventional gabions, the larger wire diameter and welded grid gives greater strength, longer life and easier installation. "Spiral" binders, used in field assembly of the gabion edges, and preformed stiffeners, are fast and simple to install.

**STEPPENED SLOPE**

The Hilfiker Steepened slope system is composed of Welded Wire Fabric components. The flat primary soil reinforcement mats are interlocked with bent facing mats, prefabricated to a 1:1 slope. The slope may be flattened, if desired, by stepping each layer back. Behind the facing mats are Welded Wire Fabric backing mats incorporated with erosion mat or sod. Virtually any type of sod or vegetation that will best suit the environment may be used with this system. Low-growth, maintenance-free vegetation is typically specified.

**REINFORCED SOIL EMBANKMENT (SMOOTH FACE)**

The R.S.E. Smooth Face Retaining Wall retains most of the advantages of the Welded Wire Wall, while providing the additional durability of precast face panels. Panels can be cast to match a variety of architectural treatments, as well as a smooth finish. In most structures, the simple 12.5' x 2.5' standard panel is used, making all the panels interchangeable. We also manufacture special panel sizes when required. Panels are cast with a cantilever footing at the back, and pre-installed reinforcement mat anchors, making installation fast and easy.

**SPIRALNAIL WALL SYSTEM**

The Spiralnail system was originally designed to replace conventional soil nailing systems. Spiralnails are driven directly into the soil, eliminating time-consuming "drill and grout". They can be used in a variety of projects, including retaining walls, slope stabilization, tie-backs for cast-in-place or precast concrete panels, repair of existing retaining structures, and can be designed to act as soil drains. They can also be faced with welded wire, gabions, and "spider" slope reinforcing.