ARMOR FLEX®

ARTICULATING CONCRETE BLOCK REVETMENT SYSTEM

- CHANNEL LINING
- RIVERBANK PROTECTION
- DRAINAGE DITCH LINING
- PIPELINE PROTECTION
- BOAT RAMPS
- RESERVOIR SLOPE PROTECTION
- LAKE SHORELINE PROTECTION
- BRIDGE ABUTMENT PROTECTION
- DYKES PROTECTION
- DAM CRESTS AND SPILLWAYS
- WEIRS AND OVERFLOW CHANNELS

BY

ARMORTEC™

EROSION CONTROL SOLUTIONS

Armorflex – strength with flexibility

The best designs are simple. Armorflex is no exception. In fact, the perfection of its design has led to its current position as one of the most popular systems used today to control erosion caused by wave action.

A machine-compressed cellular concrete block, Armorflex has a unique interlocking shape – which provides great strength when laid, yet makes it remarkably flexible during installation.

Armorflex mats are manufactured and assembled in our UK factory, where the blocks are linked longitudinally by means of galvanised wire cables or polyester ropes. The horizontal linkage is made by means of an interlocking stretcher bond.

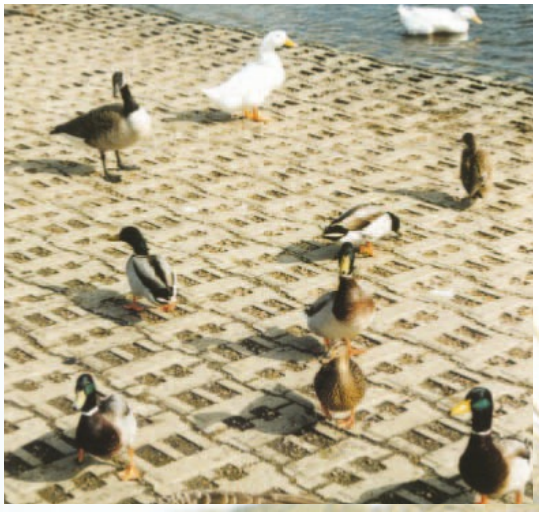
The made-up mats are then delivered to the site where suitable lifting equipment is provided.

But what about the environment? "Concrete can't be considered when a 'green' solution is desired." Nothing could be further from the truth. One of the great benefits of Armorflex is the way its open structure can actively encourage plant growth when used on canal and river banks. This not only acts as a secure binding agent but can also hide the original structure below a lush cover of vegetation. Armorflex can therefore provide a truly green solution.

With an array of important features, Armorflex is the right solution for a wide range of erosion control problems.

Quality

The blocks are produced using sophisticated, purpose-built machinery to ensure the consistent high quality commensurate with its specification: sulphate-resistant to Grade 2, for excellent durability in service.



Design features

Up to 35% of the surface area can be open by making two rectangular cells within the blocks. This permits free drainage of ground water, thus preventing a destabilising build-up of back-pressure behind the revetment and permits the establishment of indigenous vegetation.

The unique double taper on the sides of the block also greatly enhances the 'friction interlock' when the revetment is blinded with the specified granular mixture.

(Refer to H.R. Wallingford Revetment systems against wave attack - a design manual)

The mats are fully interlocked transversely, so adjacent mats can be butted against each other without discontinuity. Furthermore, mats may be linked both longitudinally and transversely for more aggressive situations. A range of mat weights, from 140 – 435 kg/m^2, enables the optimum weight to be chosen for each design requirement. Solid blocks are also available.

Easy installation

Laying is comparatively quick, 150 m^2 per hour for a 4-man team plus crane can easily be achieved.

Plenty of help

Extensive research has been carried out in the Netherlands, the USA and the UK and design recommendations can thus be made on the basis of extensive trial data and experience.

Armortec does more than provide you with the product. Our Field Engineers will help you select the right product for your particular situation and will assist with on-site advice during the installation.

Moreover, Armortec supplies a wide range of geosynthetic fabrics enabling the best possible solution to be chosen by the designer every time.

Armorflex – a quality pedigree

Armortec has carried out extensive research into wave and open channel flow conditions on Armorflex in the United States and the Netherlands. Design manuals and computer programs are available to assist in the proper Armorflex block selection for your hydraulic conditions. Design recommendations can thus be made on the basis of specific research data and sound engineering principles.

Since the early 1980's, Armortec has initiated and participated in a wide range of research projects to evaluate the performance of Armorflex, including the following:

1. Tetratech model tests – California, USA.
2. Lelystad field trials, Netherlands – Rijkswaterstaat Directorate of the Zuiderzee Project, 1982.
3. Wave attack tests, Report No. M1910 – Delft Hydraulics Laboratory, 1982.
4. Hartel Canal Trials – Rotterdam Public Works Laboratory and Delft Soil Mechanics Laboratory.
5. River Waal Breakwaters, Arnhem – Rijkswaterstaat, 1983.
6. CIRIA Report 116 Design of reinforced Grass Waterways.
7. Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow, Colorado State University 1988-2002.

Design assistance

A computer program produced by the Armortec Corporation can be utilised to give valuable assistance at the design stage as well as providing 'in-use' statistics which demonstrate the product's merits.

Installation couldn't be faster or easier

Prior to laying Armorflex, the subgrade must be profiled to line and level and compacted where necessary. As the mats are articulated and will adapt to any profile, great care is necessary at this stage. A geosynthetic fabric is then laid on the profiled surface.

The mats are delivered to the nearest hard road on 40' trailers containing 60 to 180m^2 per load, with the geosynthetic and the lifting beam delivered on the first vehicle. On suitable sites the delivery can be phased so that mats can be offloaded directly from the road vehicles onto the prepared subgrade.

If the revetment has a gradient of 1:2 or steeper, the mats may slide on the geosynthetic fabric until the system settles and vegetation begins to grow. Temporary anchorage can be achieved by means of wooden pegs driven at 0.6m centres along the top of the mats. Permanent anchorage for special installations can be achieved using ground anchors and non-corroding cables.

Mats subject to wave attack should be blinded with a 5mm to 30mm sand/gravel mixture with a D_{15} of 5mm. Above the normal waterline, mats may be topsoiled and seeded to give a 'green' effect.

Filling volumes are as follows:

Armorflex 140 – 0.02 m^3 per m^2
Armorflex 180 – 0.03 m^3 per m^2
Armorflex 220 – 0.04 m^3 per m^2
Armorflex 165 – 0.01 m^3 per m^2
Armorflex 215 – 0.012 m^3 per m^2
Armorflex 305 – 0.015 m^3 per m^2
Armorflex 435 – 0.023 m^3 per m^2

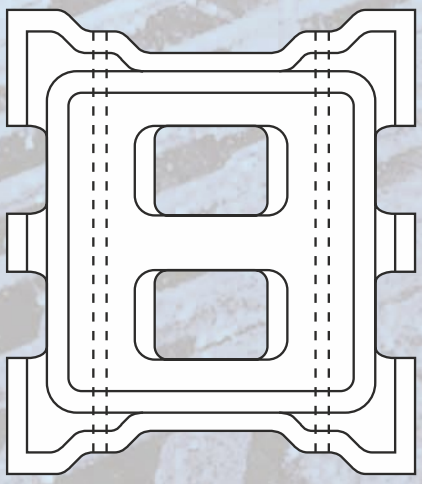
Product Advice

Our Field Engineers will help you select the right product for your particular installations and will assist with on-site advice during the installation.

Summary of benefits

Armorflex is a flexible, interlocking matrix of concrete blocks of uniform size, shape and weight connected by a series of cables which pass longitudinally through preformed ducts in each unit. **Armorflex** is installed over site-specific filter fabric on a prepared surface. **Armorflex** revetment systems combine the favourable aspects of lightweight blankets and meshes, such as porosity, flexibility, vegetation encouragement and habitat enhancement with the nonerodable, self-weight and high tractive force resistance of a rigid lining.

Armorflex has proven to be an aesthetic and functional alternative to dumped stone riprap, gabions, structural concrete and other heavy-duty, durable erosion protection systems. **Armorflex** is easy to install, therefore, can dramatically reduce overall project costs. More specifically, when compared to other revetment systems, life-cycle costs have been reduced because **Armorflex** is a permanent system and saves on subsequent maintenance expenses.



Resistant to wave attack

Prefabrication at works for fast site installation

Underwater installation possible

Economical and easy to handle

Advanced design – interlocking blocks and double-taper for greater strength

Different weights and sizes available for optimum design

Encourages plant growth – environmentally acceptable

Mats can be lifted and re-used

Resistant to frost

Flexible: will accommodate variations in profile

Specifications

Concrete cube strength: 50 N/mm^2 at 28 days
Sulphate resistant to Class DS-2.
Cables: galvanised or polyester.
Mat sizes 6 x 2.4m, 6 x 1.2m, other lengths available.
(see also detailed specification sheet)

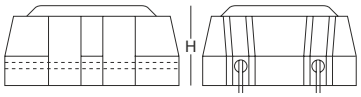
Cellular block mats

Armorflex 140
L x B x H: 340 x 400 x 85mm
Block weight: 17.5kg each
Unit weight: 140kg/m^2
Open area (max.): 35%

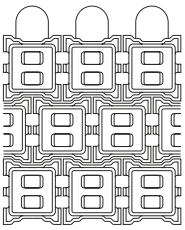
Armorflex 180
L x B x H: 340 x 300 x 120mm
Block weight: 17.3kg each
Unit weight: 180kg/m^2
Open area (max.): 35%

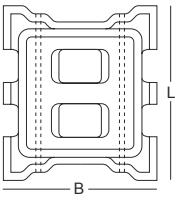
Armorflex 140S
L x B x H: 340 x 400 x 90mm
Block weight: 19kg each
Unit weight: 150kg/m^2
Open area (max.): 35%

Armorflex 220
L x B x H: 340 x 300 x 150mm
Block weight: 21.9kg each
Unit weight: 225kg/m^2
Open area (max.): 35%



Cellular block Cable ducts





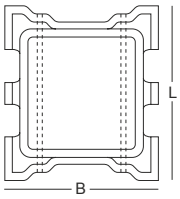
Solid block mats

Armorflex 165
L x B x H: 340 x 400 x 85mm
Block weight: 20kg each
Unit weight: 160kg/m^2
Open area (min.): 6%

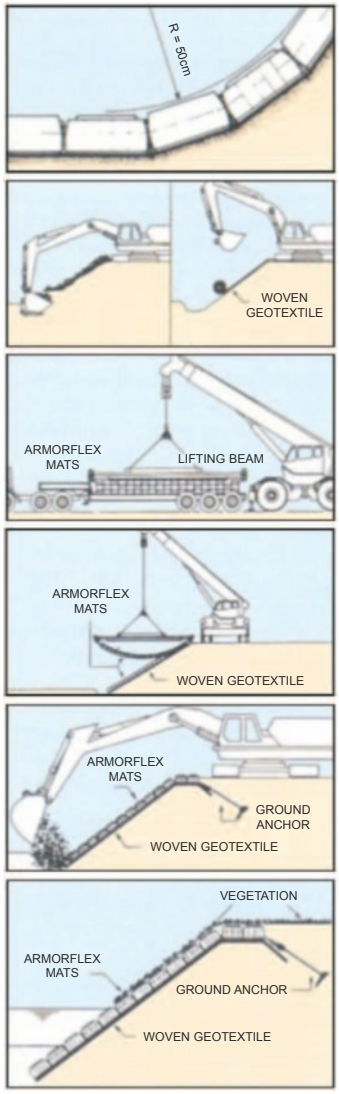
Armorflex 305
L x B x H: 340 x 300 x 150mm
Block weight: 26.7kg each
Unit weight: 285kg/m^2
Open area (min.): 6%

Armorflex 215
L x B x H: 340 x 300 x 120mm
Block weight: 21kg each
Unit weight: 220kg/m^2
Open area (min.): 6%

Armorflex 435
L x B x H: 340 x 300 x 225mm
Block weight: 41kg each
Unit weight: 435kg/m^2
Open area (min.): 6%



Also refer to:- Revetment Systems against wave attack – a design manual. Hydraulics Research, Wallingford.



Wave attack data

The following table is based on Delft Hydraulics Laboratory Report M 1910 and is intended to offer a guide to designers. Designs for specific projects can be prepared using the report itself.
The table assumes the following data:

a) Revetment slope 1 in 3.
b) No reinforcement effect from cables (assumed corroded).
c) Revetment blinded with sand/gravel mixture after installation.
d) Irregular wave pattern Tp = 3.75 secs (most damaging period found in tests).

Armorflex type	Significant Wave Height Hs	Maximum Wave Height H max
140 Cellular	1.0m	1.2m
180 Cellular	1.3m	1.5m
220 Cellular	1.6m	1.8m

NB. Run-up Cellular blocks mats can reduce wave run-up by 30% as compared with smooth revetment. This may enable a reduction in the height required for the protected area.

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