Cellular Confinement Systems

EROSION CONTROL TECHNIQUE

Revegetation	[1]	Temperate Climates	✓	Short-Term	[2]
Non Vegetation	✓	Wet Tropics	✓	Long-Term	[2]
Weed Control		Semi-Arid Zones	✓	Permanent	✓

[1] Vegetation, such as grasses, can be established within the cells.

[2] Can be used for short-term erosion control, but is most commonly used as a permanent treatment.

Symbol

Photo 1 – Cellular confinement system used to restrict gravel movement on a permanent car park

Photo 2 – Cellular confinement system used to retain soil and assist in the establishment of grass on a steep slope

Key Principles

1. Critical design parameters are the size and depth of the cells, choice of cell wall texture (smooth or rough, solid or perforated), type of anchorage system (applicable to slopes and concave surfaces), and the choice of infill material.
2. It is critical to ensure the top of the cellular confinement system (CCS) is set flush with, or slightly below, the adjacent terrain to avoid stormwater run-on water being diverted along the edge of the matrix.

Design Information

The following design information applies to applications not within a drainage channel. For use as a channel/chute lining, refer to the separate fact sheet within the *'Drainage Control'* section.

Step 1 Determine the type of cell wall: smooth, textured, or perforated.

Textured or perforated surfaces (Photo 4) are required when the honeycomb matrix is installed with a concave profile that may cause the matrix to lift from the ground. Perforated cell walls are required when it is necessary for water flow to pass laterally through the cell walls (Photos 5 & 6). This is usually required when the honeycomb matrix is to be grassed on slopes steeper than 10%. Textured surfaces are used with aggregate and concrete infill.

Step 2 Determine the design shear stress or average velocity resulting from the expected flow passing over the treated surface. Consult with, and/or review the manufacturer's design guidelines for sizing of cell depth and selection of infill material.

Cellular confinement systems are manufactured with smooth, textured, or perforated sidewalls. Each surface condition is used for a different purpose. The perforated, textured surfaces (Photo 4) are the most common and generally achieve most of the performance requirements.

Photo 3 – Smooth sidewall

Photo 4 – Textured and perforated sidewall

Cellular confinement systems allow topsoil to be placed and retained on steep slopes; however, it is important to recognise the long-term effects of retaining the plastic matrix within the ground surface, such as its impact on tree and shrub establishment, or the limitations on topsoil recovery if the slope is re-engineered.

Photo 5 – Installation of matrix on a road cutting

Photo 6 – Grass establishment on steep slope

Cellular confinement systems can be used with or without vegetation (Photos 6 & 8).

Photo 7 – Placement of filter cloth might not always be required

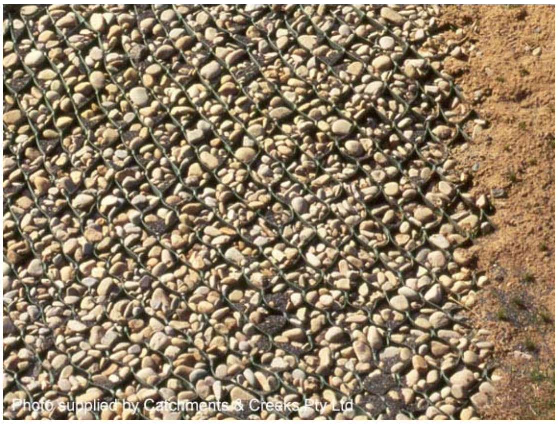

Photo 8 – Cellular confinement system used to hold aggregate on an embankment

Description

Expandable, three-dimensional, open honeycomb-like mesh manufactured from a synthetic material and filled on-site with soil, sand, small rocks, or low slump concrete.

Most products are formed from rigid plastic, while others use more flexible material.

Some products have pre-drilled drainage holes to allow the lateral movement of surface groundwater and to increase the shear resistance of the mesh to uplifting forces. The latter reduces the risk of the product lifting from the ground when placed over a concave surface.

Purpose

Can be used for the following purposes:

To hold topsoil and other loose material on steep slopes such as bridge abutments.

To restrict the lateral displacement of gravel or aggregate on car parks.

To improve the rubber-tired trafficability of sandy material (sand-confinement system).

As a form of earth or track stabilisation in muddy, boggy or sandy areas such as a temporary ford crossing of a dry, sandy river bed.

As a form of turf reinforcing.

As a form of earth reinforcing on very steep vegetated slopes—in which case the material is installed in a manner different from that discussed within this fact sheet.

Can also be used as a form of channel/chute lining (refer to appropriate channel-linings fact sheet).

Limitations

In areas of high flow velocity, cellular confinements systems in-filled with small rocks are generally not a suitable replacement the appropriate placement of suitable large rock.

Advantages

Can be used as an alternative to traditional rock armouring in areas that have limited supply of suitable large rock.

Long-term stability is not necessarily dependent on the establishment of vegetation; however, the incorporation of vegetation generally results in a significant increase in the allowable shear stress.

Easy to transport to the site.

Disadvantages

Displacement of the infill material can occur on an ongoing basis if not suitably stabilised with vegetation.

Common Problems

The mesh can lift from the channel surface if placed on a concave surface without being adequately anchored.

Can promote waterlogging of the ground unless adequate drainage exists.

Special Requirements

The mesh needs to be well anchored if placed on a concave surface.

Required good surface preparation with the removal of all major surface irregularities.

Location

Generally best used as permanent erosion control in environments where vegetation cannot be relied upon, such as arid and semi-arid areas and in heavily shaded areas.

Temporary ford crossings on dry, sandy river beds.

Site Inspection

Check for the displacement of infill material.

Ensure the cellular mesh is not lifting from the ground.

Ensure surface flow can freely enter the CCS-lined area. Check for water scour along the up-slope edges of the matrix.

Check for successful vegetation cover (if required).

Material

- Cellular confinement matrix: polyester non-woven material (flexible sidewalls), or high-density polyethylene (HDPE) (stiff cell wall).
- Tendons: steel cable, or bright, high-tenacity, industrial-continuous-filament polyester yarn woven into round braided cord.
- Anchors: wooden stakes, or 250 to 500mm steel J-pins. Wooden takes used only on mild slopes (<10%) as a temporary anchor during the placement of the infill material.
- Infill: topsoil, earth, aggregate or concrete. Maximum aggregate size no greater than 75% of the sidewall depth of the CCS matrix.

Installation

The following specification applies to use as temporary erosion control only.

1. Refer to approved plans for location, extent, and application details. If there are questions or problems with the location, extent, or method of application contact the engineer or responsible on-site officer for assistance.
2. Clear the treatment area of any debris that may interfere with placement of the cellular confinement system (CCS), or prevent good contact between the CCS matrix and the subgrade.
3. Ensure the surface is free of deep track marks of other features that may result in stormwater or groundwater passing in a concentrated under the CCS matrix.
4. Where necessary, establish up-slope drainage controls to limit run-on water that may disturb the matrix.
5. Shape and compact the subgrade surfaces to the shape and elevation shown on the Construction Drawings. When determining the elevation of the subgrade, ensure allowance is made for the thickness of the CCS matrix such that the top of the matrix will be flush with, or slightly below, the adjacent terrain.
6. Where necessary, excavate the subgrade such that when placed, the upper surface of the CCS matrix will be flush with, or slightly lower, than the adjacent terrain.
7. Remove any unstable subgrade, replace with suitable material and compact to achieve a stable surface.
8. If the material is to be placed on a slope steeper than 10%, then excavate an anchoring trench along the top of the treatment area 200mm deep and 500mm wide.
9. Where practical, roughen any excessively smooth, compacted subgrade to improve the eventual bonding between the subgrade and applied CCS matrix.
10. If specified, install the required geotextile underlay on the prepared surface, ensuring that required overlaps are maintained and that the upper edge of the geotextile is anchored (pinned) within the formed anchoring trench.
11. Spread out (expand) individual panels uniformly across the treatment area as specified by the manufacturer. Expand and stretch the panels down the slope instead of across the slope.
12. Along the top edge of the matrix anchor every other cell into the formed trench using steel J-pins.
13. On slopes steeper than 10%, anchor every other cell using steel J-pins at 2m intervals down the slope.
14. On slopes not steeper than 10%, anchor the individual panels along all four sides to prevent movement while placing infill.
15. Interleaf or overlap the edges of adjacent panels according to which sidewall profile abuts. In all cases, ensure that the upper surfaces of adjoining panel sections are flush at the joint and that adjoining cells are fully anchored (stapled).
16. Fill and compact the anchoring trench.
17. Fill the honeycomb panels mechanically or manually. Ensure earth fill and small aggregate (<75mm) is placed from a drop height not exceeding 1m, and large aggregate (>75mm) from a drop not exceeding 0.15m.
18. Place the infill evenly and such that when compacted, the fill will be level with the upper surface of the panel.
19. Lightly tamp or roll topsoil or earth fill, level aggregate fill with a plate tamper or mechanical (backhoe) bucket.

Additional specification for attachment of tendons for anchorage:

1. Feed pre-cut lengths of tendon material through the aligned holes in the cell walls of the matrix prior to expanding individual panels into position.
2. Tie off the ends of the tendons so that the knot cannot pass through the hole in the cell walls. Ensure the knots are tied to provide full tendon strength and will not slip when tensioned.
3. Attach restraining clips to the tendons at regular intervals to achieve the necessary load transfer.
4. Anchor the tendons and restraining clips with steel U-shaped or J-pins at 2m intervals. At each internal anchor location, form a loop in the tendon, insert the anchor, and drive into the subgrade.