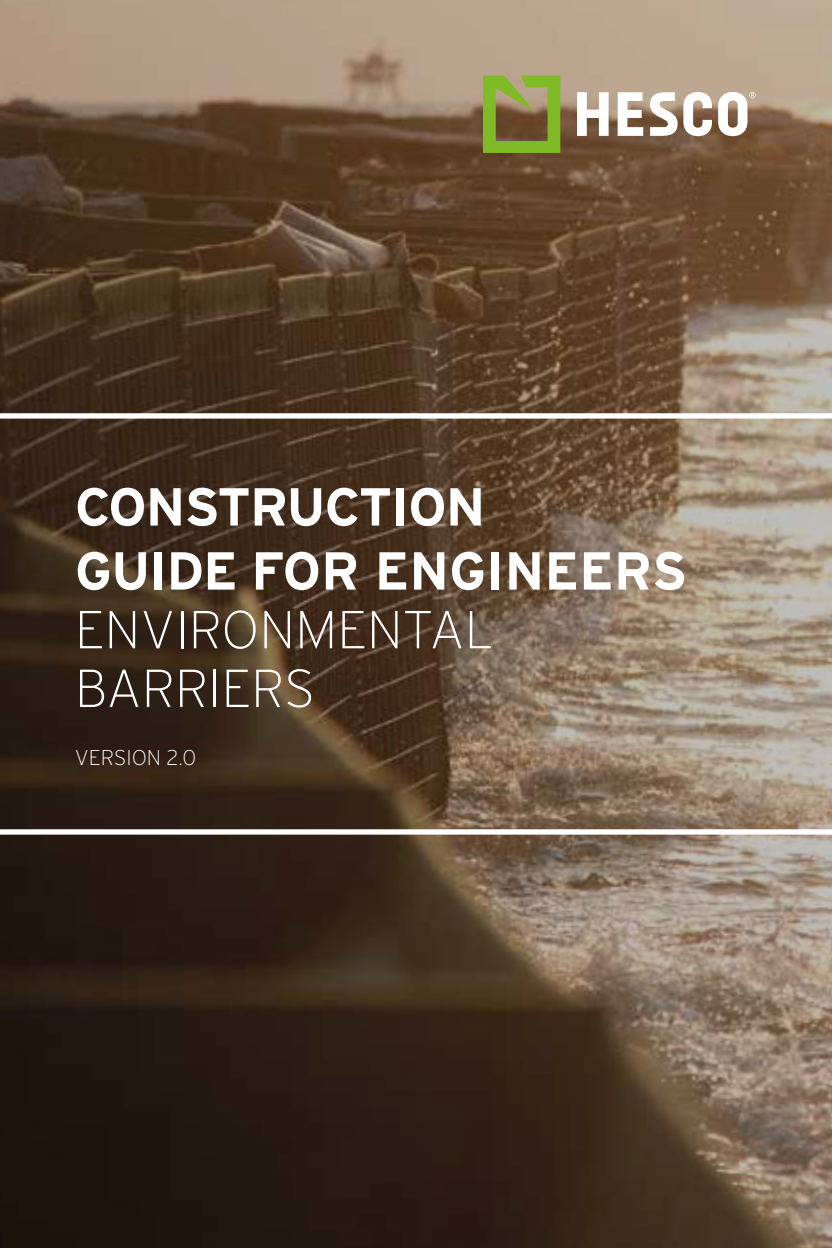


HESCO®

CONSTRUCTION GUIDE FOR ENGINEERS
ENVIRONMENTAL BARRIERS

VERSION 2.0

CONTENTS

1
PROTECT PEOPLE, PLACES AND PROPERTY

USING THIS MANUAL

This guide was published in 2017; it replaces all previous versions of the HESCO Construction Guide for Engineers Environmental Barriers.

This guide includes statements on safety issues and information on correct procedure. Examples of how these statements appear and what they constitute are shown to the right.

WARNING Statements presented in this style warn of the danger of a particular action or lack of action. These statements should be followed, as failure to do so could result in injury or death.

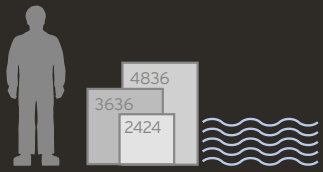
CAUTION This style advise certain actions or approaches to tasks. Failure to follow the advice could result in a failure of the product and/or danger to users.

NOTE Statements that provide general information about an issue or that draw attention to a point of detail are presented in this style, as emboldened text preceded by 'Note'.

THE FLOOD RANGE

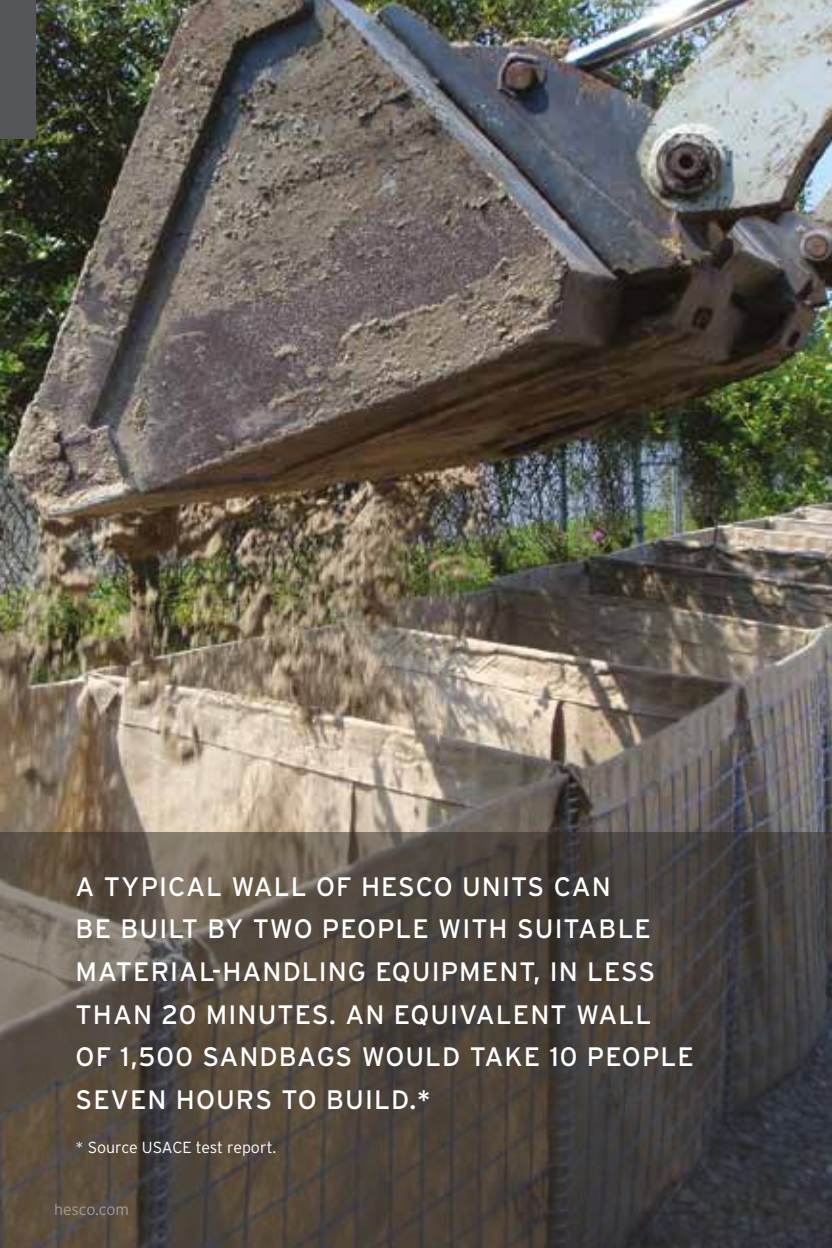
FLOODLINE

Fully lined to provide maximum integrity when subjected to debris impact.



JACKBOX

Lightweight and extremely fast deployment and removal, suitable for floods depths of 3' or less.



A TYPICAL WALL OF HESCO UNITS CAN BE BUILT BY TWO PEOPLE WITH SUITABLE MATERIAL-HANDLING EQUIPMENT, IN LESS THAN 20 MINUTES. AN EQUIVALENT WALL OF 1,500 SANDBAGS WOULD TAKE 10 PEOPLE SEVEN HOURS TO BUILD.*

* Source USACE test report.

HESCO products are used extensively in the protection of personnel, vehicles, equipment and facilities in military, peacekeeping, humanitarian and civilian operations.

They are used by all major military organizations around the world, including the US Military and other large military organizations.

It is a prefabricated, multi-cellular system, made of Zinc-Aluminum coated steel welded mesh and lined with high UV resistant geotextile

Delivered flat-packed on standard timber skids/pallets or in patented delivery systems for rapid deployment, units can be joined and extended using the joining pins provided and filled using minimal manpower and commonly available equipment.

The units can be installed in various configurations to create effective and economical structures, tailored to the specific threat and level of protection required. Commonly used to protect against natural disasters such as flood and storm surge, HESCO products are also used in wetland and shoreline restoration and re-creation, land reinforcement, field fortification, and perimeter defenses.

Flood protection is afforded by the mass of fill material contained with the Hesco units.

Users must be aware that flood protection performance may vary depending on fill material, construction techniques and external considerations such as foundation stability, velocity of water, presence of debris and other factors.

This guide provides general guidance with an emphasis on the design and construction techniques applicable to Hesco flood protection structures.

The information contained in this guide is intended solely to provide general guidance. The selection, configuration and installation of the units is the responsibility of the user. Flood barriers require observation and possibly maintenance to ensure continued performance throughout the flood event.

Hesco can provide design, training, project supervision and consulting services on request.

2
BASIC CONSTRUCTION GUIDELINES

HEALTH AND SAFETY

Supervisors must ensure that all relevant and practical health and safety precautions are taken. The main risks to health and safety during the building of HESCO products, in addition to any environmental risks that may be present, are:

- Working at height.
- Personnel working in close proximity to plant equipment.
- Manual handling injuries, back strain, cut hands etc.
- Risk of injuries from the elements, cold or heat injuries.
- Collision between personnel and loading equipment/ crushing injury.

Simple precautions should be taken to ensure a safe build, such as:

- Only qualified and properly trained equipment operators should operate the loading equipment, when used.
- Ladders, when used, should be secured at the top and bottom and be fit for purpose.
- A minimum number of persons should be employed when carrying out tasks at height.
- Keep good site organization.
- Ensure personnel only lift the weight that they are safely able to.
- Provide a properly briefed and competent spotter for the loading equipment. He is to ensure correct employment of the loading equipment, correct placement of the fill material and that working areas for the loading equipment are free from personnel.

All personnel should be fully briefed on the task, including:

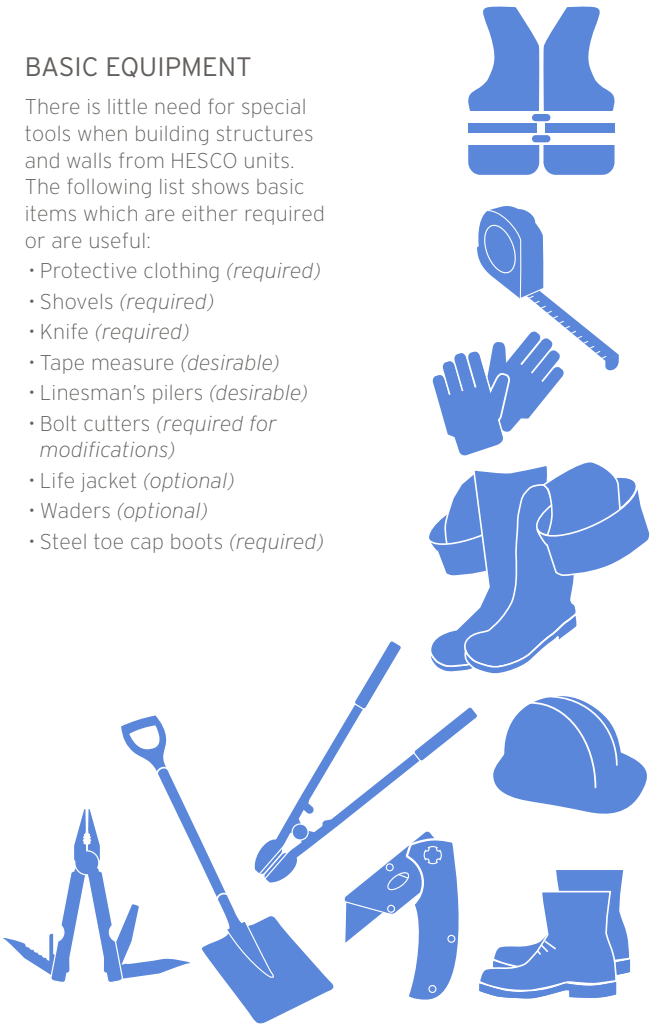
- Safe methods of work.
- Safety around moving loading equipment.
- Manual handling techniques.
- Work positions when working above ground level.

Site supervisors must ensure that they have sufficient control measures in place to protect their personnel from the risks that may be present on the site.

BASIC EQUIPMENT

There is little need for special tools when building structures and walls from HESCO units. The following list shows basic items which are either required or are useful:

- Protective clothing *(required)*
- Shovels *(required)*
- Knife *(required)*
- Tape measure *(desirable)*
- Linesman's pilers *(desirable)*
- Bolt cutters *(required for modifications)*
- Life jacket *(optional)*
- Waders *(optional)*
- Steel toe cap boots *(required)*



A HESCO unit is a simple product that is used to create effective and economical protective structures. The guidelines contained in this publication will refer to "normal" conditions of expected use in operational situations.

The operational situation may however dictate that speed of build is more important than properly prepared foundations and the use of a carefully selected fill. In this case the life of the structure may be reduced. The use of a poor fill material may require the structure to be wider to ensure that it provides the level of protection required.

Once erected the service life of structures built from Hesco's units depends upon how well they were built, local environmental conditions and the maintenance regime implemented.

Hesco barrier walls are relatively simple to construct, however it is imperative that a number of simple steps are followed during the construction:

- Firm level foundations.
- Adequate drainage.
- Use of appropriate fill units laid out, line and level checked.
- Correct joining of units.
- Tucking in geotextile flaps.
- Bottom center of the units pulled out after the first 6" (150mm) of fill is placed.
- Fill material placed in layers of 6" (150mm) max depth for first layer and 12" (300mm) max for subsequent layers.
- Fill material is spread and compacted before placing further layers.

WARNING Structures built in a hasty manner due to operational circumstances must be routinely inspected to ensure that they are structurally sound and do not present a hazard to those working or living around them.

SITE CONSIDERATIONS, FOUNDATIONS AND DRAINAGE

The location where the flood barrier is constructed will be dictated by the elevations required and the most efficient path for the barrier. Considerations should include the elevation or level of protection required, site access for construction, surface type and access for barrier monitoring during the flood event.

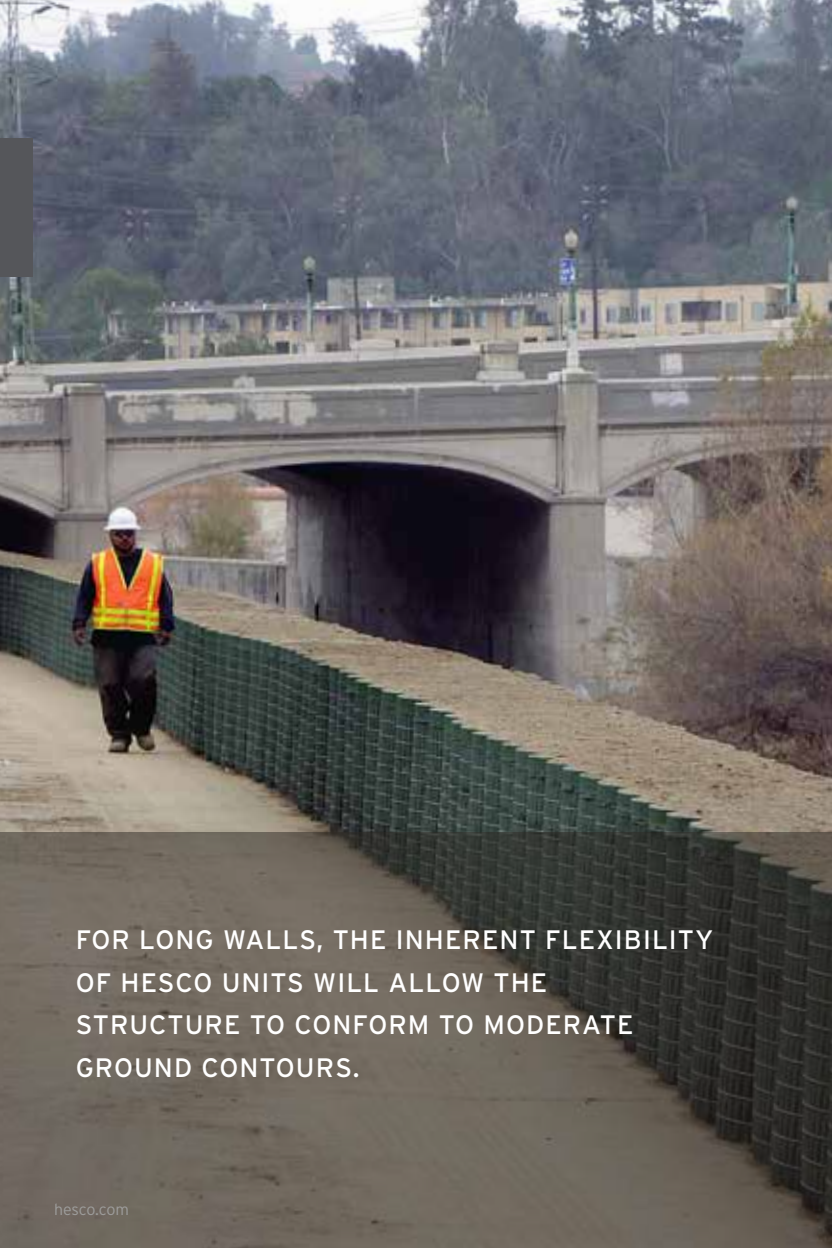
In many cases no surface preparation will be required. Paved surfaces, hard-packed earth, established turf and similar ground do not generally require additional work before placing Hesco units. If the surface has significant irregularities such as ruts, potholes, woody brush or other obstacles, it should be grubbed and graded.

Any surface which has a slope greater than 10 degrees, should be cut to achieve a flat surface. Never add fill material to build up a surface for Hesco units, rather cut down to achieve a suitable foundation surface. When building on a lateral slope, it is better to build such that the lean of the barrier is away from the water rather than towards it.

The foundation surface must be capable of supporting the load of the barrier (approx. 300 lb/ft^2 for a single row of 4' tall units) and of uniform strength such that any subsidence will be even. It is vital that the barrier not be placed half-on, half-off of a soft surface such as partially on a sidewalk and partially on the tree belt.

An improved foundation may be required when:

- The barrier will be stacked to greater heights
- The surface is soft and/or of variable bearing capacity
- Unusual site conditions make foundation assessment impossible



FOR LONG WALLS, THE INHERENT FLEXIBILITY OF HESCO UNITS WILL ALLOW THE STRUCTURE TO CONFORM TO MODERATE GROUND CONTOURS.

BASIC CONSTRUCTION TECHNIQUES

Whether the structure is a simple, single-course wall or a more complex structure, basic construction techniques are still the same:

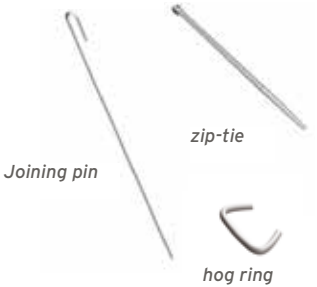
› layout

› join

› fill

OTHER COMPONENTS

Other components are supplied with HESCO units, as shown below. Hog rings and zip-ties are interchangeable for certain tasks, as described on the following pages.



LAYOUT

Two people place a HESCO unit on the ground horizontally in the location in which the wall is to be erected *(Figure 1)*.

Stand the unit upright with the stapled row at the top. Two people each grasp an end panel and together open the unit out in the desired direction. The unit will unfold and be self-supporting. Pull the unit out to its full length, by reaching for the right-hand coil, and ensure it is in the correct position *(Figure 2)*.

Adjust the outer walls of the segments so they are parallel, or as close as the ground will allow *(Figure 3)*.

CAUTION Ensure all personnel are properly briefed on the correct method of lifting and carrying weight. Persons should only lift and carry the weight that they feel comfortable with.

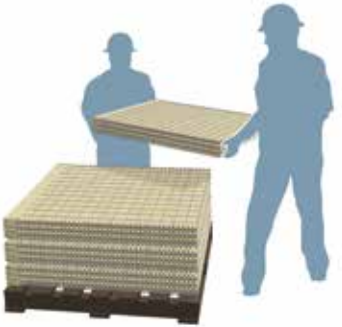


Figure 1
Remove a unit from the pallet

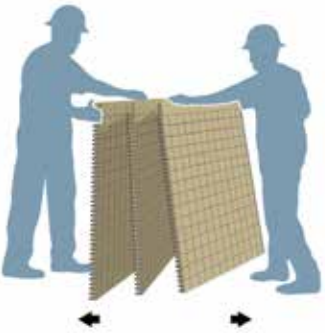
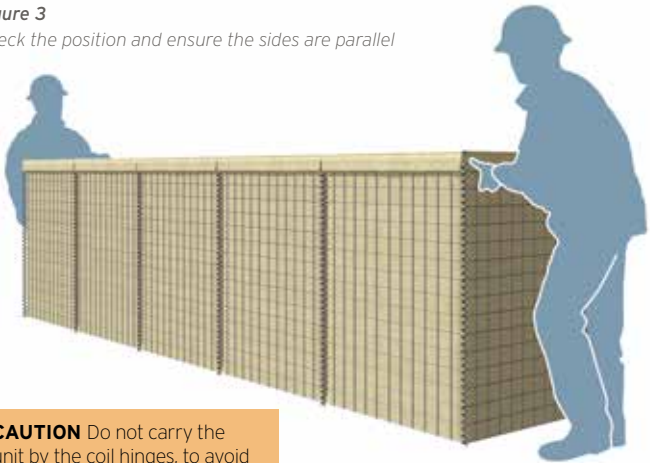


Figure 2
Stand it up and open the unit out

Figure 3
Check the position and ensure the sides are parallel



CAUTION Do not carry the unit by the coil hinges, to avoid injury to hands.

JOINING

Most walls will require HESCO units to be joined end to end. This is achieved by using the supplied joining pins.

Butt together the two unfilled units to be joined *(Figure 4)*. Pull the corner coils of both units together until they overlap.

Insert a joining pin down the center of both the front and back overlapped corner coils, thus joining them together *(Figure 5)*. Ensure the pin is fully fitted.

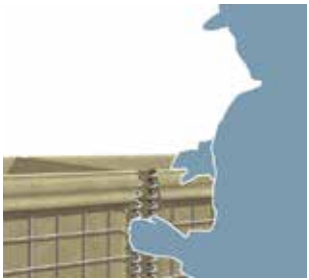
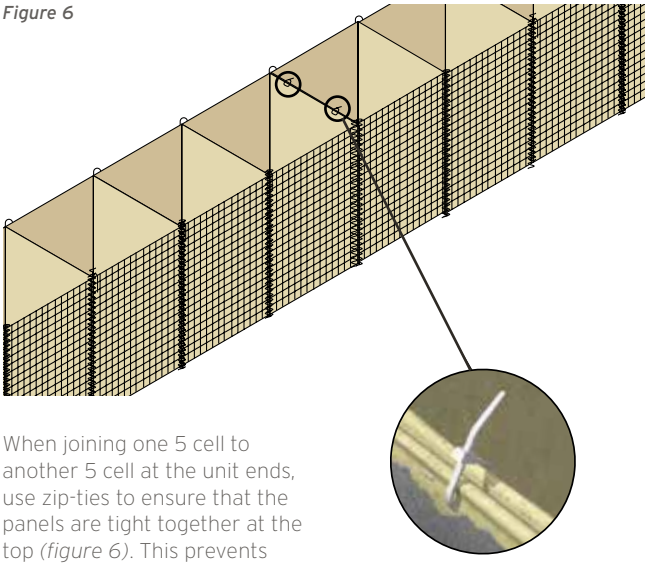


Figure 4
Butt together and overlap coils

Figure 5
Insert joining pins securely on both sides of the barrier

NOTE The joining operation must be carried out prior to placing fill in any of the cells to be joined. Care should be taken to ensure that units are horizontally aligned before joining.

Figure 6



When joining one 5 cell to another 5 cell at the unit ends, use zip-ties to ensure that the panels are tight together at the top *(figure 6)*. This prevents fill material from becoming lodged between the end panels of joined units.

Before filling, ensure all geotextile flaps at the base of the unit are tucked in, laid flat and overlapped where possible *(Figure 7)*. It is required to anchor the flaps down with a shovelful of fill material in each corner of every cell.

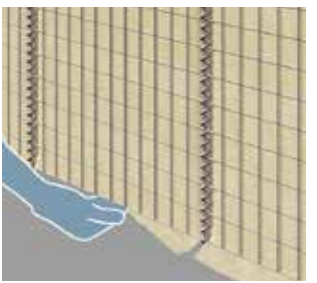


Figure 7
Tuck in flaps at base

FILLING

Prior to filling, units must be joined (pinned together) before setting flaps and filling. Ensure that the barrier is in the proper, final position before filling.

Place 12" - 18" (300mm - 450mm) of fill material in the center of the cells. Take care that the Hesco unit is not moved by impact of falling fill material. Never place fill material into a cell (typically at the end of the barrier) which will later be connected to another Hesco unit. If the barrier construction is not yet complete always leave the last two cells empty.

Ensure that the fill material is placed in the center of the cell, and once in place use shovels to move the fill against the outer panels, taking care not to disturb the flaps. The bottom-center of each panel should be pulled out 3 to 4 inches, allowing fill material to flow into the space and maintain the curvature of the panel. The cells are designed to bulge when filled, and pulling the bottoms out prevents the mesh from being caught and turned under. The side-panels of cells are designed to bow as fill is added.

Figure 8
Place the first 12" - 18" (300mm - 450mm) of fill in the units.

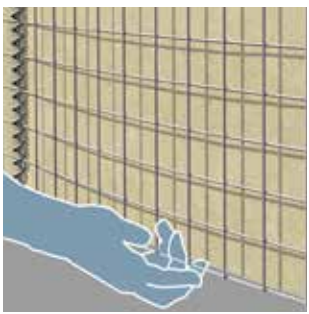


Figure 9
Pull out panels after the first layer of fill is deposited. The side panels of cells are designed to bow as fill is added.

Figure 10

Each layer of fill should be evenly distributed and then manually compacted by foot or hand-tamper before continuing the process *(Figure 10)*. Failure to compact could result in unstable structures and potential failure of the structure.

NOTE Position and joining of units must be checked and completed prior to filling.

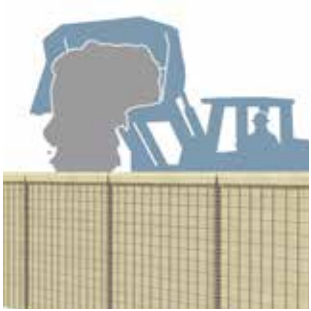


Figure 11

Continue to place 12" - 18" (300mm - 450mm) of fill in all other cells *(Figure 11)*. It is important that the cells are filled evenly, as failure to do so pulls in the side panels and reduces the width of the base. Adjacent cells should not differ more than 12" (300mm) in soil fill height, as this may lead to distorted internal panels. Distorted internal panels are an indication that fill is not being added evenly.

Once the anchoring fill has been placed and compacted, follow the steps shown in Figures 12 to 14 on next page.

Place the first layer of fill 12" – 18" (300mm – 450mm) in first two cells, on top of the anchoring fill *(Figure 12)*.

Continue along the section to be filled *(Figure 13)*. Ensure that the bottom center of each panel is pulled out as the cell is filled. Before adding the next layer, ensure that each fill layer is evenly distributed and compacted.

Return to the beginning and continue the process until the units are completely filled *(Figure 14)*.

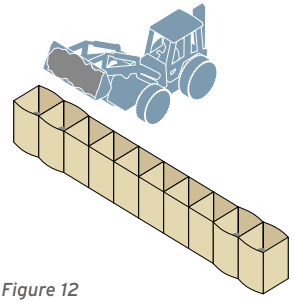


Figure 12

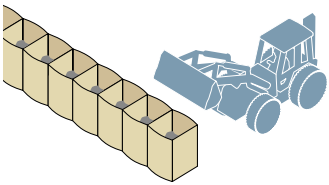


Figure 13

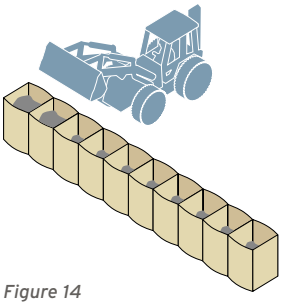


Figure 14

NOTE If there are special requirements, such as adding units to filled units at a later time or speeding up the filling process, contact HESCO for advice.

STACKING

There are two options for stacking to greater heights, a pyramid stack or a flat-face (stair-stepped) stack. Site conditions will favor one technique over the other.

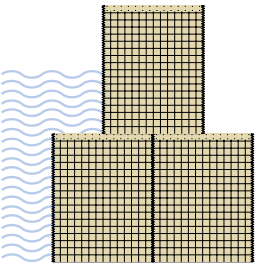
Pyramid Stack

- Provides even pressure on ground surface
- Intuitive to build
- Only choice if short of pins
- Horizontal surface of fill material exposed which should be protected to prevent scour.

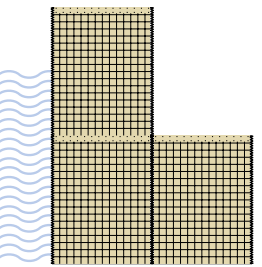
Flat-front Stack

- Continuous face towards water
- No exposed fill material
- Better seepage performance at layer transition
- Greater bearing pressure on toe of structure, requires stable foundation surface

Examples of 2-1 stack:



Pyramid stack

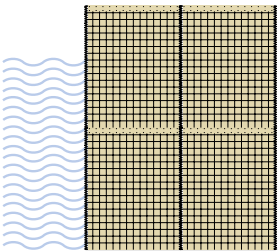


Flat-front stack

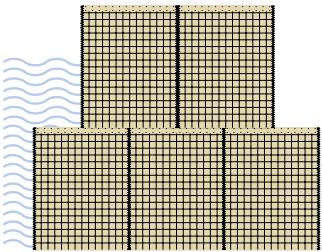
When stacking, the layout must always maintain at least a 3:4 base to height ratio. Eg a 2-1 structure gives a 6' wide base for an 8' height. A 2-2 structure gives the same ratio, but greater overall mass and will provide better strength against waves, surge, current or debris impact.

The same applies to larger structures, for example a 3-2-1 is sufficient in many cases, but a 3-2-2 will be stronger, and a 3-3-2 might be advisable in extreme conditions.

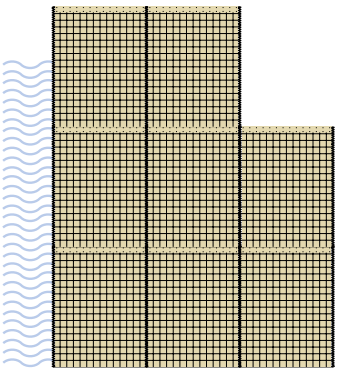
Contact Hesco for advise when constructing larger structures: support@hesco.com



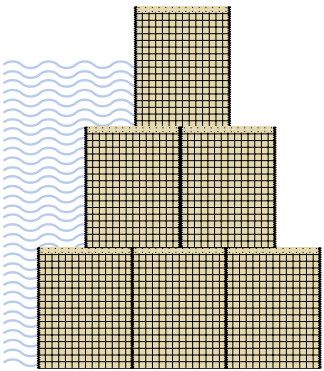
2-2 stack



3-2 Pyramid stack

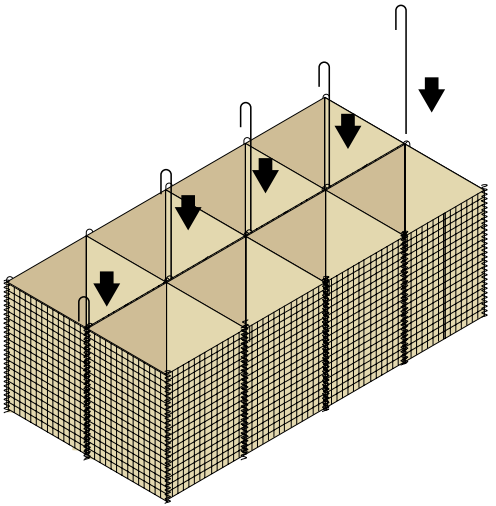


3-3-2 Flat-front stack



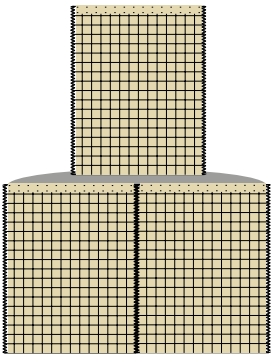
3-2-1 Pyramid stack

All cells must be pinned to the adjacent cells for the entire length of the barrier. Every cell must be very well compacted, and care taken to ensure that no fill material can escape.



Pin every adjacent cell

When stacking in pyramid format, the lower layer should be crowned to a depth of 2" - 3" and fully compacted to achieve a strong, smooth surface. The next layer is constructed in the normal manner, with flaps set, bottom wires pulled out and all care taken to ensure fill material cannot escape.

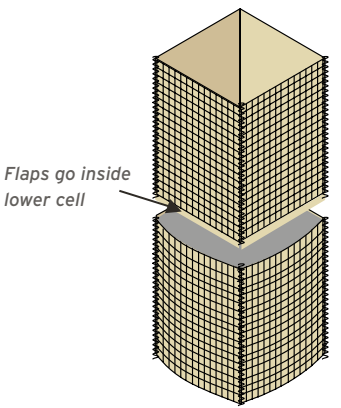


When stacking in flat-front format, the lower tier should be filled and compacted to a level approximately 4" below the top of the cell. This will allow the flaps from the upper cell to hang down inside the lower cell. Pull the flaps down as tight and straight as possible, ensuring that the flaps are inside the lower cell.

When filled and compacted, these flaps will be pressed to the inside of the cell across the layer-to-layer joint, creating a seal that prevents any fill material from escaping.

Before filling use zip ties or hog rings to flex the panels of the upper cells to match the expanded (bowed) panels of the lower cells. Ensure that the coils line up, and if possible keep the upper mesh panel just slightly inside the lower cell to 'trap' the upper mesh panel. The aim is to flex the empty upper cell to match the filled lower cell, so that they will be identical once the upper layer is filled.

Fill and compact the upper layer as usual, paying close attention to compaction across the layer-to-layer joint.



POLY WRAP

Testing shows that seepage reduces dramatically over time, but in some cases it may be desirable to have the minimum possible amount of seepage immediately after installation.

An impermeable barrier such as polyethylene sheeting (e.g. "Visqueen" and similar products) may be used to reduce seepage through Hesco flood barriers. This material (hereafter "poly") is placed on the ground during construction, the units are placed on top of it and then the poly is wrapped up and over the barrier after filling.

It is important that the poly only extend for 6" underneath the water-side edge of the Hesco wall.

This maintains the full contact of the fill material with the supporting ground, maintaining the stability of the wall and the resistance to sliding forces.

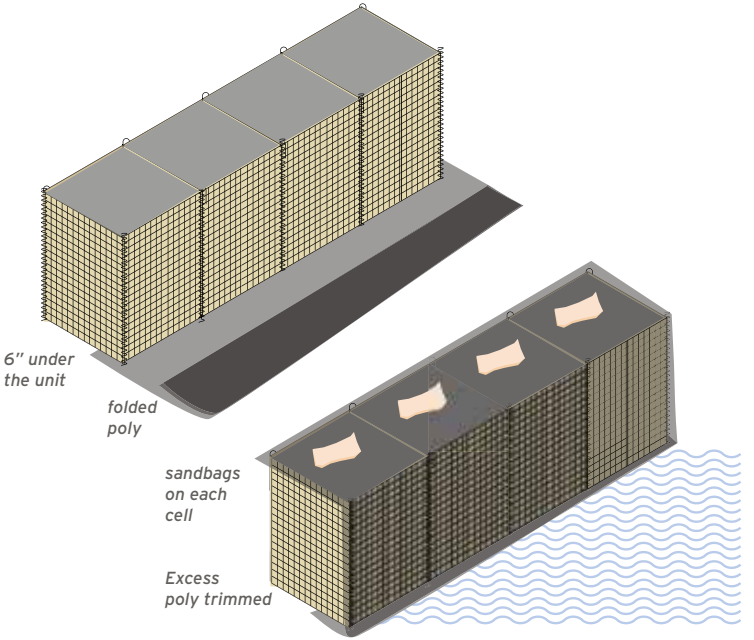
The most effective technique is to unroll the appropriate length of poly and lay it along the row of unfilled Hesco units on the "wet" side.

Do not completely unfold the poly sheeting, rather only unfold one edge of the poly to tuck under the unit, not more than 6". This preserves the tight fold of the poly sheeting as it comes off of the roll, making it more compact and less prone to being damaged. At seams, where one roll of poly needs to be connected to another, they should be overlapped at least 12" and both sides of the seam should be fully taped with a waterproof tape (e.g. Gorilla Tape).

Wherever possible, the Hesco barrier should be filled from the dry, protected side of the wall.

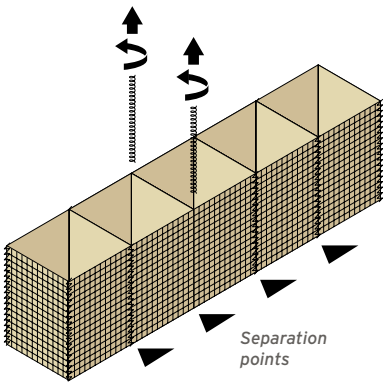
This prevents damage to the poly from material handling equipment. Construction personnel should be careful not to step on or otherwise damage the poly. Any accidental damage should be repaired; often small areas of damage can be patched with the waterproof tape.

Once the Hesco barrier is filled and compacted, the poly sheeting should be unfolded and wrapped up over the barrier. The sheeting is secured at the top by placing a sandbag on each cell on top of the poly, or by dumping loose sand to cover the poly sheeting. Be sure that the sandbags or other material are sufficient to hold the poly in place during prevailing or expected weather conditions. If there is excess material that hangs over the dry side of the Hesco barrier, it is preferred to trim this off rather than pull it to the ground and sandbag. This allows easy inspection of the dry side of the wall and give the ability to spot and correct potential problems before they become serious.



SHORTENING FLOODLINE UNITS

A FLOODLINE unit can be shortened by one, two, three or four cells, if required. Erect the unit as previously described, but do not fill. Establish the separation point and remove the coil hinges (Using bolt-cutters, clip the crimped ends of the coils at the top and the bottom. Ensure that there is a "clean" coil end to allow it to spin freely without binding) on both sides. The geotextile can be cut when separating cells so that both sections are usable.



Make a 3" (75mm) vertical cut in the liner from the top corner downward (A), as shown in Figure 15, stopping at the stapled flap corner. Turn the knife 90 degrees and continue cutting the liner just below the stapled flap (B). Cut to the opposite corner, turn the knife again and cut upwards to finish separating the cells (C), *(Figure 16)*.

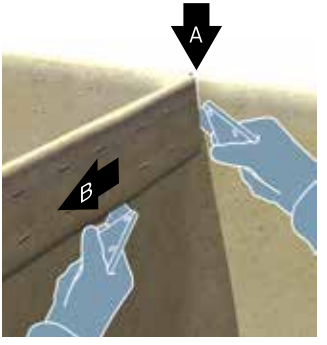


Figure 15

Although separation has been achieved at the top, the linings are still tack stapled at the bottom. To complete the separation, step on the fabric at the bottom (between sections) and pull the two sections apart *(Figure 17)*. Finally, rewind and crimp the two coils at the end corners of the shortened unit, to secure the mesh panels as they were *(Figure 18)*.

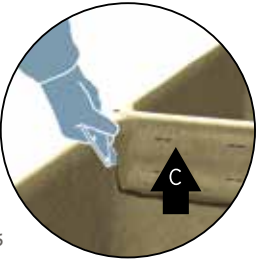


Figure 16

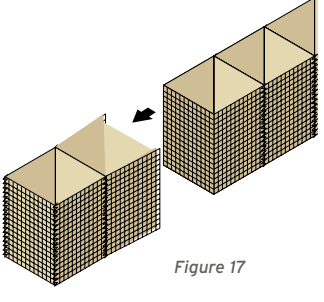


Figure 17

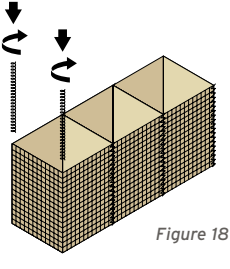


Figure 18

CURVES

Walls with gradual curves can be created using HESCO units. The HESCO unit's flexibility allows each cell of the unit to be gradually turned away from the previous unit's tangent, as shown below. This can be useful when following the line of a road, levee, berm or other geographical feature unit. *(Figure 19)*.

Never allow the cells to become out-of-square. In cases where a greater curve or angle is required, eliminate or shorten one panel as shown below to maintain squareness of the cells.

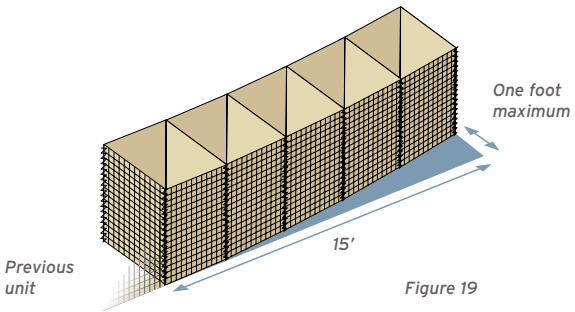


Figure 19

CORNERS, OVERLAPS AND TIE-IN'S

Simple, right-angled joins and junctures are shown in Figure 20. Where a right angled corner is required, join two units at 90˚ by meshing the coils of the cells and inserting the joining pins, as previously described. Also, the offset join shown can be useful to step a run of units around an obstruction. Remember, you cannot join units once they are filled.

Curving is done during setting up and, as with a linear section, all curved units must be set out and joined before filling. It is not recommended to curve each unit more than one foot from the tangent line set by the previous

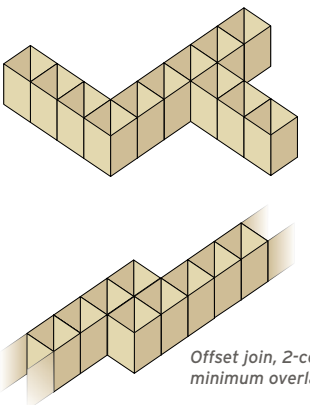
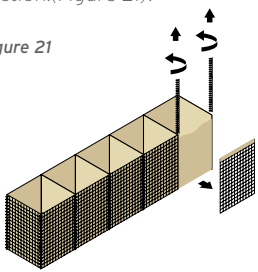


Figure 20

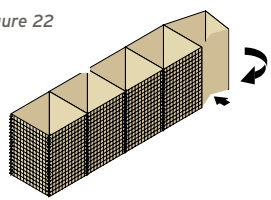
Angled corners may be created by removing or shortening the mesh panel from an end cell at the point you want to change direction. To remove a panel, remove both coils, or to remove part of a panel remove one coil and trim the panel vertically to the reqired size. Cut along the geotextile inside the unit just under the lower row of staples, removing the panel or panel section.*(Figure 21)*.

Figure 21



Swing the end panel in towards the diaphragm (inside) panel, until the corners meet and the mesh panels form a triangle. Fold the geotextile fabric into the triangular void *(Figure 22)*.

Figure 22



Reapply one of the coils to secure the mesh panels at the triangle's apex. Zip-tie the excess geotextile liner to the mesh panel, to keep it out of the way during filling *(Figure 23)*.

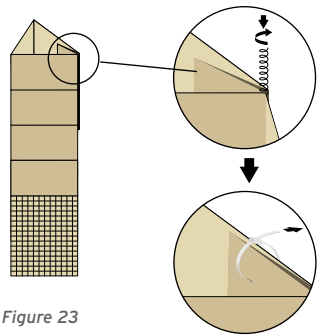


Figure 23

Connect another unit to the new angled end, and continue the linear construction in the new direction *(Figure 24)*.

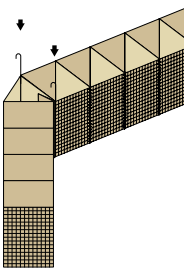
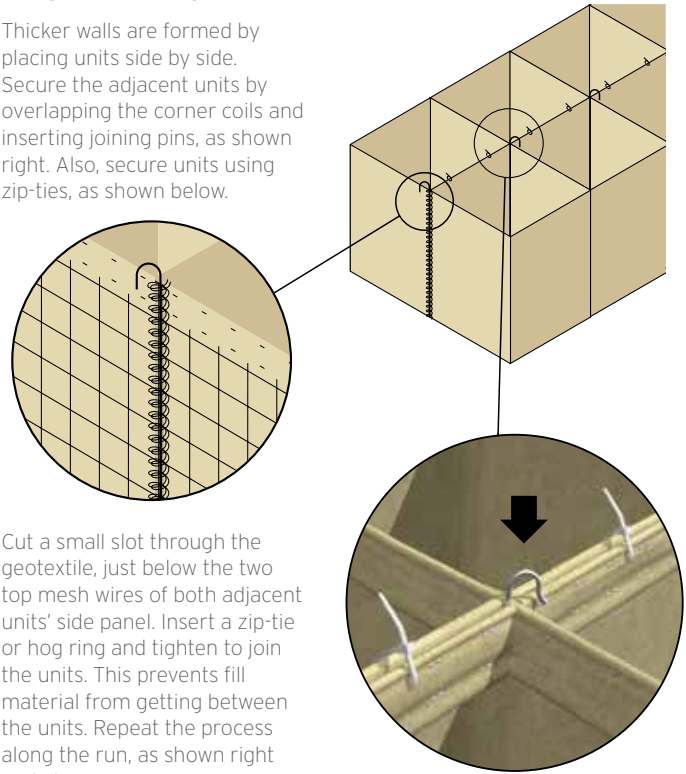


Figure 24

THICKER WALLS

Thicker walls are formed by placing units side by side. Secure the adjacent units by overlapping the corner coils and inserting joining pins, as shown right. Also, secure units using zip-ties, as shown below.



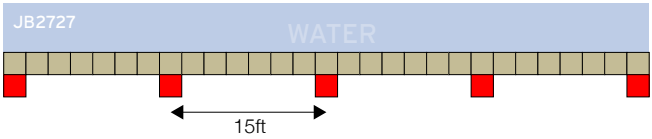
Cut a small slot through the geotextile, just below the two top mesh wires of both adjacent units' side panel. Insert a zip-tie or hog ring and tighten to join the units. This prevents fill material from getting between the units. Repeat the process along the run, as shown right and above.

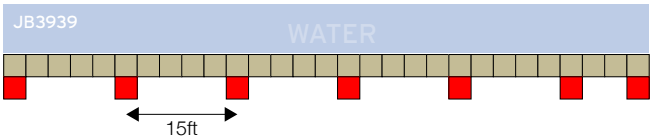
NOTE: When building thicker or stacked configurations, extra joining pins may be needed.

JACKBOX

Our JACKBOX™ flood barrier offers protection against threats posed by extreme flood events and supports rapid, post-event recovery. Tested at the US Army Corps of Engineers Research and Development Center in Vicksburg, Mississippi, JACKBOX is a light and an effective flood barrier, delivering exceptional speed of both deployment and recovery - with minimal cleanup - crucial to any flood defense operation.

Where over-topping or large waves in excess of 6 inches are expected, separate individual cell abutment bags must be positioned against the back (dry side) of the barrier at 15ft intervals. See below for example:

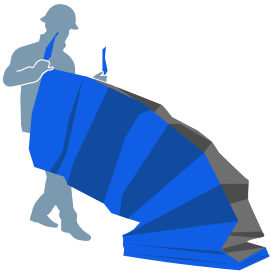




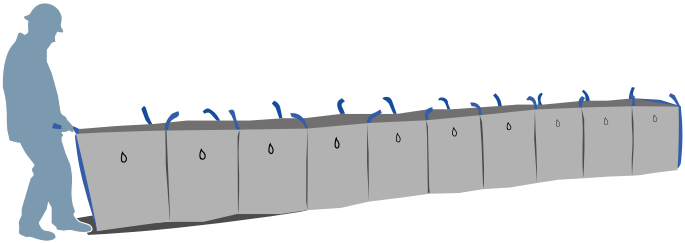
WARNING This product is not designed to be stacked.

Undo the stitching and remove the top cover.

Carefully cut the baling straps



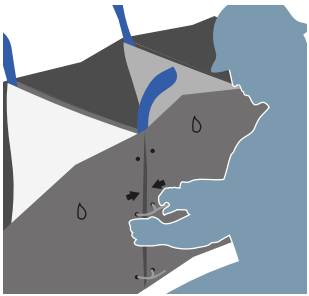
Using the lifting loops, lift out the units into the desired position



Pull the unit out completely to the desired length.

Prior to filling, ensure that the skirt is tucked underneath the unit.

Ensure that the lid is not obstructing the top of the unit prior to filling. When filling the unit make sure the lid is free to access when filling is complete.

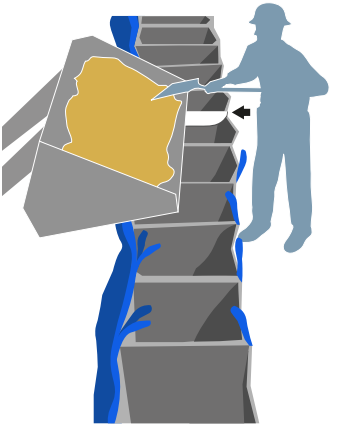


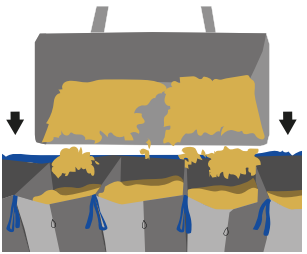
If the wall is to exceed 10-cells, it is imperative that additional units be attached before filling adjoining end cells. Using the ties provided, join the cells together, all eyelets must be joined.

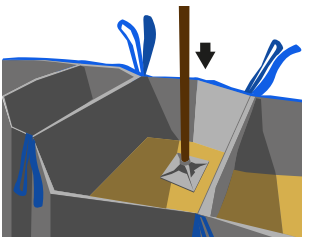
FILLING

Once all eyelets have been secured with zip ties (hand tight) and checked, lift over the white joining flap into the next adjacent cell. This will prevent fill from falling between the cells.

At this point – prior to filling – the loose front face (blue material) should be joined to the next unit, using the Velcro strip. Ensure that the Velcro strip is carefully aligned and completely attached along the surface with no bumps or loops.







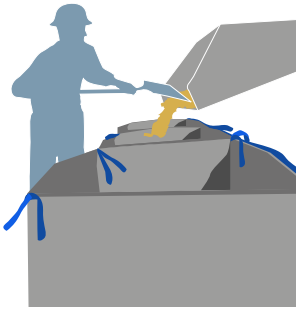
Fill the units evenly, lifting in 12" (300mm) layers and compact each layer in turn; filling units to the top but not beyond.

Do not fill the last cell of the JACKBOX unit if another unit must be connected to complete the barrier. Ensure that sand is compacted in the corner of each cell.

Correct compaction can be achieved by using your feet or using a hand tamping device.

Pull out the second unit and start filling in layers as before, again leaving the end cell unfilled and continue joining units as required. It is helpful to manually pull the cell walls taut as the filling process begins.

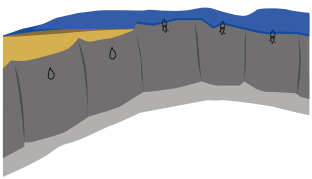
When enough of the cells have been filled, lift over the unit cover and secure using the rear tie and loops on each cell.



DEPLOYMENT CHECKS

It is important to ensure a supervisor walks the length of the deployed wall to check that the following has taken place:

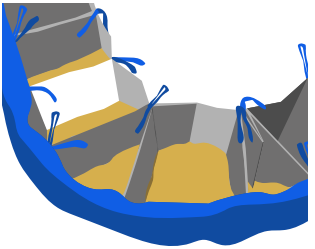
- White joining flaps have been folded over into the adjacent unit prior to filling.
- The front waterproof sheet has been tucked under the unit prior to filling.
- Units have been correctly joined with the tie wraps provided.
- Each cell has been fully compacted and not over filled.
- The front sheet has been joined correctly using the Velcro strips.



CORNERS

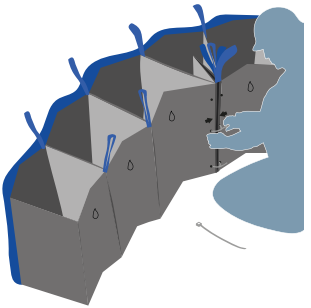
90° corners can be achieved by adopting the following procedures:

Place the units into position and pull in the side of the unit and secure with 4 plastic ties, evenly spaced as required. Fill the unit carefully ensuring not to put too much pressure on one side of the unit more than the other. Again, compact in layers.



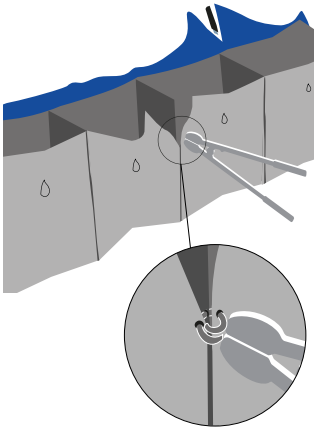
90° CORNERS

Place the unit to be deployed into position. Simply push in the inside wall in to the center of the unit and join the corner of the units together using tie wraps.



Where units are required to be split simply cut the hog rings which join each cell together. This is achieved by using a bolt-cutter (not provided). Ensure correct eye protection is worn during this process.

The front waterproof sheet can then be cut to the desired length, but ensure enough material is left to wrap around the end cell, which will reduce seepage.

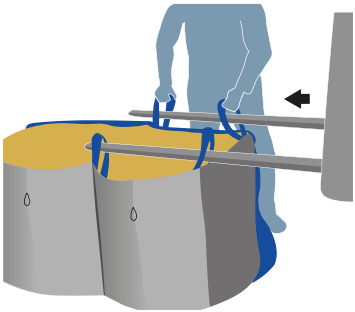


RECOVERY

Untie or cut the securing ties and lift the lid away from the top of the unit to expose the lifting loops.

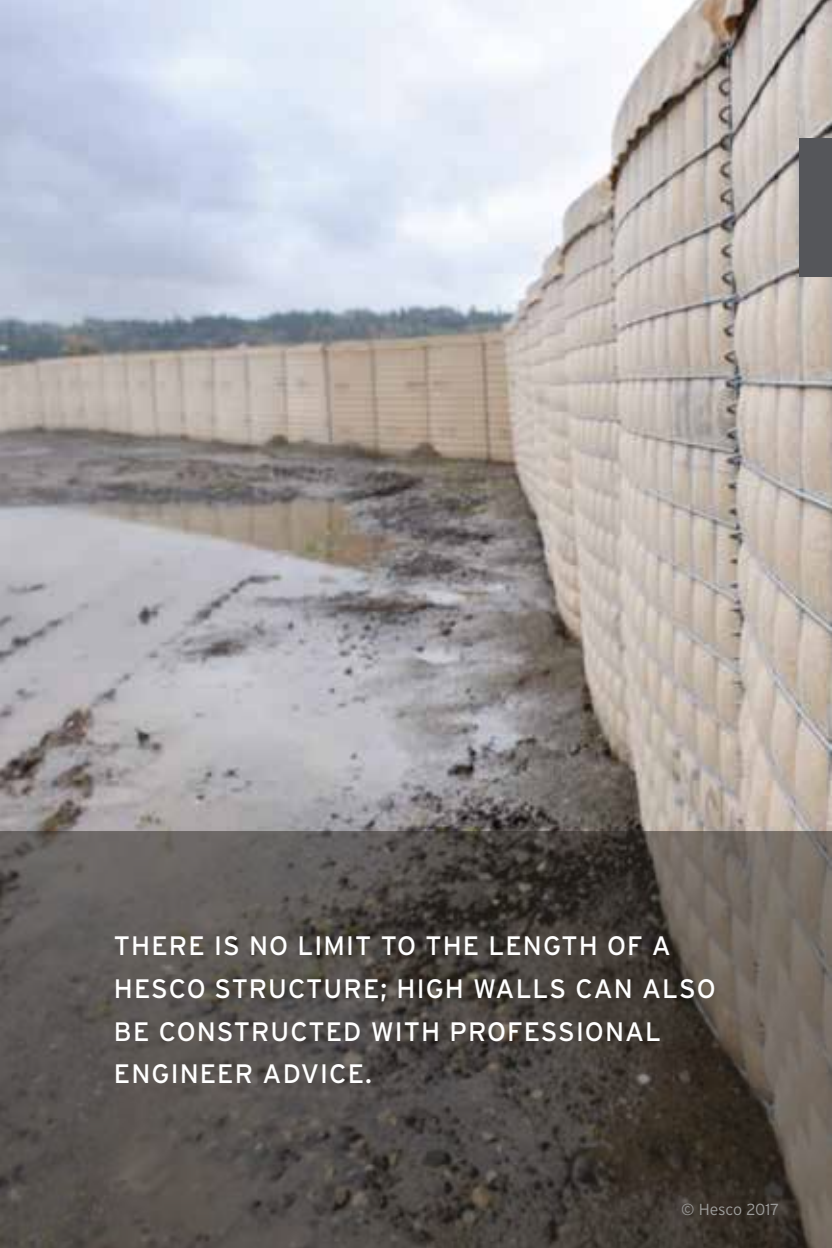
Locate and recover the four lifting loops in each cell corner (use eye protection for this procedure).

Guide the fork lift tines into the loops (one cell at a time) taking care not to trap fingers. Stand clear of the cell as it is lifted. With guidance from a co-worker, lift the individual cell clear of the ground until the hog rings have separated. Recover the cell for final disposal. Continue this operation until the barrier has been completely removed.



NOTE Fill material can be emptied off-site allowing for units to be recycled.


JACKBOX
JACKBOX
JACKBOX



THERE IS NO LIMIT TO THE LENGTH OF A HESCO STRUCTURE; HIGH WALLS CAN ALSO BE CONSTRUCTED WITH PROFESSIONAL ENGINEER ADVICE.

CONSTRUCTION PLANNING BASICS

The following pages describe basic planning issues that should be addressed when installing a HESCO wall. While not exhaustive, they cover:

- fill material
- manpower
- construction time
- heavy equipment

FILL MATERIAL

The fill material used in building HESCO walls has a significant bearing on the walls' protective qualities.

Fine material such as silt and clay do not provide good structural integrity and may require the wall to be wider. Large clumps of earth, large stones or sticks should be avoided, as these may damage the unit and increase seepage.

Table 1, on the following page, provides a brief outline of potential fill materials. Table 2 provides a guide to quantities of fill required per unit. Table 2 is a guide only and actual figures will depend on type of fill, construction methods and control, amount of loss etc.

Fill material is discussed in more detail in Section 4.

TABLE 1
BRIEF OUTLINE OF FILL MATERIALS

VERY GOOD	GOOD	POOR	DO NOT USE
Well graded sands and gravels	Sands	Clay	Large rocks
Concrete should be poured in layers and left to set *(Completely filling the unit may rupture the unit)*	Naturally occurring soils	Organic materials	Large clumps of earth or soil

TABLE 2
FILL MATERIAL REQUIREMENT PER UNIT

UNIT TYPE	UNIT LENGTH (ft)	UNIT LENGTH (m)	NO. OF CELLS	MATERIAL PER UNIT (m^3)	MATERIAL PER UNIT (y^3)
SL2424	10	3.05	5	1.5	2
SL3636	15	4.57	5	5	6.5
SL4836	15	4.57	5	6.5	8.5
JB2727	20	6.1	10	3	4
JB3939	20	9.15	10	13	17

NOTE: Weights may vary according to fill material characteristics

WORKFORCE

A crew of four to six is ideal to support a front loader or skid steer loader during filling operations. The crew-members' tasks are:

- unpacking of materials and laying out of units.
- joining units.
- laying flaps.
- spreading and compacting fill material.
- pulling out the bottom of cells.
- direction of loading equipment.

CONSTRUCTION TIME

HESCO units can be installed in various configurations to provide effective and economical structures which can be tailored to protect people, property and natural heritage through their use in civil projects. However as with all construction it is important to be able to estimate the time it is likely to take to carry out the build.

It is accepted that various factors will affect the time it takes to construct any given structure, such as:

- time of year and prevailing weather conditions and light.
- availability of resources and manpower.
- haul distance from stockpile for the fill material.
- accessibility/ground conditions.
- type of equipment available for your use.
- emergency situation and threat level.
- type of HESCO unit being used.
- experience of the installation crew.

Given ideal conditions, a basic linear construction of a wall equivalent to 1,500 sandbags should take approximately 20 minutes using one loader and two men. This includes unpacking from a pallet, unfolding the cells, positioning and filling. This is a good guide figure and is assumed with the fill material close by and a loader with a bucket capacity of 1.3 - 2.6yd^3.

HEAVY EQUIPMENT

Many different types of equipment may be used for placing the fill material.

- The type of equipment selected will depend on a number of factors, not least:
- the type of equipment available.
- the space available to maneuver.
- the height that the fill must be lifted to.
- the type of terrain.
- the distance that the fill must be hauled.
- the type of HESCO unit being filled.

The selected equipment must be able to raise the fill to the required height and place it with sufficient accuracy for efficiency, safety and economy.

For lower levels, front-end loaders are ideal. In all cases a 'bottom opening' (4:1) bucket is ideal.

CAUTION Only qualified and properly trained equipment operators should operate the loading equipment. Also, provide a properly briefed and competent ground guide for the loading equipment. He/she is to ensure correct employment of the loading equipment, correct placement of the fill material and that working areas for the loading equipment are free from personnel.

For higher levels, excavators, particularly those with articulated or clamshell buckets, are effective.

Tracked loading equipment has proven to be very effective and versatile when loading HESCO units.

Conveyor-type equipment is increasingly used for filling structures.

Detailed instructions on how to assemble the system are also provided with each pallet of units supplied.

Further explanation on all these topics can be given by our technical representatives. If you require any assistance, of any kind, on the use of HESCO products, please email:

support@hesco.com

NOTE: If you have a requirement to remove existing HESCO installations, or wish to build in removal as part of your project plan, please contact HESCO directly for more information.

REMOVAL

There may be a requirement to remove protective structures. This operation is often undertaken using heavy earthmoving equipment to topple the walls and rip the welded mesh away from the fill material. While this method works, it results in a mass of welded mesh that is very difficult to handle and dispose of. The following pages, describe three alternative methods for removal.

The following risks may be present during demolition work:

- Working at height.
- Premature collapse of structure.
- Manual handling injuries.
- Collisions between earthmoving plant and pedestrians.

A safe system of work must be adopted and followed and should include the practices described below:

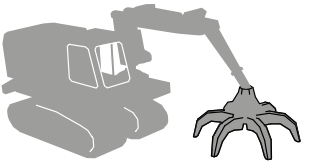
- Working at height should be minimized.
- When cutting the welded mesh always cut from the bottom up.
- Wear gloves and protective eye wear when handling cut and removed welded mesh.
- Competent spotter to be appointed to manage earthmoving equipment and to ensure the operating area is kept clear of personnel.
- Ensure dump trucks are supervised whilst reversing.
- When an electric angle grinder or disk cutter is used it should be supplied with site-safe electricity.

WARNING Any demolition work can be dangerous. It is imperative that a safe system of work is adopted and followed, as described on this page.

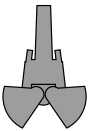
REMOVAL - METHOD 1

This method uses earthmoving equipment fitted with a demolition grab, grapple attachment, orange peel grab or timber grab attachment.

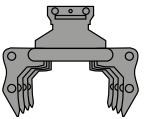
- Identify and remove all material and equipment from the area that is not to be disposed of.
- Cut all hog rings by bolt croppers, angle grinder or abrasive cutting tool.
- Cut all units into two-cell lengths by bolt croppers or angle grinder.
- Ensure all personnel are removed from the area prior to using the grab or grapple.
- Remove each two-cell length at a time with the demolition equipment. As the segment is removed it should be shaken to remove as much of the fill as possible.
- The removed welded mesh should be stockpiled at the site for later removal or placed immediately into a dump truck or skip for transportation to the disposal area.



Orange peel



Clamshell



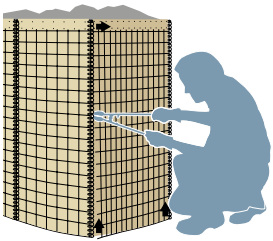
Demolition grab

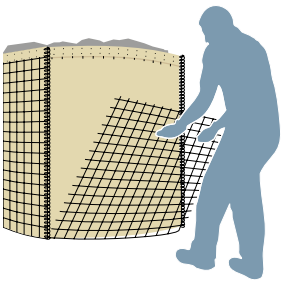
- Work in a methodical and logical manner removing two-cell segments, but ensuring that remaining cells do not become buried in dislodged fill.
- Surplus fill material may be removed from the area by means of a loading shovel once the grapple has progressed a sufficient distance.
- The above process should continue until the site is cleared.

REMOVAL - METHOD 2

This method involves removing the welded mesh by hand and is only suitable for low walls.

- Identify and remove all material and equipment that is not to be disposed of.
- Use bolt croppers or an angle grinder to cut off all hog rings.
- Beginning at the bottom, cut the welded mesh all the way up both sides adjacent to the corner coils. Then cut the welded mesh across the top just under the stapled flap. Continue cutting until the welded mesh panel can be removed.
- Remove all accessible panels on a cell, as described in the previous step. The welded mesh of the diaphragm wall (between each cell's geotextile) should be removed as and when it becomes free.
- Do not cut the geotextile.
- Use earthmoving equipment to remove the fill (this will still be contained in the geotextile). The removal of the fill, where possible, should be carried out cell by cell.
- Continue until the site is cleared.



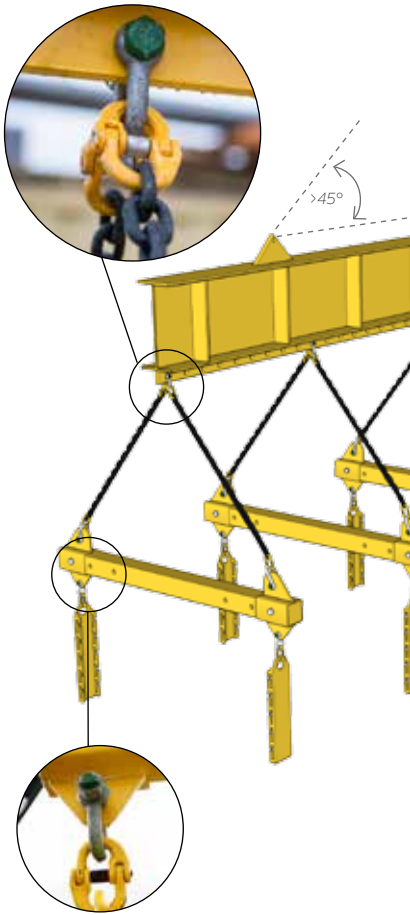


REMOVAL - METHOD 3

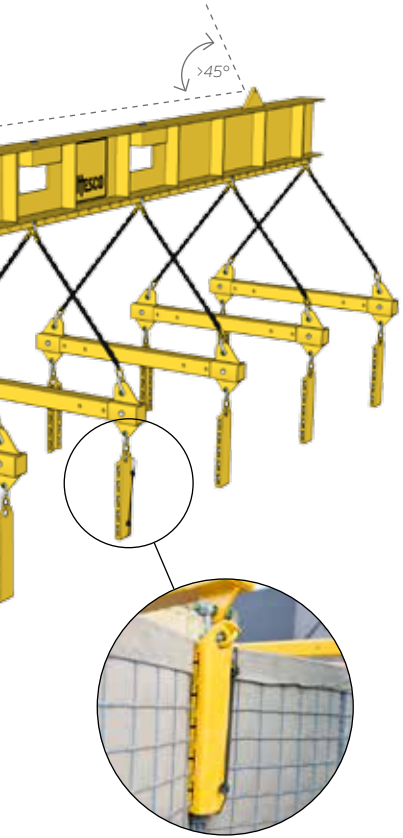
The HESCO Recovery Frame is designed for the lifting of selected units, allowing fill material to drop out, and empty units to be re-palletized.

- The beam is to be inspected for serviceability by a competent person, daily, prior to use. Records of these inspections are to be kept in a register of lifting equipment which should accompany the Recovery Frame at all times. Details of any damage or excessive wear and tear are to be reported to a qualified person.
- Particular care is to be taken to ensure that all split pins on shackles are located and secured correctly.
- Ensure that the material handling equipment being used for lifting the Recovery Frame is suitable and is serviceable.
- Lift the Frame up and ensure the chains are not twisted and check that the lugs are facing inwards.

NOTE Recovery Frame for up to 4ft (1.22m) high units.

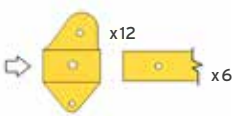


Lifting strops/chains must be no less than 45 degrees from the horizontal Recovery Frame



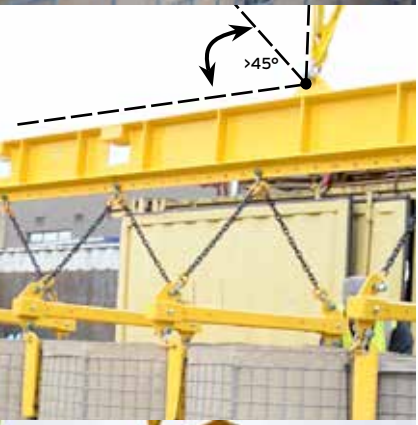
Ensure all nuts on 'D' shackles are secured correctly using the split pins provided

Securing cords used to hold the grips in place during the lifting phase



Secure sleeve on the spreader-bar using the pin, with 'R' Clip

- Using a competent spotter, position the frame over the HESCO units to be recovered. At this point, care is to be taken to ensure that the frame is positioned centrally above the 5 cells to be recovered.
- Lower the frame down into position whereby the lifting lugs straddle the joining coils. Insert the lifting lugs into position as shown on previous page. Once the lugs have been located, lift and lock them into position using the elastic securing cords. Care is to be taken when applying the securing cords. Protective glasses are to be worn. Continue applying all 12 lugs into position.
- Using the securing cords. Prior to lifting, walk around the unit ensuring all lugs are securely located and that each lug is in the same position as the other 11. Failure to achieve this will result in uneven weight distribution and subsequent damage to the units to be lifted.



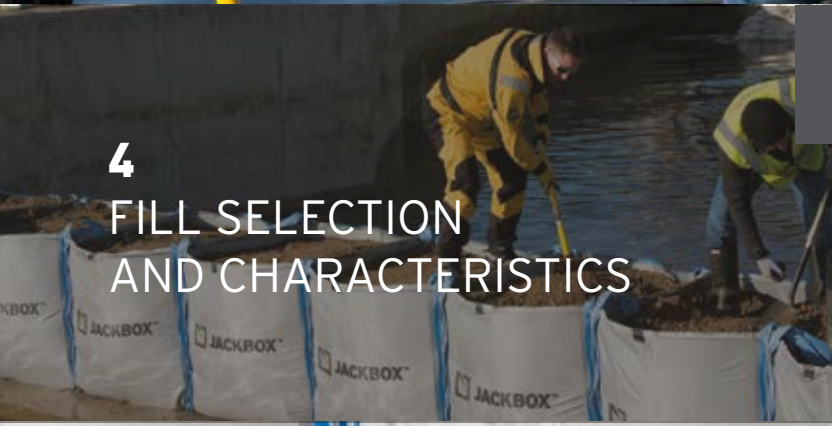
- Prior to lifting, all personnel are to stand clear at least 5m from the units to be lifted. Once the spotter has confirmed that all lugs are located and that all personnel are clear from the area, the recovery process can begin.
- The lifting strops/chains must be no less than 45 degrees from the horizontal Recovery Frame as shown.
- Care should be taken to lift slowly and carefully paying particular attention to ensure that no chains or slings are twisted during lifting.
- Once the units have been lifted clear of the fill, the empty units can be lowered to the ground under guidance.
- Using a competent spotter; position the forks into the beam and secure using the T screws provided.
- Ensure that the beam is level, that the forks are parallel to the ground before securing and lifting, and that the machine is as close to the units to be lifted as reasonably practical.

3
DESIGN OF HESCO STRUCTURES

The versatility of Hesco units extends across all products in the range. This versatility allows a myriad of structures to be created, from a single-tier flood defense wall to large multi-tier structures.

Hesco structures have been successfully installed at a number of locations, for a variety of projects.

These structures were specified only after qualified engineers had verified the design, and after some or all of the parameters discussed in this document had been satisfied, as well as others specific to the projects shown.



4
FILL SELECTION AND CHARACTERISTICS

The protective properties of defense walls built from HESCO units are substantially defined by the characteristics of the fill material. Generally, the ideal fill is a sand to sand/gravel mix. Offering a high degree of protection and structural integrity, a sand/gravel mix is easily handled. Fine material such as silt and clay makes filling more difficult, as they do not flow easily from the buckets of the loading shovels and, in fact, may tend to clump causing voids in the structure.

Clumps and frozen soils can also damage the unit during filling, as can large stones and rocks.

The information that follows is given to assist in preliminary design. It is not provided as data to be used in final design.

GUIDE TO SUITABILITY OF FILL MATERIALS

FILL MATERIAL	APPLICATION	
	LOAD BEARING AND LARGE STRUCTURES	FLOOD PROTECTION
CONCRETE	Excellent	Good
	Concrete should not be in placed lifts of greater then 24" without engineer approval.	
WASHED GRAVEL	Very good	Suitable*
	Washed gravel is generally very suitable, but should not be used around stores containing large quantities of explosives. **polyethylene sheeting to be used on the face*	
WELL GRADED SAND AND GRAVEL	Good	Good
	Good quality gravels and sands are generally very suitable.	
OTHER SAND	May be suitable	Generally good
OTHER NON-COHESIVE SOILS	Poor	Generally good
CLAY SOILS	Unsuitable	Suitable if it can be placed, often difficult to place
	Generally difficult to place and unsuitable.	
ORGANIC SOILS	Unsuitable	Can be used in temporary barriers
	Generally unsuitable. They shouldn't be used in permanent structures.	
PEAT	Unsuitable	In an emergency can sometimes be used in temporary barriers
	Generally unsuitable. It should only be used as a temporary expedient if no better material is available.	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5
MAINTENANCE AND REPAIR

REPAIR PROCEDURE

Prior to repair, an assessment of the structure must be carried out by a qualified engineer/ competent person.

Repairs to structures may be required as a result of attack or accidental mechanical damage. There are a number of repair techniques available, with the technique adopted depending on the nature and extent of the damage. In the majority of cases once repairs have been carried out the wall will once again be as competent as it was before the damage occurred.

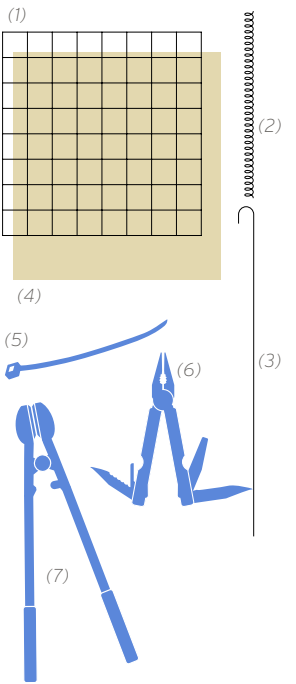
In general, material required for repair consists of:

- Welded mesh panels *(1)*
- Coils *(2)*
- Pins *(3)*
- Geotextile *(4)*
- Zip-tie *(5)*
- Multi-tool *(6)*
- Bolt cutters *(7)*

Alternately repair material can be gained by cannibalizing parts from unused units.

Repairs may range from minor repair of torn geotextile to the repair or replacement of complete sections of wall.

The modular design of the units allows all of these repairs to be completed in an economical and efficient manner.



MINOR REPAIR

It is very rare for a complete unit or cell to require replacement, but more common for an exterior panel to have suffered some damage. This can be repaired by the application of a repair panel or a small section of panel if cannibalizing materials from unused units. Measure the size of repair patch required *(Figure 1)* and decide whether to apply a patch over the damaged area, or apply a complete panel.

For a small patch

- Cut an oversize patch from the repair panel or cannibalized unit.
- Cut two coils to the patch's depth *(Figure 2)*.
- Cut a geotextile patch. Leave a generous overlap – 6" (150mm) all round is generally sufficient *(Figure 2)*.
- Place the welded mesh patch over the damaged area.
- Secure the left side to the existing wall by means of a coil coiled through the patch and the existing cell panel *(Figure 3)*.
- Place the cut geotextile behind the welded mesh patch ensuring the 6" (150mm) overlap is folded within the welded mesh patch *(Figure 4)*.
- Close the welded mesh patch over the area of repair, then wind in the right-hand coil *(Figure 5)*.
- Refill or top up the fill in the unit, as necessary.

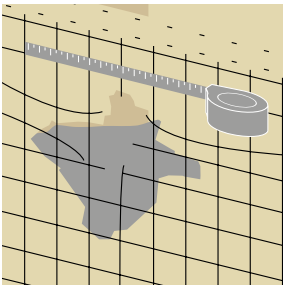


Figure 1

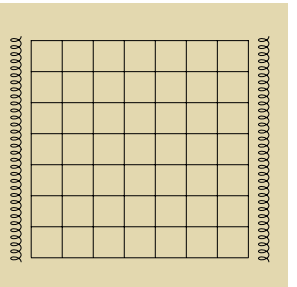


Figure 2

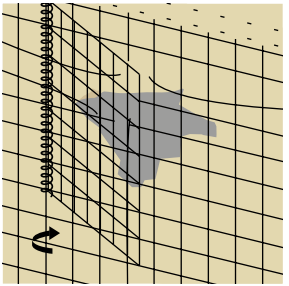


Figure 3

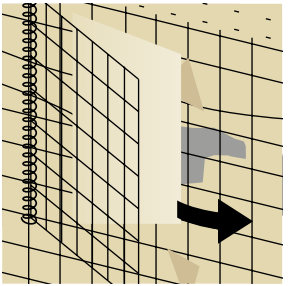


Figure 4

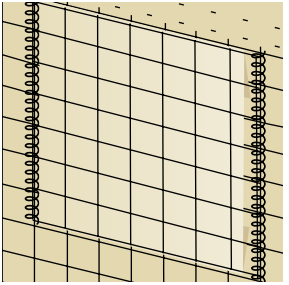


Figure 5

FOR A COMPLETE PANEL

Obtain a full size panel to the correct size, two coils, two joining pins and a piece of geotextile 6" (150mm) larger on all sides *(Figure 6)*.

- Fit coils to both sides of the repair panel *(Figure 6)*.
- Interlink the coil on one side with the coil of the existing unit and fit a joining pin *(Figure 7)*.
- Place the geotextile patch on inside of the repair panel and fold in the 6" (150mm) overlap *(Figure 8)*.
- Close the repair panel tight. Interlink the coil on the opposite side and fit a pin *(Figure 9)*.
- Refill the unit to complete the repair *(Figure 10)*.

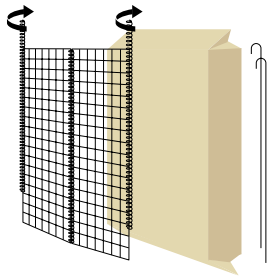


Figure 6

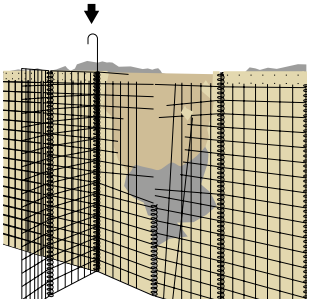


Figure 7

NOTE It may be necessary to fit additional coils to increase the length of the repair panel to enable the coils to be overlapped and a joining pin to be fitted.

If water is against the flood wall, the re-enforcement repair method is to be adopted, page 83.

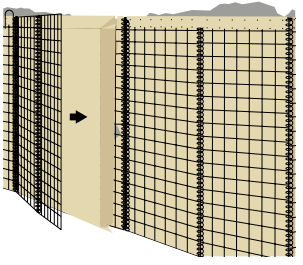


Figure 8

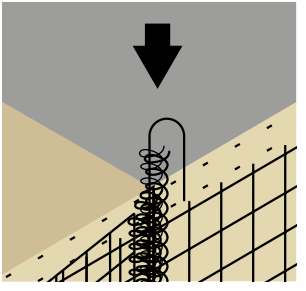


Figure 9

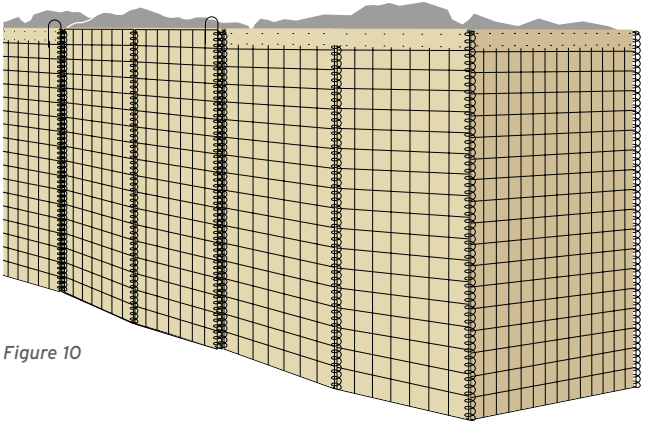


Figure 10

REINFORCEMENT

In this technique, new cells are established alongside the damaged section *(Figure 11)*. Where damage has been incurred in the upper layers of a multi-layer structure, it may be necessary to build a buttress *(Figure 12)*. This is a quick and efficient repair method but relies on the availability of ground to increase the size of the structure's footprint.

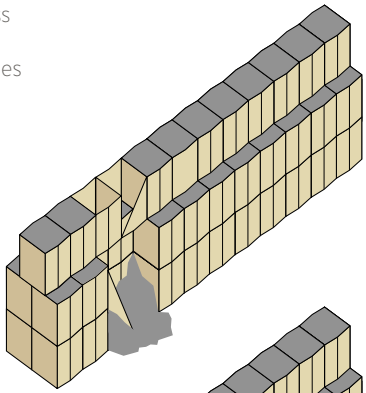


Figure 11

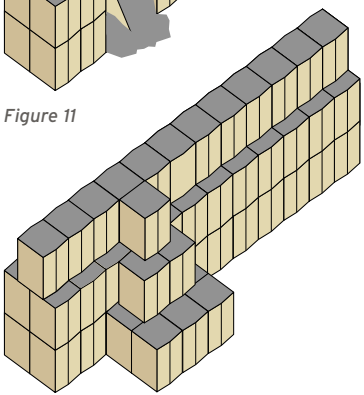


Figure 12

CAPPING

For structures which are expected to have a long service life, are in wind-affected areas or are adjacent to aircraft operating surfaces, it is important that loss of fill material is prevented. This can be achieved by a number of means:

- Fill material should be shaped and sufficiently compacted to allow moisture to run off.
- The structure can be covered by tarpaulins or other waterproof membranes.
- A lean mix concrete or cement bound material can be used as the final layer.
- Where fine sand has been used as the bulk fill and is susceptible to being blown out by the wind, then a slightly coarser aggregate can be used to cap the cells.

PROTECTION AGAINST ULTRAVIOLET RADIATION

The geotextile used in HESCO units is susceptible to the effects of UV radiation after a period of prolonged exposure.

Substantial developments and testing was carried out to produce the geotextile.

One of the problems with trying to predict the effects of UV is that it varies considerably from region to region and can, in fact, differ within the same region. There are, of course, a number of other issues which affect the severity of any degradation that may occur:

- Fill material used in the cells.
- Orientation of the units exposure to the sun.
- The level of fill within the unit.
- Stresses placed on the geotextile.

GENERAL ADVICE

If the material is to be in service for more than four years then you should apply a protective layer to the outer surfaces of the units.

HOW TO PROTECT

There a number of ways to protect the geotextile from the effects of UV radiation generated by the sun: the application of a protective coating such as cement slurry or paint covering the structure with a sacrificial layer of material the planting of foliage to provide shade

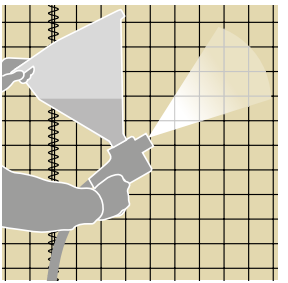
HESCO can provide information on job-specific coating systems to prolong the life of a structure, all of which are available in a variety of colors and are each unique in technology. Applications include, UV resistance, corrosion prevention, permeability, fire retardant, asphaltic, cementitious and grass seeding coatings.

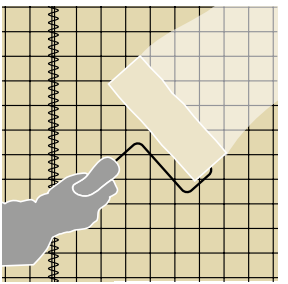
APPLICATION OF PROTECTIVE COATINGS

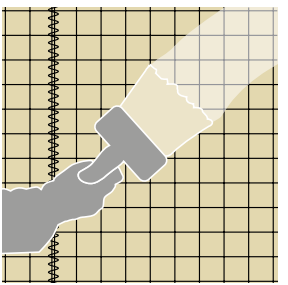
The application of a protective coating, such as cement slurry or, indeed, paint (water-based emulsion), is likely to significantly extend the life span of the geotextile.

A sprayer such as a stucco gun (texture gun) connected to a 7.5 cu ft/min compressor is ideal for the application of cement slurry or paint. Cement slurry or paint can also be applied by brush or roller.

Cement slurry is simply a mixture of cement powder and water. It is mixed to a strength of approximately 1:1 but this can be adjusted to suit whatever application method is being used. Sand can also be added if desired. The unit to be coated is often wetted prior to the application of the slurry; this prevents the slurry from drying out too quickly.







6
TESTING INFORMATION

TESTED TO THE LIMIT

Designed to be put in harm's way, our products are tested to the limit. Our flood products have undergone an intensive series of laboratory and field tests and have been assessed by leading authorities in the US and worldwide.

Tests in the US include those undertaken as part of a research program into temporary flood-fighting structures. The research was conducted by the US Army Engineer Research and Development Center (ERDC).

The resulting report concluded that HESCO units had significant advantages over traditional sandbags in terms of cost, time and labor requirement for installation, and also outperformed alternative systems in many areas tested.

Hesco continue to test new products to the same high standards and continue to test existing products against new threats and in new configurations.

For further information about Hesco product testing please contact us direct:

support@hesco.com

7
CONVERSION TABLES

The following pages provide tables of conversions for common measurement systems, in both directions.

DIMENSION	TO CONVERT	INTO	MULTIPLY BY
Length	inches	mm	25.4
	feet	m	0.3048
	yards	m	0.9144
	miles	km	1.609
Area	square inches	cm^2	6.452
	square feet	m^2	0.093
	square yards	m^2	0.8361
	acres	hectares	0.405
	square miles	km^2	2.590
Volume	cubic feet	m^3	0.0283
	cubic yards	m^3	0.765
	imperial gallons	litres	4.5461
	US gallon	litres	3.7851
Mass	ounces	g	28.35
	pounds (lb)	kg	0.4536
	hundred weight	kg	50.8
	ton	kg	1.016

NOTE Every care has been taken to ensure that the conversion factors are accurate. However, the conversion factors contained within this document are included as a courtesy and should not be relied upon for use in complex engineering problems.

DIMENSION	TO CONVERT	INTO	MULTIPLY BY
Length	mm	inches	0.039
	m	feet	3.28
	m	yards	1.09
	km	miles	0.621
Area	mm^2	square inches	0.0016
	m^2	square feet	10.764
	m^2	square yards	1.196
	m^2	hectares	0.0001
	hectares	acres	2.47
	km^2	square miles	0.386
Volume	cm^3	cubic inches	0.061
	m^3	cubic feet	35.31
	m^3	cubic yards	1.307
	cm^3	fluid ounces	0.035
	litres	m^3	0.001
	litres	imperial gallons	0.2198
	litres	US gallon	0.264
Mass	g	ounces	0.035
	kg	pounds (lb)	2.204
	kg	hundred weight	0.020
	tonnes	ton	0.984

DIMENSION	TO CONVERT	INTO	MULTIPLY BY
Density	ton/yard	t/m^3	1.329
Speed	miles/hour	m/s	0.4470
	miles/hour	km/hour	1.61
	knots	m/s	0.5148
Force	lb.force (lb.f)	N	4.444
	poundal (pdl)	N	0.13831
	ton force	kN	9.964
Pressure	lb/ft^2	N/m^2	47.88
	PSI (lb/in^2)	kN/m^2	6.895
	ton/ft^2	kN/m^2	107.2
	ton/in^2	N/mm^2	15.44
	bar	N/mm^2	0.1
	atmosphere	bar	1.013
	PSI (lb/in^2)	kPa	6.895

DIMENSION	TO CONVERT	INTO	MULTIPLY BY
Density	t/m^3	ton/yard	0.752
Speed	m/s	miles/hour	2.237
	km/hour	miles/hour	0.621
	m/s	knots	1.945
Force	N	lb.force (lb.f)	0.225
	N	poundal (pdl)	7.233
	kN	ton force	0.1
Pressure	N/m^2	lb/ft^2	0.021
	kN/m^2	PSI (lb/in^2)	0.145
	kN/m^2	ton/ft^2	0.009
	N/mm^2	ton/in^2	0.065
	N/mm^2	bar	10
	bar	atmosphere	0.987
	kPa	PSI (lb/in^2)	0.145

UK and Rest of World Inquiries
Hesco Group
Unit 41 Knowsthorpe Way, Leeds
LS9 OSW United Kingdom

Telephone: +44 113 248 6633

Email: support@hesco.com

US and Americas Inquiries
Hesco Group
1525 King Street, Alexandria
VA 22314 United States

Telephone: +1 (985) 345-7332

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