HR Wallingford
Working with water

Isles of Scilly - Design Services for Off Islands Coastal Erosion Defence and Dune Management

Construction Specification

DKR6499-RT010-R02-00

10 August 2022

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1 Scope of this document

This document is a Specification which covers the design, supply, installation and construction relating to the construction works associated with the Design Services for Off Islands of Scilly Isles - Coastal Erosion Defence and Dune Management, construction contracts and should be read in conjunction with the documents set out in Section 2.

In the event of any conflict with other requirements, obtain formal clarification from the EMPLOYER.

2 Reference documents and data sources

2.1 Reference documents and drawings

The CONTRACTOR shall comply with any local rules or regulations specified in this document.

Besides the international codes, standards, and regulations, compliance is required with all UK laws and Regulations, which are applicable at the installation site. All applicable codes, standards and regulations comprise the appendices, amendments, supplements, revisions, etc. Unless otherwise specified herein, the CONTRACTOR is to use the latest edition. The Rock Manual, (CIRIA; CUR; CETMEF, (2007)) is referenced in detail in this document. The CONTRACTOR is expected to possess a copy of this document on site.

This specification should also be read in conjunction with all documents issued with the CONTRACT including the engineering documents below.

Table 2.1: Reference Engineering Documents

Report Number	Title
DKR64499-RT001	Site Visit Note
DKR64499-RT005	Detailed Design Report - St Agnes
DKR64499-RT006	Detailed Design Report - Bryher
DKR64499-RT007	Detailed Design Report - St Martin's

The following specifications should also be read in conjunction with this document.

Table 2.2: Construction Specifications

HR Wallingford Report Number	Title
DKR6499-RT008	General Specification
DKR64499-RT010	Construction Specification (This document)
DKR64499-RT011	Specification for Ground Investigations

This report should also be read in conjunction with all drawings issued under this contract and the works shall be constructed in accordance with the CONTRACTORS's own requirements but as a minimum are to comply with the requirements of this specification.

2.2 Abbreviations/Acronyms

Abbreviations are given below.

CD	Chart Datum
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHW	Mean High Water
MLW	Mean Low Water
ODN	Ordnance Datum Newlyn
QMS	Quality Management System
QSE	Quality Safety and Environment
SLR	Sea Level Rise
SWL	Still Water Level
UKPC	United Kingdom Climate Projections

2.3 Definitions

The following terms shall have the meanings stated:

Revetment	means any type of armoured slope protection designed to withstand wave action or high flows.
Armour	means rock or concrete placed on the face of a breakwater in pieces large enough to withstand movement by waves.
Aspect Ratio	of a piece of rock means the ratio between the length, l, (defined as the greatest distance between two points on the stone, e.g., diametrically opposite corners of a cuboidal block) and the thickness, d, (the minimum distance between two parallel straight lines through which the stone can just pass).
Quarried stone	means broken natural stone that is coarser than road stone.
Graded quarry stone	means quarried stone which is graded by sieve sizes or by weight of the stone.
Light-graded quarried stone	means a quarried stone grading which is determined by weight or size of stone for weights less than 300kg.
Heavy-graded quarried stone	means a quarried stone grading which is determined by weight for stones of at least 300kg.
Stone fragment	means a piece of stone in a grading with a lesser weight or size than the extreme lower class limit (ELCL) for that particular grading class.
Effective mean weight, W_{em}	means the arithmetic average weight of all blocks in a sample excluding any stone fragments.
Load of quarried stone	means the quantity of quarried stone per unit of transport.
Producer	means the organisation that operates the production of rock materials from the quarry.
Supplier	means the organisation which supplies, including transporting, the rock from the quarry to the construction site. This may be the Producer, an independent organisation, or the Contractor.
ELL	Extreme lower limit (see BSEN13383).
NLL	Nominal lower limit (see BSEN13383).
NUL	Nominal upper limit (see BSEN13383).
EUL	Extreme upper limit (see BSEN13383).

3 Excavation and earthworks

3.1 Excavation generally

Excavation shall be undertaken in all material by whatever means necessary, to the lines and levels shown on the Drawings, or as ordered by the ENGINEER. Slopes and formation surfaces shall be trimmed true to the required profiles.

3.2 Site clearance

Trees, shrubs, hedges, walls, buildings and other items which are to be preserved as indicated on the Drawings or instructed by the ENGINEER shall be protected from injury or damage arising from the operations of the Contractor, his subcontractors and other persons under his control and from any other injury or damage which is the responsibility of the CONTRACTOR under the Contract.

Where vegetation is to be removed and replanted the CONTRACTOR shall excavate as directed by the ENGINEER and place in designated storage areas and be maintained until they are to be replanted. Debris, loose soil, contaminated soil, organic material, rubbish and the like shall be removed.

Where underground structures, manholes, wells and similar items are discovered, their presence shall be reported immediately to the ENGINEER and they shall not be further disturbed until the ENGINEER has given instructions for their disposal.

Where such underground structures, manholes, wells and similar items are demolished and removed from areas which are to be occupied by other Works, any holes or depressions resulting from such removal shall be filled with material similar to that in the surrounding ground and compacted to a density equal to that of the surrounding ground unless other treatment is shown on the Drawings or instructed by the ENGINEER.

The Contractor shall lift and remove to a place off the Site all seaweed, vegetation, other organic matter, rubbish and any other unsuitable overburden overlying or contained within the work area. The Contractor shall also take such measures as may be necessary to prevent the build-up of seaweed, vegetation, other organic matter and rubbish in the area being reclaimed during the course of the work.

Combustible material arising from site clearance shall not be burnt on Site. Non-combustible material shall be disposed of as spoil.

All removable items which are to be preserved in accordance with the Drawings, the Specification or the instructions of the ENGINEER shall be stored on Site in a place of safety and in a manner appropriate to their nature. All such items shall remain the property of the EMPLOYER.

3.3 Supports to excavations

The responsibility of the Contractor for the safety and care of the Works under the Contract shall include taking the following measures:

- The Contractor shall excavate the sides of excavations which are not positively supported to slopes which will remain stable;
- The sides of excavations which are not cut to a stable slope shall be properly and adequately supported to the extent necessary to ensure stability during the period of construction of the Permanent Works and the excavation shall then be backfilled unless otherwise indicated on the Drawings;
- No materials, plant or other load shall be placed so close to any excavation that the stability of the sides of the excavation is endangered;

- The CONTRACTOR shall remove or otherwise secure by barriers, nets or other means any material which might fall and thereby cause damage to the Permanent Works or injury to any person.

The CONTRACTOR shall be responsible for the installation and subsequent removal of all necessary sheeting, timbering, strutting, shoring and the like to secure the excavations, to prevent any movement of adjacent ground and to ensure the safety of workmen and freedom from damage to structures, buildings, streets, sewers, drains, walls, services or any other thing.

3.4 Slips and over-excavation

The CONTRACTOR shall avoid excavating beyond the lines and levels shown on the Drawings, disturbing ground adjacent to excavations, or damaging material beyond the limits of the required excavation.

Slippage, over-excavation and damaged areas shall be made good to the satisfaction of the ENGINEER. In the case of surfaces on which or against which the Permanent Works are to be constructed, the remedial work shall comprise replacing the slipped, over-excavated or damaged material with suitable filling material or with other material (e.g. concrete) as instructed by the ENGINEER.

Slips, falls, subsidence and other damage which have the effect of removing or reducing support to existing or proposed structures, services and the like shall be made good in a manner acceptable to the ENGINEER.

In the case of permanently exposed surfaces, remedial work shall comprise replacing and compacting material similar to that which has been removed in order to provide a surface not less satisfactory than adjacent correctly excavated surfaces. If this is not possible, remedial work shall be as instructed by the ENGINEER.

3.5 Disposal of excavated material

Unless areas within the Site have been agreed by the ENGINEER as spoil areas, all spoil shall be disposed of in areas to be found by the CONTRACTOR outside the Site.

Temporary stockpiles of material for later use in the Permanent Works shall be formed with side slopes which will remain stable under all conditions to which they will be subject and the tops shall be graded to prevent the ponding of water.

Different materials shall be placed in separate stockpiles unless otherwise agreed by the ENGINEER.

3.6 Borrow areas

Borrow areas within the Site which are not required to be backfilled shall be excavated with side slopes which will remain stable under all conditions to which they may be subject. All excavated surfaces shall be finished neatly to the lines and levels instructed by the ENGINEER.

Excavated surfaces which will remain permanently exposed on completion of the Permanent Works shall be cleared of all loose material, pieces of rock, debris, rubbish and the like.

3.7 Filling and compaction

Fill shall be selected clean material free from organic matter, debris, rubbish, contaminated soil and the like. Fill shall be sourced either from excavated material or imported to match existing material on site. Imported material to be stored as per the requirements of Section 3.5 and is to approved by ENGINEER prior to placing. Fill shall be hand compacted in layers not exceeding 300mm and to a density as approved or determined by the ENGINEER.

3.8 Seeding

Where identified on relevant drawings or scope of work, seeding of native plants is to be undertaken. The seed mix is to be approved by the ENGINEER following relevant stakeholder consultation.

4 Armourstone

4.1 General construction requirements

4.1.1 General

The Contractor shall submit details of the methods he proposes to adopt and the Construction Plant he proposes to employ.

4.1.2 Access to the works

Site access and working areas are described in the contract.

Delivery methods and routes are to be advised by the CONTRACTOR for approval by the EMPLOYER.

The site is exposed to the sea. The CONTRACTOR's attention is drawn to the potential for beach and seabed level fluctuations as a result of waves and current action.

4.1.3 Transportation and stockpiling of additional armourstone

Any additional armourstone shall be transported to the site of the permanent works along an approved route. The Contractor shall:

- Trucks used to transport armourstone for this Project shall be of a type specifically constructed for hauling armourstone and shall have tail boards or scow-ends. If transporting heavy armourstone on flat top wagon, proper chains and slings shall be used and verified before it leaves the quarry to ensure optimum security. No other mode of armourstone road transportation may be employed unless first approved by the ENGINEER and the relevant Authorities.
- Ensure all barges are seaworthy and have the necessary safety certificates and insurance issued by the relevant Authorities. Permission for safe mooring of sea transport vessels shall be obtained from the relevant Authorities. The Contractor (or supplier if armourstone delivery is sub-contracted to a supplier) shall have an emergency procedure in place should there be an imminent threat of sea and wind conditions beyond the safe mooring design conditions.
- Subject to the approval of the ENGINEER, the CONTRACTOR may be permitted to stockpile armourstone at or near the site of the permanent works. Separate stockpiles shall be made and identified for different grades of armourstone and filter material. Stored materials shall not obstruct normal access to the beach by pedestrians and boat users, to public footpaths by pedestrians, and for emergency access. The stockpiles shall be formed so that they do not constitute a hazard; the locations, side slopes and heights and other factors affecting safety shall be as approved by the ENGINEER.

4.1.4 Data to be submitted by the supplier at delivery of additional armourstone

The Contractor shall provide a certificate of origin submitted by the Producer, in accordance with BS EN 13383-1:2002, for each load of a consignment of quarried stone. The following data shall be included on the Certificate:

- The Project Title;
- The name of the Producer;
- The name and location of the quarry or other source where the grading has been produced;
- The designation of the grading;
- The weight of the load;
- The delivery date;
- The name of the vessel or the registration number of the road transport vehicle that delivered the rock;
- A reference to this standard.

4.1.5 On-site inspection

The Contractor shall provide all necessary facilities for any on-site inspection, categorisation, and approval/rejection activities on materials.

4.2 Rock sources

The CONTRACTOR shall be responsible for locating and making arrangements for the supply of the required quantities of rock to the specified quality and gradings. All costs incurred in locating and delivering such supply, shall be included in CONTRACTOR's tendered rates and prices. The source of materials shall be subject to the ENGINEER approval.

It is expected to use some of the rock at the site. However, depending on CONTRACTOR's own assessment, further quantities may be required. It is assumed that rock will be sourced from Cornish quarries such as West of England Quarry (COLAS) though the CONTRACTOR may propose alternative source for the rock.

For all works, it is essential that materials are separated and placed according to their respective sources (i.e. density) as the design section differs for each source. Material from one source shall not be placed in a Section designed for another source.

Prior to delivery to WORKSITE, the CONTRACTOR shall certify that the rock meets the requirements of this specification. Before any rock is used, the CONTRACTOR shall carry out such test that may deem necessary to satisfy the ENGINEER that the rock is of suitable quality and not liable to deterioration when placed in its intended environment.

The CONTRACTOR shall also satisfy himself regarding the quantities of the various rock materials existing on site and shall provide sufficient rock to complete the works in accordance with this specification.

4.3 Material specification

The rock armourstone material shall be in accordance with BS EN 13383 Parts 1 & 2. For the avoidance of doubt LMA and HMA is armour used in the cover layer and LMB and HMB is armour rock used in the underlayer.

In particular the following four parameters shall be defined for each grading in accordance with BS EN 13383: ELL – extreme lower limit, NLL – nominal lower limit, NUL – nominal upper limit, EUL – extreme upper limit.

The rock material and sampling shall be in accordance with the values specified in Table 4.1.

Table 4.1: Rock specification Category to BS EN 13383

Properties		
Gradings		
Light gradings	For use in armour layers, including toe protection: For use in underlayers or filters: Category $LMB_{60/300}$ in accordance with BS EN 13383-1:2002, Table 3 or declared if non-standard grading.	
Heavy gradings	For use in armour layers: Category $HMA_{300/1000}$ in accordance with BS EN 13383-1:2002, Table 4 Category $HMA_{1000/3000}$ in accordance with BS EN 13383-1:2002, Table 4	
Shape	In accordance with BS EN 13383-1:2002, Table 6 for category LTA.	
Proportion of crushed or broken surfaces	In accordance with BS EN 13383-1:2002, Table 7: Where quarried boulders are used, Category RONR. Where river boulders are used, Category RO5.	
Particle density	In accordance with BS EN 13383-1:2002, Table 8, the minimum value of x shall be 2900 kg/m3	In accordance with BS EN 13383-1:2002, Table 8, the minimum value of x shall be 2650 kg/m3
Resistance to breakage	In accordance with BS EN 13383-1:2002, Table 9 for category CS80	
Resistance to wear	In accordance with BS EN 13383-1:2002, Table 10 for category MDE20	
Water absorption to BS EN 13383-2:2000, Clause 8	In accordance with BS EN 13383-1:2002, Table 12 for category WA0.5	
Resistance to salt crystallisation, where WA exceeds 0.5	In accordance with BS EN 13383-1:2002, Table 14 for category MS25	
Block integrity	The rock shall comply with the requirements in the advisory Note in Section 5.3 of BS EN 13383-1:2002.	

Before any rock is used the Contractor shall carry out such tests to prove the material properties given in Table 4.1. to satisfy himself that the rock is of suitable quality and not liable to deterioration when placed in its intended environment include undertaking Sonic Velocity or Drop tests.

For all material, whether on site or imported or drawn from stock piles, one set of tests shall be undertaken as follows, as required for The Rock Manual:

- Minimum one test of integrity tests for every 10,000t of each source and each grade (minimum 4No tests for each source and 4No test for each rock grade); and,
- Minimum one set of grading tests for every 3,000t for each source and each grade (minimum 4No tests for each source and 4No test for each rock grade).

The samples shall be taken from different locations in the stock piles for each source and each grade to ensure good representation of the material source.

The test results shall be submitted to the EMPLOYER for approval. If the material shows significant variability then the Engineer may instruct further testing to be undertaken check integrity and grading. The required gradings are as stated on the Contract Drawings.

4.4 Placement

4.4.1 General

At least 30 days before commencement of the construction work the CONTRACTOR shall submit to the ENGINEER for his approval full details of his proposed method of forming the Works to the profiles indicated on the Drawings (to be prepared after the pre-construction survey).

The CONTRACTOR shall not commence any Permanent Works until the ENGINEER has approved in writing the Contractors working method for forming the Works.

The CONTRACTOR should take measures to protect any structures which are vulnerable to damage until protected by the permanent works.

During the course of the Works, the sequential placing of individual armourstone gradings shall proceed as closely-spaced defined fronts in only one grade of material as required at each front location. At each location, construction with material associated with the placing of the next front is only permitted to proceed upon approval by the Engineer of the previous front.

Placing of materials shall be one continuous operation, to ensure that none of the underlying layers is left unprotected over a distance greater than agreed or for a duration greater than agreed between the CONTRACTOR and the ENGINEER. If the operation has to be interrupted, temporary protection of the underlying layers shall be provided with the same material as to be used for the permanent works.

Sand (stent) material excavated for the placement of the armour shall be stockpiled for reuse in the works.

4.4.2 Survey

Before placing armourstone the CONTRACTOR shall:

1. Submit to the ENGINEER for approval, details of the survey methods to be adopted to ensure accurate setting out, alignment, level and cross-sectional control during construction of all parts of the Works that involve armourstone.
2. Carry out initial ground, beach and sea bed survey lines at 10 metre centres, or other closer spacing if required, extending for at least 10 metres outside the intended toes or other edges of the parts of the Works that involve armourstone. A land-based survey shall be carried out with a staff fitted with a foot plate of at least 50 cm^2.

Measurements of armourstone layers and other structures containing armourstone shall be carried out using a probe with a spherical foot of diameter 0.5Dn50 unless for reasons such as health and safety, an alternative method is deemed necessary e.g. for certain gradings of heavy armourstone. If the Contractor intends to use an alternative method to the spherical foot probe, the alternative method for obtaining individual armourstone surface heights across the profile shall be submitted to the ENGINEER for approval. This submission shall include the conversion factor to be used to relate the reference levels in the design drawings (these assume a spherical foot probe survey) to levels that would be measured by the alternative method.

[NOTE: Table 9.9 of the Rock Manual provides recommended factors for orthogonal thickness corrections using two alternative survey systems for double rock armour layers].

In this specification, Dn50 is the nominal stone diameter for the median armour size for the grading (m), and shall be calculated as the cube root of the volume of the stone, VT (m3). The volume shall be calculated by dividing the mass of the median stone, M50 (kg), by the apparent mass density of the stone, ρapp (kg/m3). For the purposes of calculations in this construction specification only, the mass of the median stone may be

assumed to be close to the average of the nominal upper and lower limits of the grading: M50 = (NUL + NLL)/2. Stone density values for zero saturation are applicable for such mass values.

When above water survey measurements are based on fixed interval methods, measurements shall be carried out at the following intervals across the measurement profile:

- Coarse and light grading: 1 m to 2 m;
- Heavy grading: 0.75Dn50.

Measurement profiles shall be at intervals along the length of the structure (breakwater, seawall, etc) approved by the ENGINEER. These will generally be every 10 m, but may need to be more frequent where the profile is changing rapidly or on tight-radius curves; for example, on breakwater roundheads, radial sections at every 15 degrees from the centre of the roundhead shall be taken. The CONTRACTOR shall provide and maintain chainage markers at the approved measurement intervals along the lines of the parts of the Works that involve armourstone. Chainage markers should be visible from both the land and seaward side of the structure.

Surveyed sections shall extend to a distance of 5 m seaward of the as-constructed toe and 2 m for the other edges or up to the seawall whichever is the lesser.

No layer shall be covered by a subsequent layer until the profile of the former layer has been approved by the ENGINEER. The CONTRACTOR shall give an agreed minimum period prior notice of survey to the ENGINEER and shall provide facilities for his attendance during surveys. The minimum period shall take into account the working method, sea state and current conditions.

[Further details of survey techniques are given in Section 9.9.8 of the Rock Manual.]

4.4.3 Test panel or test section

As explained in Section 9.8.4 of the Rock Manual, test panels or test sections are a very useful way of testing and reaching agreement on the form of construction (including placing, packing and the resulting surface profiles).

At the commencement of constructing each new section of works that involve armourstone, the Contractor shall as required by the Engineer, construct a test panel or test section of structure, which shall be used to demonstrate the quality of placing of armourstone for all layers including the core, scour apron, under layer(s) and armour layer, for approval by the Engineer. For structures or parts of structures above water, a 10 m length (commonly designated as the ‘test panel’) may be adequate. The Contractor shall obtain approval of each layer or element prior to commencing subsequent elements and shall make any adjustments necessary to obtain the Engineer’s approval.

For each approved test panel or test section, the Contractor shall record accurately for agreement:

1. The grading of each armourstone class used;
2. The quantity (tonnes) and volume (m^3) of material used in each armourstone class;
3. In addition, for cover layer, the slope area covered and the number of piece of armourstone placed.

The significance of these quantities is explained in the Rock Manual.

During the progress of the Works, the Contractor may, from time to time, be required to demonstrate that the placed packing density being achieved is in accordance with the approved test panel for that particular section of the Works. The visual quality achieved in test panels shall be maintained throughout the remainder of the Works. Areas of placed armourstone that show an appearance distinguishably different from the agreed test panel in terms of quality of the construction finish, may be rejected. Block counting methods (see Rock Manual) may be used to further substantiate grounds for rejection or acceptance by the Engineer. Rejected panels shall be reworked until test panel quality is achieved.

4.4.4 Working near the water environment

Subject to complying with the general survey requirements above, each placed layer shall be protected by the subsequent layer (as indicated on the drawings) as soon as possible after placement. A maximum length of each material of 10 metres should be left unprotected, in order to minimise wave damage in the event of storms during the construction period.

The Contractor shall make good any location where material has been eroded by wave and/or current action or removed by other cause before placing the appropriate material for the overlying (protective) layer.

Notwithstanding the above, the Contractor shall take all reasonable care to avoid disturbing a previously placed layer by avoiding dropping armourstone or any other potentially disturbing placing methods.

Preference will be given by the EMPLOYER to methods of working that progress from undesirable siltation in the work area prior to stone dumping/placing.

For work above low-tide level, sufficient fine material on the surface of already placed stones (including stones within the layer being placed) shall be removed from those areas where surface contact will arise between the stone being placed and those already placed to ensure sound bearing and interlock between stones. The Contractor shall make due allowance for the removal of such fine material.

4.4.5 Placing of cover layer armourstone

Armourstone placing for the cover layer shall comply with the following requirements:

1. Heavy armourstone defined in EN 13383-1 or with a NLL > 300 kg) shall be individually placed to achieve a dense, fully interlocked armoured slope so that each armour stone is securely held in place by its neighbours. Placing shall commence at the toe and proceed upwards towards the crest. Stones shall be lowered into place individually. Stones shall be placed in such a way that they obtain their stability from interlocking and frictional resistance, and not from friction on one plane alone. Light armourstone (as defined in EN 13383-1 or with a NUL < 300 kg) may be placed with several stones at a time.
2. Tipping of armourstone from vehicles, or bulldozing or dumping from hoppers or barges into final position shall not be permitted without the prior approval of the Engineer. Such permission may only be given following placing trials.
3. Placement of the cover layer shall be STANDARD PLACEMENT methods described in the Rock Manual - Section 9.8.1.1 and as summarised below to achieve a minimum ‘three-point support’ and be stable to the lines and levels shown on the drawings.

Box 1 – Definition of placement types

Random placement is without control of orientation and should not be assumed to be any tighter than would be expected if the blocks were placed out of view underwater by single cable release from a crane using a spatial positioning grid.
Standard placement is where minimum orientation control is applied so that the block attitude is effectively governed by its orientation in the stockpile before lifting. However, a minimum of three points of contact within the layer being placed should be ensured, i.e. excluding blocks effectively beneath.
Dense placement involves the rotation of stones until the orientation achieved is expected to give the maximum number of point contacts and minimum voids. Individual stones are removed and replaced if necessary.
Specific placement is used when the procedures coupled with stone shape constraints are specified to be other than random, standard or dense.

4. Unless otherwise stated, the surface of the armoured slope shall present an angular uneven face to the water to achieve the desired energy dissipation of waves. Pieces of armourstone smaller than the equivalent of the ELL value of the grading shall not be used to fill interstices, or to prop larger stones in order to achieve the required profile.

5. Pieces of armourstone broken during handling or placing shall be removed immediately at the Contractor's expense. Subject to the Engineer's approval, broken pieces of armourstone may be included in smaller gradings.
6. Any void below the finished profile level as shown on the drawings (but modified according to survey technique as set out in Section 6.2 above) in excess of 0.75Dn50 shall be filled with an appropriate stone or stones. Determination of the acceptability of any void shall be by means of use of the survey probe or other a test sphere or cage of diameter 0.75Dn50.

Vertical achievable placing tolerances for rock armour shall be in accordance with Table 6.1. Measurement shall be in accordance with Section 6.2 with profiles taken at 10 m intervals along the length of the structure.

Table 4.2: Vertical placing tolerances for placing armour layers

	Dry, i.e. above low water, placed using land-based plant	Below low water placed using land-based plant	Below low water, placed by water-borne equipment
Maximum allowable deviations based on individual measurements (m)	±0.3 D_{n50}	±0.5 D_{n50}	±0.8 D_{n50}

Notwithstanding the above tolerances, the following criteria shall apply to the armourstone cover layer:

1. The tolerances on two consecutive mean actual profiles shall not be negative;
2. Notwithstanding any accumulation of positive tolerances on underlying layers, the thickness of the layer shall not be less than 80% of the nominal thickness when calculated using mean actual profiles.

4.4.6 Placing of armourstone in underlayer

Placing of underlayer shall comply with the following requirements:

1. Underlayer material shall be placed to achieve a dense underlayer but shall not be compacted.
2. Underlayer material shall be placed carefully to avoid damage to the surface below or to the geotextile if used. In the case of geotextiles, drop heights shall not exceed maximum allowable heights set out in Section 7.
3. Underlayer material shall be placed to achieve an even distribution of stone sizes without concentrations of smaller stone sizes.
4. Armourstone shall be placed to achieve a void porosity in the range of 35% - 40%. The stones shall be placed in such a way that they do not obtain their stability on a plane by frictional resistance alone, but also by interlocking. The Contractor shall take measures to ensure this prior to placing further stones. Tipping of armourstone for underlayers from vehicles, or bulldozing into final position, shall not be permitted without the prior approval of the Engineer. Such permission may only be given following placing trials.

Armourstone for underlayers shall be placed to the following tolerances:

1. The vertical placing tolerance of individually-placed underlayers consisting of heavy grading shall be the same as the tolerances for armourstone given in Section 4.8 of this Appendix.
2. The vertical tolerance of underlayers and core consisting of bulk placed armourstone shall be in accordance with Table 6.2 below.

Table 4.3: Vertical placing tolerances for bulk placed underlayers

Depth of placing	Coarse gradings	Light gradings (NUL < 300kg)	Heavy gradings (NLL > 300kg)
Placed with land-based plant above low water	+0.1m to -0.1m	+0.2m to -0.2m	+0.4m to -0.2m
Placed with land-based plant up 5 m below low water	+0.15m to -0.15m	+0.5m to -0.3m	+0.8m to -0.3m

4.4.7 Disposal of surplus material

With the exception of clean stent which shall be retained seaward of the Primary Wall, it shall be the Contractor's responsibility to remove from the site of the works all surplus material, rubbish, debris and material unsuitable for inclusion in the works and dispose thereof at an approved location.

5 Concrete

Concrete where included in the works is to be suitable for the marine environment. The design mix and method statement for the works should be provided to the ENGINEER for approval prior to any concrete pour and where possible pre-casting should be used to minimise concrete works on the islands. Lifting hooks, where used, are to be cut down to and the concrete filled with an approved high strength grout following placement of the precast units.

5.1 Concrete mixtures

5.1.1 Compressive strength

The required concrete and reinforcement grade, cover and exposure class are included on the relevant drawings together with any bedding requirements with the strength and specification requirements as below.

Concrete shall achieve a minimum 28-day compressive strength, f_{ck} in accordance with BS EN 206, not less than shown in Table 5.1.

Table 5.1: Minimum 28 day compressive strength

Group	Application	Exposure class	Concrete class[1]	f_{ck} (MPa)[2]
A	Reinforced concrete slabs	XS3	C28/35	28
B	Mass concrete blocks	XAS	C25/30	25

Notes: *[1]Concrete class is in accordance with BS EN 1992-1-1 with the first annotation for compressive strength in cylinders and the second annotation for compressive strength in cubes.*

[2] The minimum compressive strength of concrete (or 7-day compressive strength of high-early strength concrete) as determined by test on 150mm diameter by 300mm length cylinders.

Concrete specification shall comply with BS EN 1992-1-1:2004 and BS EN 206:2013 and present the following characteristics:

Table 5.2: Concrete composition after BS EN 1992-1-1

Minimum characteristic compressive strength:	C28/35	C25/30
- in cylinders	28	25
- in cubes	25	30

Minimum characteristic compressive strength:	C28/35	C25/30
Exposure class:	XS3	XAS
Chlorine content class:	0.3	1.0
Maximum aggregate size:	20mm	20mm
Fluidity – Slump class:	S3	S4
Maximum Water/Cement ratio:	0.45	0.55
Minimum cement (kg/m³):	360	300
Minimum air content	4.50%	-
Acceptable cements:	IVB-V, IIIB	IIB-V, IIB-V+SR, IIIA, IIIA+SR

Source: BS EN 1992-1-1:2004 and BS 8500-1:2015

5.1.2 Cementitious Materials

All cement for concrete shall conform to BS EN 197-1:2011 or performance based cements in accordance with BS EN 196, Parts 1 to 10 may be used subject to approval by ENGINEER.

The use of supplementary cementing materials, such as fly ash (EN 450-1), silica fume (EN 13263-1), and ground granulated blast-furnace slag (EN 15167-1) as a partial replacement for Portland cement may be used subject to approval by ENGINEER.

5.1.3 Aggregates

Coarse and fine aggregate for normal-weight concrete shall be in accordance with BS EN 17555, BS EN 12620 and lightweight aggregates in accordance with BS EN 13055:2016. The coarse aggregate shall be one of the following materials, in order of preference: (1) crushed stone, (2) crushed gravel, and (3) gravel.

All normal density aggregates shall be evaluated in accordance with BS EN 17555 for alkali-aggregate reactivity (AAR) with the proposed job cement. If the aggregate is found to have unacceptable expansion, steps must be taken to mitigate the expansion either by the use of low-alkali cement or supplementary cementing materials or both.

Maximum aggregate size shall not exceed 20 mm.

All aggregates must be free of alkalis and any other substance reactive to cement. In the material selection process, the CONTRACTOR must verify through tests approved by the Construction Manager, that the aggregates are free of these substances. It is not recommended the use of recycled aggregates.

5.1.4 Water

Water used in concrete shall be potable and not contain any impurities or chemicals deleterious to the concrete or reinforcement. Portable water shall meet the requirements of EN 1008:2002.

5.1.5 Chemical Admixtures

Use of admixtures requires approval of ENGINEER.

Admixtures shall be in accordance with BS EN 934 parts 1 to 6.

For concrete subjected to cycles of freezing and thawing, air-entraining admixtures shall be used to provide an entrained air content in the concrete of 6 ± 1%.

Calcium chloride or any other chloride-based admixtures shall not be used.

5.2 Reinforcement

1. All reinforcement shall be new material.
2. Reinforcing bars shall conform to the requirements of BS EN 10080:2005, BS 4449:2005 (Grade B500H).
3. The use of T-headed bars for shear reinforcement and bar end-anchorage shall be permitted only with prior approval of EMPLOYER. The use of stud-rails for shear reinforcement in flatwork shall be permitted only with prior approval of EMPLOYER.
4. Welded wire reinforcement shall conform to BS 4483:2005.

Steel or synthetic fibers may be used in lieu of welded wire reinforcement in flatwork in accordance with BS 4449:2005 subject to approval by ENGINEER. Guidance on the use of fiber reinforcement can be found in BS EN 14889-1:2006 and BS EN 14889-2:2006.

6 Rock bags

Rock bags are to be proprietary products to be submitted to the ENGINEER for approval. The bags are to be appropriate for a coastal environment and the material submission should include all relevant performance and durability specification information to demonstrate suitable for the design life of the CONTRACT WORKS. Product is to be an inert material and CONTRACTOR is to demonstrate environmental performance and durability over the design life of the works.

Rock fill is to be specified by the bag supplier to meet the grading included on the CONTRACT drawings but is assumed to be local screened rock approved by the ENGINEER. Where additional rock is required, rock shall be graded to the supplier's requirements and have minimum density of 2650 kg/m³.

Bags are to be transported, stored, filled, lifted and placed as per the manufacturer's requirements. Sample filled bags shall be prepared for ENGINEER approval prior to placement of first bag in the permanent works. The specification of the product included in the CONTRACT drawings is included as Appendix A.

7 Geotextiles

7.1 Geotextile filters

Geotextile filters shall be delivered to site in packaging, which will protect the rolls from ultra-violet light degradation. The labelling of the rolls shall clearly identify the product supplied in accordance with EN 10320: 1999. Geotextiles shall be protected at all times against physical or chemical damage. Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the works.

The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextiles.

The Contractor shall ensure that filter fabric is not exposed to direct sunlight for more than the number of days written in the geotextile CE certificate in accordance with EN 13253:2014 Annex B, or a maximum of one day if not tested.

The Contractor shall ensure that the geotextile complies with the requirements set out in the specification (or the manufacturers recommendations which ever more stringent), in particular regarding the appropriate functional characteristics, that the geotextile is sufficiently robust to withstand, without being damaged, the working method of placing the geotextile and the subsequent placing of the armourstone layer on top, and that it is durable for the lifetime of the project, specified elsewhere in the specification. The geotextile filters

shall be laid on prepared surfaces in accordance with the manufacturer's recommendations. On sloping surfaces, the fabric shall be laid with its longitudinal axis down the slope. The geotextile shall be installed in the positions and to the lines and levels described on the drawings. Folds shall be avoided to obtain the best contact between the geotextile and the material beneath to be filtered. Material that may be in contact with the geotextile shall not have protrusions, which are likely to damage the geotextile during installation or in service. Construction plant shall not operate directly on the geotextile.

Overlapping widths between adjacent sheets/rolls shall be adapted to compensate the risk of soil uncovering during its installation or during stone placement. Filter fabric shall be laid with minimum 1000 mm overlaps unless detailed or specified otherwise. Where fabric is laid under water and visibility is poor, i.e. the fabric cannot be seen clearly from the surface, then overlaps shall be increased to 2000 mm, unless the Contractor has other means of guaranteeing the minimum 1000 mm overlap. On sloping surfaces, the geotextile filter shall be laid to have overlaps parallel to the slope. The stitching of adjacent sheets in accordance with the manufacturer's instructions may be considered by the Engineer, as an alternative to overlapping.

Stones shall be placed on the geotextile filter from the bottom to the top of the slope. The placing method shall comply with the requirements of Section 6.5 of this specification. The Contractor shall adopt such placing method that moving of stones over the geotextile filter is prevented. The maximum drop height onto geotextile layers shall not exceed the following:

- 60 to 300kg, Drop height = 2.5m;
- 1-3t, Drop height = 1m.

The thickness of the stone layer shall be such that the geotextile filter is protected against direct UV exposure.

Fabric damaged or displaced before or during installation or during placement of overlaying material shall be replaced or repaired to the satisfaction of the Engineer at the Contractor's expense. The specification of the product included in the CONTRACT drawings is included in Appendix B.

Table 7.1: Geotextile properties

Physical Properties:					
Polymer type:	Prime-quality virgin polypropylene fibre containing 1% carbon black by weight.				
Geotextile type:	Needle punched non-woven fabric manufactured from mechanically entangled staple fibre.				
	Approved test method	Units	Typical Mean values required for following armour rocks (tonnes)		Allowable tolerance to 95% confidence limits
			0.06 - 0.3	1 - 3	
Thickness @ 2kPa:	EN ISO 9863-1: 2005	mm	4.9	7.8	+/-30%
Mechanical Properties:					
Static puncture strength (CBR)	EN ISO 12236	kN	5	14	-10%
Push-through displacement	EN ISO 12236	mm	65	65	n/a*
Tensile strength	EN ISO 10319	kN/m	30	75	-10%
Tensile elongation	EN ISO 10319	%	80	80	+/-30%
Cone drop perforation hole diameter	BS EN 13433	mm	5	0	+3mm
Filtration Properties:					
Water flow normal to the plane of the geotextile @50mm head	EN ISO 11058	l/s/m2	65	25	-30%
Characteristic opening	EN ISO 12956	µm	80	<69	+/-30 %

Physical Properties:			
size: 90% finer [O90]			
Durability (according to annex B: EN 13253):			
Resistance to weathering (UV) @ 50MJ/m2 radiant exposure	EN 12224	Retained Strength	>80%
Resistance to Oxidation (150 years)	EN 12225	Retained Strength after 84 days	>80%
Microbiological Resistance	EN 12225	Retained Strength	>80%
Resistance to liquids	EN 14030	Retained Strength	>80%

7.2 Geobags

Geobags are to be woven fabric material from an approved manufacturer. CONTRACTOR shall submit product for ENGINEER's approval including all relevant performance specification information. Product is to be a specialist geobag product suitable for coastal embankments. Product is to be an inert environmentally sound fabric and CONTRACTOR is to demonstrate environmental performance and durability over the required design life.

Bag dimensions should be as a minimum as are stated in the drawings, CONTRACTOR may propose bags of other dimensions for ENGINEER's approval. CONTRACTOR shall follow the manufacturer's guidance for transport, storage, filling, sealing and placing the bags. Fill material shall be from an approved on site source and shall be clean from rubbish, stones and other materials capable of penetrating the fabric.

Materials are to be stored on site as per the requirements of Section 7.1 and are not to be exposed to UV light for more than one day. The specification of the product included in the CONTRACT drawings is included in Appendix C.

7.3 Geomats

Geomats to reinforce embankments and encourage revegetation are to be from an approved manufacturer. CONTRACTOR shall submit product for ENGINEER's approval including all relevant performance specification. Product is to be an inert environmentally sound fabric and CONTRACTOR IS to demonstrate environmental performance.

CONTRACTOR shall follow the manufacturer's guidance for transport, storage and placing the mats.

Materials are to be stored on site as per the requirements of Section 7.1 and are not to be exposed to UV light for more than one day. The specification and environmental performance of the of the product included in the CONTRACT drawings is included in Appendix D.

8 Ground reinforcement grid

Gridded surfacing product to be suitable for road and agricultural traffic to be approved by ENGINEER. Product installation and foundations thickness and compaction to be as specified by supplier. Surface fill material to be reinstated sand excavated during the works.

Product is to be an inert environmentally sound material and CONTRACTOR IS to demonstrate environmental performance. The specification of the of the product included in the CONTRACT drawings is included in Appendix E.

9 Flood gate

Demountable flood gate to be supplied from an approved manufacturer. Gate is to be suitable for one individual to install and dismantle the barrier without assistance. CONTRACTOR will provide necessary training to the EMPLOYER for operation, storage and maintenance requirements.

Barrier supports and all preparation and foundation works to be carried out as per manufacturer's requirements. The supplier specification, installation guide and O&M manual are included as Appendix F.

Where existing concrete is broken out for gate installation, CONTRACTOR to make good as per the requirements included on relevant drawings.

10 Dune fencing

Dune fencing is to be a standard product from an approved supplier, comprising chestnut slats, tied together with tensioning wire. Support posts should be 1.2 to 1.5m high chestnut palings, 10cm diameter, with 3 strands of galvanised wire and no more than 50% porosity.

Support posts are to be at a maximum spacing of 1.8m and inserted at least 1m into the ground. CONTRACTOR to submit proposed supplier and product for EMPLOYER approval.

11 Temporary slipway

A temporary slipway is to be a proprietary product that has a minimum 25 year life span.

The slipway is to be an aluminium mat that can be rolled out and back up as required. The slipway is to carry an axle load of 13 tonnes. The slipway is to be a minimum of 3m wide and 10m long. CONTRACTOR to provide EMPLOYER with necessary training/demonstration for the roll out and removal of the product.

The slipway is to be capable of being rolled out and recovered by a small tractor or 4x4 vehicle and the slipway is to be provided with the necessary roll out and recovery equipment and straps that can be simply connected to the tractor or 4x4 with no additional fixtures or fittings.

Details of the product included in the CONTRACT drawings is included in Appendix G.

12 Finished levels

All works shall be completed to the levels shown on the drawings. Any settlement or subsidence that might occur during construction shall be corrected as approved or determined by the ENGINEER prior to handover of the finished works. The Contractor may over-fill to account for the anticipated future settlement with the approval of the Engineer.

Appendices

A Rock Bag – SALIX specification

iGG Internationale Geotextil GmbH	**Technical Data Sheet**	**AquaRockBag** **2T- AquaRockBag**

APPLICATION	River Training, Erosion control, Bank protection, Flood Control and Embankment works
STANDARDS	EN 13249-EN 13257:2016
BAG DIMENSIONS FILLED (APPROXIMATE)	2.1m diameter x 0.55m height when filled and placed
NETTING FOR BAG	Polyester material

TENSILE STRENGHT MD	≤50KN/M	EN ISO 10319
TENSILE STRENGHT CMD	≤9KN/M	EN ISO 10319
ELONGATION AT MAXIMUM LOAD MD	≤44.4KN/M ≥49.1KN/M	EN ISO 10319
RESISTANCE TO HYDROLYSIS TEST	Retained Strength 90%	NF EN 12447
MICROBIOLOGICAL RESISTANCE TEST	Retained Strength 88%	ENV ISO 12225
RESISTANCE TO CHEMICAL DEGRADATION MENTHOD	Retained Strength 100%	ISO TR 12960
RESISTANCE TO CHEMICAL DEGRADATION MENTHOD	Retained Strength 92%	ISO TR 12960
RESISTANCE TO WEATHERING TEST	Retained Strength 92%	EN 12224

DURABILITY TO BE COVERED WITHIN 1 MONTH FROM INSTALLATION DESIGN LIFE EXCEEDING 50 YEARS	EN 12224 Natural Soils pH range 4-9	Soil temperature <25°

WE CERTIFY THE PERFORMANCE OF PRODUCT AS PER ABOVE PARAMETI

International Geosynthetics Society

* This information is provided for reference purposes only and is not intended as a warranty or guarantee. Dimensions vary based on type of fill material
* Internationale Geotextil GmbH reserves the right to change the specifications without prior notice.
* Drag is not a functionality during use, it is a representative test

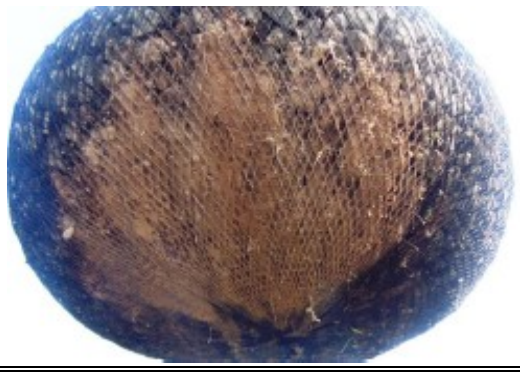
ISO 9001 BUREAU VERITAS Certification

UKAS QUALITY MANAGEMENT 008

The Product with complete 2T load has been dragged for 10 meters on natural terrain

Observation- 1. No holes observed

2. No tear



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*Tel. +49 (0) 42 43 - 92 88 20 * Fax+49 (0) 42 43 - 92 88 22 * sales@igg.de

B Geotextile – Geofabrics specification

Coastal and River Defence Systems: Design Guidance

hps
HIGH PERFORMANCE SQUARE

GEOfabrics®



Quality

High Performance

Easy Installation

Mechanical Strength

Construction Cost Savings

Value Engineering

Long Term Durability

About Us

GEOfabrics Limited is the UK's leading manufacturer of geotextiles. Since its formation in 1992, millions of square metres of HPS geotextile have been deployed along coastlines and watercourses beneath rock armour and prefabricated concrete units.

The company's ethos is to continually exceed the expectations of both existing and future customers with innovative and effective products supported by an established technical service. Successful product development is achieved by understanding the customer's problem, determining the necessary properties and functions that are required, manufacturing the solution and then rigorous quality testing to demonstrate that the product meets those requirements. GEOfabrics has a dedicated and experienced team of personnel that cover both commercial and technical departments and that work in unison to provide the necessary attributes to meet our global challenges.

Coastal Defence Structures Using HPS Geotextiles

For many years GEOfabrics have developed and provided a broad spectrum of tailored engineering HPS products that are specifically manufactured to address the many problematic challenges of coastal/river defence and erosion.

HPS Geotextiles Coastal Applications

- Artificial Islands
- Beaches
- Bridge Abutments
- Revetments
- River Protection
- Flood Bunds
- Harbours
- Lagoons, Lakes & Reservoirs
- Land Reclamation Offshore
- Wind Generators
- Rock Groynes
- Scour Control
- Submerged Breakwaters
- Coastal Defence

Typical primary rock armour revetment installation directly on HPS geotextile. Location: Colwyn Bay.

GEOfabrics HPS filter/separators have been designed to provide sustained permeability whilst maintaining structural stability. They provide excellent filtering efficiency, a high level of stress absorption and are highly resistant to abrasion.

Quality in Manufacturing

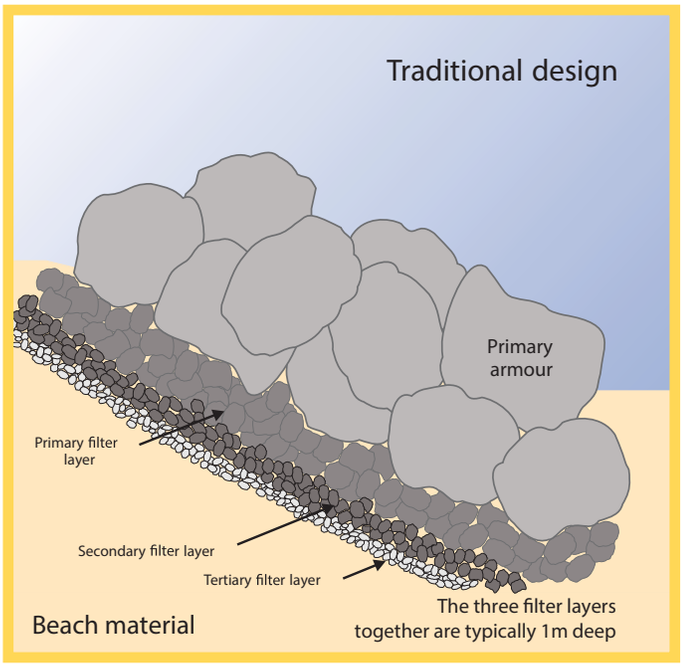
GEOfabrics Limited is the UK's leading manufacturer of geotextiles. Since its formation in 1992, millions of square metres of HPS geotextile have been deployed along coastlines and watercourses beneath rock armour and prefabricated concrete units. Their use is due to the quality of the products, their cost effectiveness and the comprehensive help provided to design engineers and contractors at every stage of a project.

Quality in Service

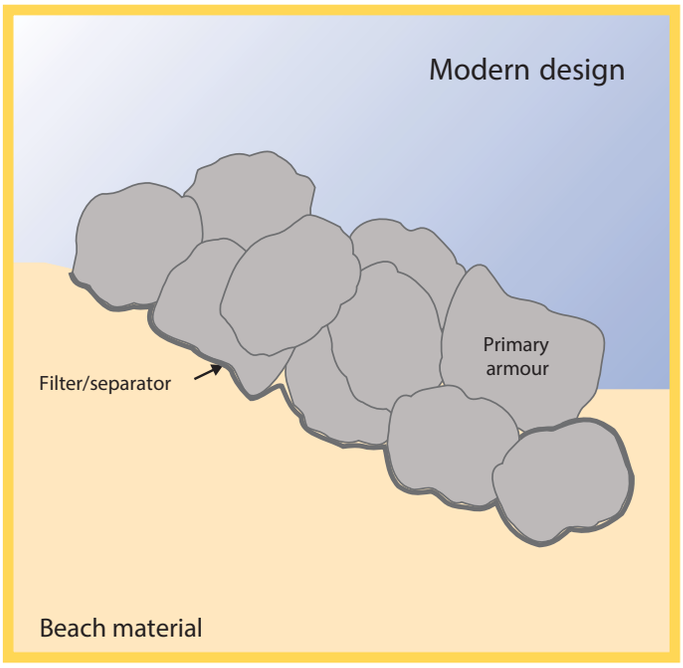
The HPS products have been designed and are manufactured to meet the most demanding performance levels. Using a modern computer-controlled plant, all products are manufactured in an ISO9001 environment and sampled and tested to the appropriate standards.

HPS Solutions – Preventing Erosion

The insidious effects of wave action and high-velocity water flow are a permanent reminder that the environment cannot be tamed. HPS geotextiles offer long-term protection against erosion in some of the most aggressive environments.



A graded stone filter is a complex, time-consuming and costly installation.



A high strength HPS geotextile replaces a multilayered stone filter system and is quicker to install when battling the tides.

On one hand, storms and flash flooding cause high-profile failures, but a slow-moving, low-level stream is just as capable of undercutting its banks and causing slope instability.

Protection to combat erosion currently tends towards soft and natural solutions including beach nourishment and rock armour, the size of which is determined by the anticipated wave or erosional scour action. Filter layers are required beneath rock armour to prevent erosion of the underlying soil. Otherwise, the armour would progressively drop into the increasing void and its effectiveness would be diminished.

Historically, graduated granular filter layers, with progressively larger grain size, were used to prevent this type of erosion.

Installation was time-consuming and they could be difficult to install, particularly if this involved inter-tidal working.

The environmental impact of importing thousands of tonnes of stone of the required gradings, often with restricted access, and their expense, meant that there was scope for alternative solutions.

Revetments constructed from rock armour or pre-cast concrete units require a filter to prevent mobilisation of underlying soil and to allow the free movement of water in both directions.

Without the ability to provide these functions over the entire life of the revetment, there is the potential for the armour to be undermined, as beach material is progressively eroded, or for a build up in hydrostatic pressure.

Of equal importance is the ability of the HPS filter/separator to withstand the rigours of installation and the in-service conditions. Materials susceptible to puncture, tearing and abrasion would exclude them from consideration.

HPS needlepunched, non-woven geotextiles provide all of the required functionality at the levels demanded for erosion prevention applications.

Case Study: Yas Island Race Track Marina, Abu Dhabi, UAE.

hps
HIGH PERFORMANCE SQUARE

- Our established HPS range of materials for construction consists of high performance geotextiles manufactured from high quality, high tenacity, 100% virgin polypropylene fibres.
- Oxidation tests indicate in excess of 150 years durability, as demonstrated on our product CE declarations.
- With a capability to manufacture up to a maximum width of 6m, GEOfabrics' HPS needlepunched geotextiles are specified by engineers due to their longevity and proven ability to work in the most demanding installations.
- High static and dynamic puncture resistance.
- High elongation to break.
- Superior abrasion resistance.
- Excellent filtration characteristics at all strains.
- UV resistance – 1% carbon black.
- Light weight and easy to handle.

Selecting the Most Appropriate HPS Grade

There is a diversity of geotextile types available. To make the appropriate selection a design engineer needs to match their functions and properties with the requirements of the project, to ensure the selected geotextile is both fit for purpose and will function as intended for the design lifetime.

Permeability

Classic filter rules state that each layer of a filter system must be more permeable than the layer beneath. Similar rules developed for geotextiles suggest a coefficient of permeability 10 to 100 times greater than that of the filtered soil. It is important that the geotextile should maintain or exceed its index permeability whilst under load, i.e. any re-orientation of the fibres should not increase or decrease permeability.

Filtration

The characteristic pore size of the geotextile has to be less than the average grain size of the soil to be filtered in order to prevent loss of material through the geotextile. Established design rules for reversing flow applications and a non-cohesive soil state that the geotextile's O_{90} should be less than the d_{50} of the soil to be filtered. For a cohesive soil, $O_{90} < 10 \times d_{50}$.

Both the permeability and filtration rules apply factors of safety to allow for reductions in these properties by soil particles clogging within the geotextile. A filter will be regularly flushed if the system is subject to reversing flows, thus minimising any reduction in filtering efficiency.

Static and Dynamic Puncture Resistance

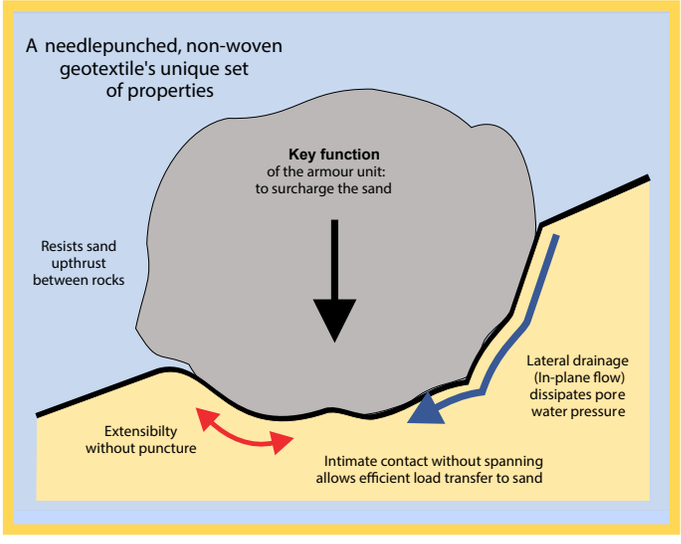
The geotextile must be able to withstand puncture loads imposed during installation and service. The rock weight, its angularity and the drop height all contribute to puncture load. This can be further intensified if due care is not taken during installation. Ideally, it will also possess isotropic (square) tensile properties in order to spread load consistently in all directions.

Elongation

Rock armour functions by virtue of its dead weight being transmitted over as wide an area as possible to consolidate the underlying soil and minimise particle movement. The load imposed on a geotextile by large rock is not evenly distributed. The highest stress concentration will be at the point of intimate contact which in turn will impose high localised strains. The geotextile needs to be sufficiently extensible to enable it to adapt to point loads without puncturing and without loss of hydraulic properties.

Thickness

Thickness is required to cushion potentially penetrating point loads and also to provide a lateral drainage path around any compressed areas. Lateral drainage capacity is defined by the geotextile's in-plane flow under load.



High elongation of HPS geotextile under aggressive rock armour loading.

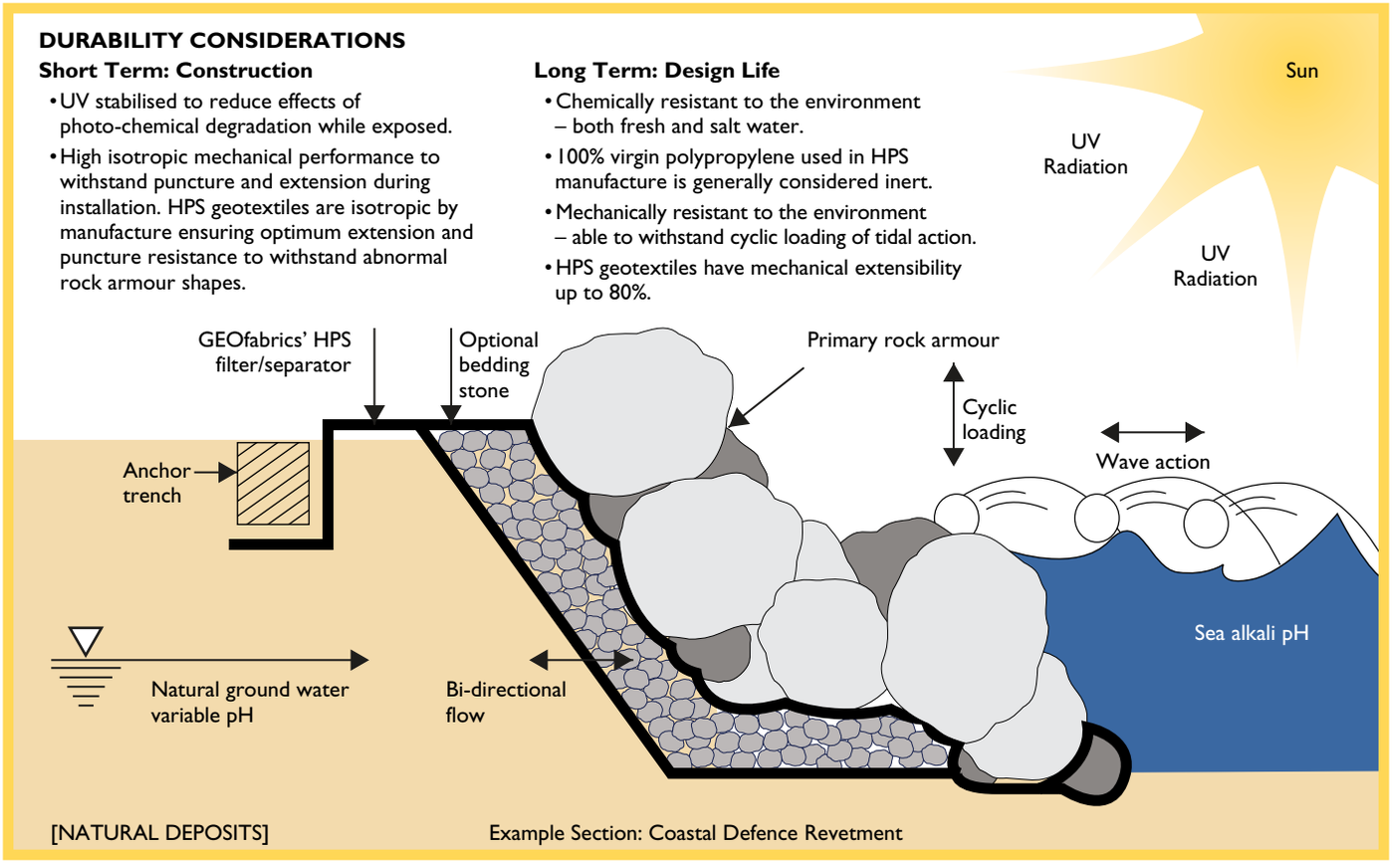
Classic filter rules state that each layer of a filter system must be more permeable than the layer beneath. Similar rules developed for geotextiles suggest a coefficient of permeability 10 to 100 times greater than that of the filtered soil.

Case Study: Hulayla Marina Development. HPS filter/separator geotextiles preventing intermixing of fill layers behind quay wall structure.

Whilst standard index tests do not exactly simulate the performance of the filter/separator there needs to be some rationale for the specification. HPS geotextiles are manufactured such that the following key properties are maximised for coastal and river applications. A model specification should address the following properties:

- **Water Flow Normal to the Plane**
  Closely linked to permeability. Very important in dynamic, high-flow applications.
- **Pore Size**
  Defines the opening size of a geotextile and its ability to trap particles and prevent their passage.
- **Minimum Tensile Extension**
  Placing rock is potentially the greatest cause of damage and the extensibility of a geotextile is important to avoid localised damage.
- **Static Puncture Resistance (CBR)**
  Simulates the in-situ punching effect of rock, normal to a geotextile, during service.
- **Dynamic Perforation Resistance (Cone Drop)**
  Indicates the ability of a geotextile to accommodate dynamic puncture during rock placement.
- **Coefficient of Permeability**
  Related to the thickness of a geotextile. Expresses water flow as a k_g value allowing comparison with soil values (k_s).
- **Tensile Strength**
  Simulates a geotextile's ability to be handled on-site using heavy excavators. It is common for operators to spread and unroll the geotextile using the bucket of an excavator.
- **Push-through Displacement**
  Simulates biaxial strain caused by rock placed on the geotextile, and the capacity to resist localised damage.
- **Thickness Under Load**
  Ensures that there is a water path beneath the stone allowing dissipation of pore water pressure.

HPS Durability Considerations



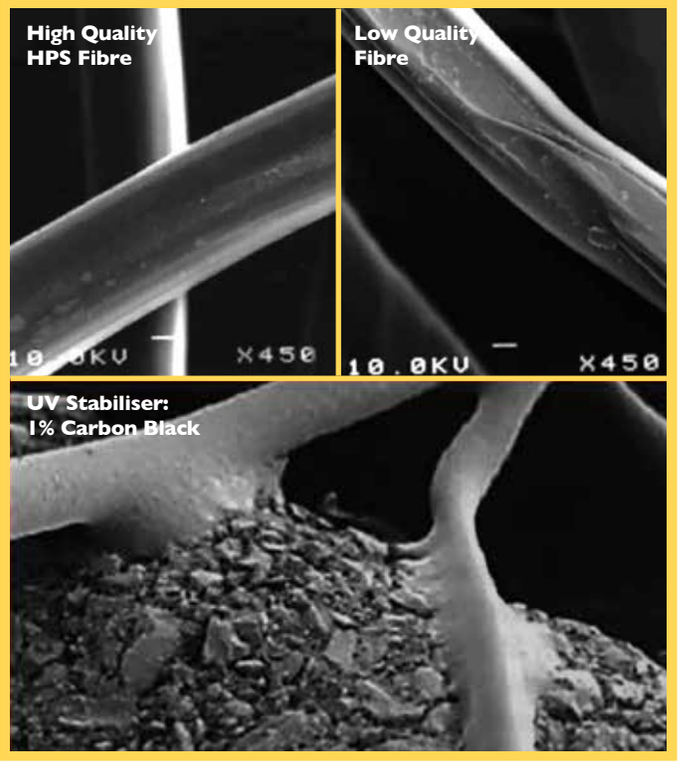
Application specific durability demands.

Raw Material

Fabrics can be produced from both post-industrial and post-consumer recycled fibres. Such fibre types can be of different thicknesses, and volume to surface ratios. Some types of degradation, such as oxidation and UV exposure, are dependent on surface area, whilst others such as diffusion and absorption are inversely related to thickness. It is strongly advised that the use of post-industrial/post-consumer fibre is avoided.

Another polymer fibre that is used within geotextile manufacturing is polyester, of which the most common type is polyethylene-terephthalate (PET) which is produced using condensation polymerisation. PET can offer good mechanical properties and is suitable for some applications, however the ester group can be hydrolysed in the presence of water which is accelerated by alkaline conditions such as salt water. Although polyester can have advantages over other polymers the alkaline sensitivity of this polymer through hydrolysis under long-term loadings, should be a major concern in coastal geotextile applications.

GEOfabrics' HPS range is manufactured from 100% virgin, staple length, high tenacity polypropylene fibres which have a high resistance to acids, alkalis and most solvents. Polypropylene can be considered as inert to acid and alkali attack and is suitable for most geotextile applications.



High resolution images of fibre morphology. GEOfabrics 'thinking about the fine detail'.

The Design Mechanism

The type of polymer and the fibre, together with the production process, define the inherent properties of a geotextile. GEOfabrics' needlepunched, non-woven geotextiles are manufactured using specially engineered fibres and these are bound to each other by mechanical needling.

The balance between hydraulic and mechanical properties is optimised for:

- High permeability with fine filtration.
- High isotropic puncture resistance with high strains to failure.
- Good cushioning ability and impact resistance.
- Good water flow performance.

Design methodology will consider whether the primary armour is to be placed directly or indirectly on the filter/separator. Armour can be placed directly on top of the HPS products so there is no need for an intermediate bedding layer of stone.

Step by Step Specification Procedure

STEP 1

Establish the primary armour weight from wave height predictions.

ROCK WEIGHT EXAMPLE:

4t Maximum Armour Size.

STEP 2

Establish the type and permeability of the underlying soil.

Table 1

Soil type	Filtration d_{50} (mm)	Permeability k_s (m/s)
Clayey silt	0.02	1×10^{-9}
Sandy silt	0.02	1×10^{-7}
Fine sand	0.30	1×10^{-5}
Coarse sand	0.50	1×10^{-4}
Mixed sand & shingle	2.00	1×10^{-3}

STEP 3

Provisionally select an HPS grade based upon its permeability e.g. if soil permeability is 10^{-5}m/s then the grade must have a permeability $>10^{-4}$m/s.

PERMEABILITY EXAMPLE:

Beach material is fine sand with a permeability (k_s) = 1×10^{-5}m/s.

The filter/separator should have a permeability (k_g) >10 x permeability of soil.

Therefore, geotextile k_g should be > 1×10^{-4}m/s.

- GEOfabrics' HPS filter/separators are in the range 3×10^{-3} m/s to 10×10^{-3} m/s.

STEP 4

Check that the grade's O_{90}< d_{50} of the subsoil.
This requirement is satisfied by most of the HPS product range.

FILTRATION EXAMPLE:

d_{50} of fine sand is typically 0.3mm (see Table 1). The filter/separator O_{90} must be < d_{50}.

For d_{50} of 0.3mm – required O_{90} must be <0.3mm.

- GEOfabrics' geotextiles have an O_{90} in the range 0.2mm to 0.07mm.

STEP 5

Check that the selected grade can withstand installation loading without puncture.

INSTALLATION DAMAGE RESISTANCE EXAMPLE:

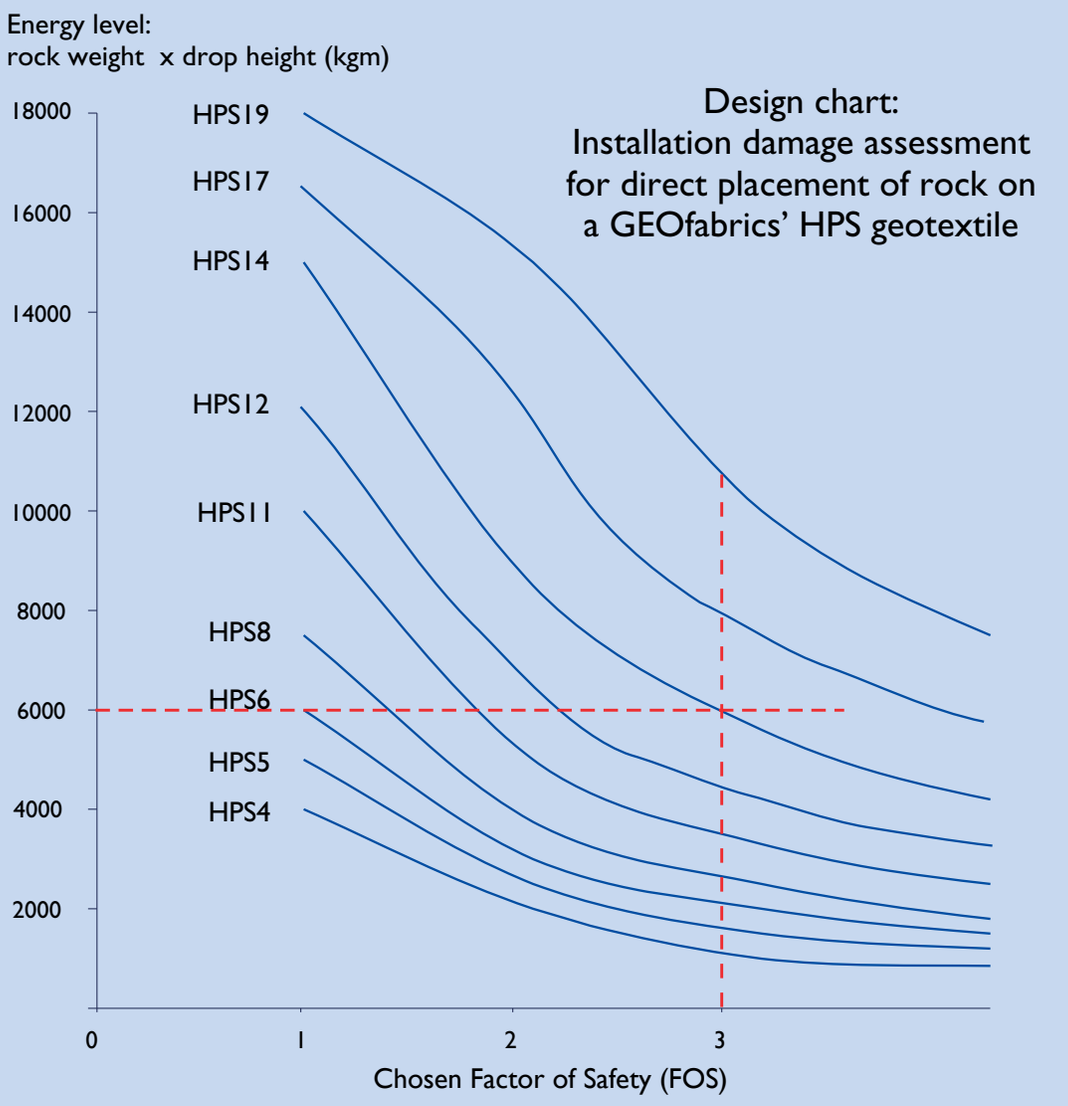
FOS against damage = 3.0.

Maximum likely drop height = 1.5m.

Maximum rock size in contact with geotextile = 4000kg.

Rock drop energy = 1.5 x 4000 = 6000kgm. From installation damage graph below.

- GEOfabrics HPS14 would be suitable in this instance.



STEP 6

Check that there is sufficient design elongation for the fabric to function without tearing. Assuming rock diameter is approx 1.5m, and the rock is depressed into subsoil to a third of its depth, i.e. 0.5m, the localised elongation in the geotextile due to the friction between subsoil and rough edges of the rock could be as much as 20%. To allow a FOS = 3, a minimum tensile extension would therefore be 60%.

ELONGATION EXAMPLE:

FOS against damage = 3.0.

Maximum likely rock diameter = 1.5m (OD).

Depression depth 0.5m (1/3rd OD).

Elongation approx. 20% x FoS 3.0 = 60% elongation required (Tensile Extension).

- GEOfabrics' HPS14 would be suitable in this instance.

Live Installation: 3t rock armour dropped from 2m height onto HPS14 overlying a sandy clay unconsolidated beach deposit.

Specification Considerations

A well-written specification for a filter/separator is of paramount importance as there are many geotextile types available with widely varying physical characteristics and production qualities. Testing and quality assurance is as important for geotextiles as it is for other materials incorporated in the works.

British Standard (BS) and European (EN) index tests are available to enable engineers to compare one geotextile with another. These tests and quality control schemes need to be referenced in the specification **(see example specification below)**.

The tests should then be used to assess the suitability of a proposed geotextile for the works. The manufacturer's Quality Control procedures should be made available and a Certificate of Conformance should cover each consignment. Additional samples may be taken from each consignment, by the contractor, to be tested as directed by the engineer.

As an example, a performance specification is provided based on HPS14 – the product identified in the worked example.

2.1 Physical Properties:				
Polymer type:	Prime-quality virgin polypropylene fibre containing 1% carbon black by weight.			
Geotextile type:	Needlepunched non-woven fabric manufactured from mechanically entangled staple fibre.			
	Approved test method	**Units**	**Typical mean value**	**Allowable tolerance to 95% confidence limits**
Thickness @ 2kPa:	EN ISO 9863-1: 2005	mm	7.8	n/a*
2.2 Mechanical Properties:				
Static puncture strength (CBR)	EN ISO 12236	kN	14	-10%
Push-through displacement	EN ISO 12236	mm	65	n/a*
Tensile strength	EN ISO 10319	kN/m	75	-10%
Tensile elongation	EN ISO 10319	%	80	+/-30%
Cone drop perforation hole diameter	BS EN 13433	mm	0	+3mm
2.3 Filtration Properties:				
Water flow normal to the plane of the geotextile @50mm head	EN ISO 11058	l/s/m^2	25	-30%
Characteristic opening size: 90% finer [O_{90}]	EN ISO 12956	µm	<69	+/-30%
** Indicates property not used for quality control as part of harmonised testing within EN 13253.*				

2.4 Durability (according to annex B: EN 13253):			
Resistance to weathering (UV) @ 50MJ/m^2 radiant exposure	EN 12224	Retained strength	>80%
Resistance to oxidation (150 years)	EN 13438	Retained strength after 84 days	>80%
Microbiological resistance	EN 12225	Retained strength	>80%
Resistance to liquids	EN 14030	Retained strength	>80%
** Durability test data can be supplied by the manufacturer – test frequency must not exceed 3 years.*			

Model specifications are available to download from www.geofabrics.com

Performance Specification

- The geotextile to be used as a filter/separator beneath the rock armour shall be a non-woven fabric manufactured by needlepunching virgin, staple fibres of polypropylene incorporating a minimum of 1% by weight active carbon black. Geotextiles manufactured from fibres of more than one polymer will not be permitted.

- The geotextile shall have the following properties:
  - Geotextiles shall be delivered to site in packaging, which will protect the rolls from ultra-violet light degradation. The labelling shall clearly identify the product supplied in accordance with **BS EN 10320: 1999.** Geotextiles shall be protected at all times against physical or chemical damage. Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the works.
  - The geotextile manufacturer shall provide production test certificates at the rate of one set of certificates per 6,000m^2 delivered to site and a minimum of one set per contract. Test methods employed shall be in accordance with the requirements of **BS EN ISO 13253:A1 2005** and be accredited by UKAS to carry out the required tests. Certificates relevant to a batch of geotextile shall be furnished to the engineer prior to that batch of geotextile being incorporated in the works.
  - The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextiles.
  - The geotextile shall not be exposed to direct sunlight for longer than thirty days.
  - The geotextile shall be laid and installed in the positions and to the line and levels described on the drawings. Material, which will be in contact with the geotextile, shall not have protrusions which are likely to damage the geotextile during installation or in service. Construction plant must not operate directly on the geotextile.
  - Joints shall be formed by overlapping by a minimum of 1000mm. A reduction in overlap to 300mm may be considered by the engineer where the sub-layer is firm and above water level.

The following definitions shall apply when considering test results:

A *set of test results* shall be those results derived from specimens cut from one sample. The *mean value* for any set of test results shall be the arithmetic mean of that set of results.

The *characteristic value* is the value below which not more than 5% of the test results may be expected to fall. This represents the value at 1.64 standard deviations below the mean value.

Rock armour Groyne installation to inhibit 'Long Shore Drift' and protect the coastline.

Installation Guidance

The high strain capacity of the HPS products may be used to advantage when designing anchoring and edge details. Wrapping around a run of small stone or bedding stone, if available, is a proven toe detail. At the top of the revetment the geotextile should be anchored in a trench or fixed to a structure such as a sheet-piled wall. The sides should be treated in a similar fashion for the permanent works and suitable precautions taken to protect them at high tides during the progress of the works.

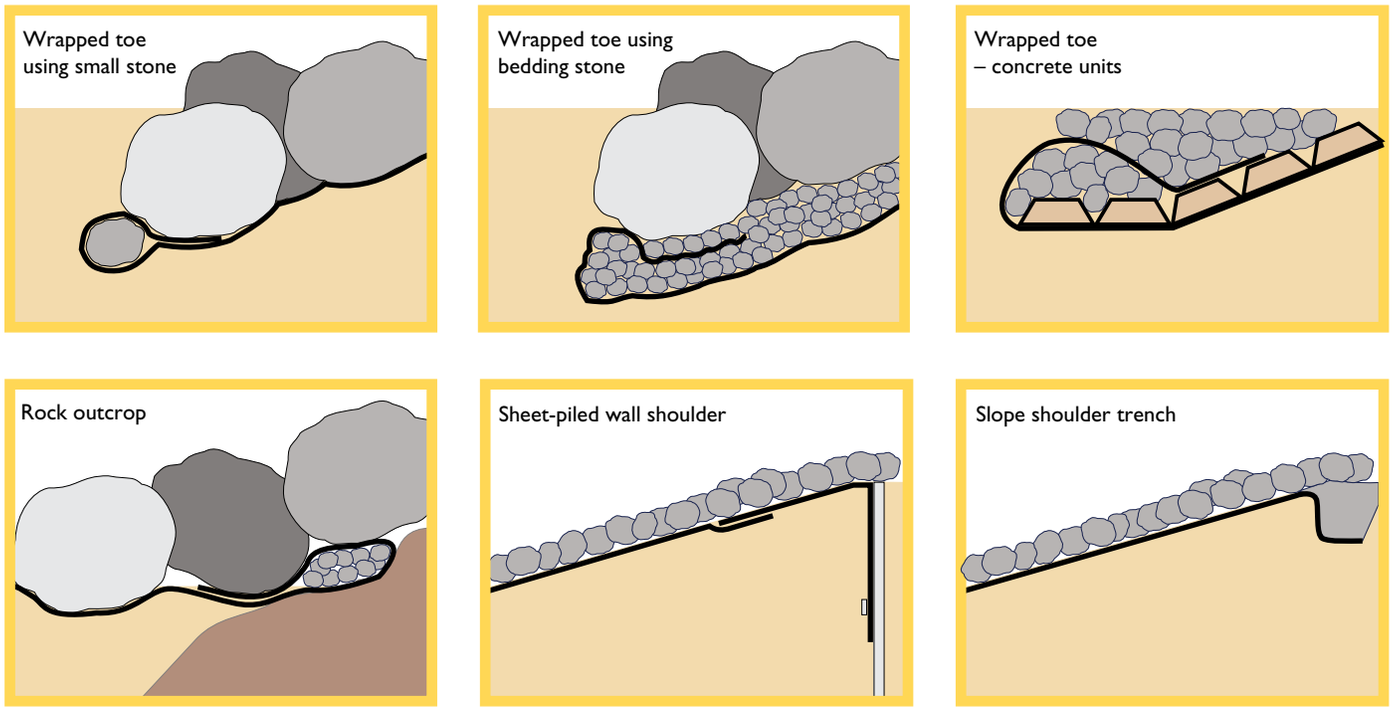
Joints

HPS geotextiles are produced up to 6m wide to minimise overlaps. Unbonded overlaps should be between 300mm and 1000mm (at the discretion of the engineer) depending upon the firmness of the underlying soil and the relative ease of working.

300mm overlaps are acceptable for above-water working on firm subsoil and 1000mm overlaps are recommended for under water working on soft silts.

Contractors placing the HPS products under water often prefer to joint and re-roll the product onto a metal core. This enables widths up to 12m to be pre-fabricated prior to installation.

Joints can be made by sewing a prayer seam using a bag-closing, handheld sewing machine. This procedure can achieve joints with 60% of the geotextile's strength.



Typical HPS installation details. *For further site specific installation details, please contact the GEOfabrics' technical team for assistance.*

Quality and Development

GEOfabrics continue as one of the main geosynthetic innovators in the industry with our highly active Research and Development department.

GEOfabrics has an extensive laboratory and test facilities. We have a wide range of UKAS accredited tests used for quality control and research and development.

Mechanical testing equipment for tensile strength and elongation.

Our continued success in new products is as a result of an experienced team and our ongoing relationships with an expanding list of professional clients who partner with us to produce bespoke geosynthetic solutions.

GEOfabrics' priority is to manufacture a high quality end product that provides the exact needs of our customers, in line with function, durability, value and in accordance with all current legislation and design standards.

HPS: Long-Term Durability

GEOfabrics manufacture from 100% virgin staple polypropylene fibre including 1% carbon black. Such fibres are generally considered chemically and biologically inert, in all but the most aggressive environmental applications.

GEOfabrics' HPS geotextiles are resistant to chemical and biological clogging, have UV stability to prevent degradation when exposed to sunlight and provide long-term strength without reduction in performance or function.

GEOfabrics' innovative products are produced using the latest manufacturing technology and UKAS accredited testing facilities.

Should you require any information or assistance in relation to this support service please contact us on +44 (0)113 202 5678.

Accreditations

BTTG ISO 9001:2008 — UKAS MANAGEMENT SYSTEMS 0246

The ISO 9001 Management system uses customer feedback, continuous assessment and independent auditing to drive both improvement and the control required for a professional and quality based environment.

UKAS TESTING 1773

Accredited laboratories that operate in line with UKAS methodology, policy and audits to provide accurate performance information.

CE 0338

GEOfabrics Limited manufactures CE Marked products that meet the construction products directive.

Acknowledgements given to Ciria C683 'The Rock Manual':

CIRIA

GEOfabrics®

Global Supply Network

GEOfabrics Limited supply a world class range of engineering products for a diverse set of applications, across the UK and international markets. We pride ourselves on building strong, long-term and mutually beneficial partnerships with our agents and distributors, in order to provide a quality technical supply service to our clients.

UK EUROPE MIDDLE EAST NORTH AMERICA AFRICA ASIA

Further literature, in the form of case studies, design guides, installation procedures, product data sheets and model specifications **can be downloaded from www.geofabrics.com**

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CERTIFICATE NO. FM 31473 1773 0338

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ICM 10167 03 2017

C Geobags – TENCATE Geotube GB580 MSS2 specification

TENCATE
Geotube®

Geobags

Woven fabric with lifting straps

The Geotube® Geobag is a containment product manufactured from engineered fabrics combined with high capacity seams that allow sand or other suitable material to be in-filled. They are engineered to provide strength, durability and soil tightness during installation and operational life. The bags are filled with sand through open top or through inlet fabric sleeve on top of the bags. The resulting filled bag can be easily handled and are used to replace rock for the construction of dyke structures or for erosion protection works.

This range of Geotube® Geobags is manufactured using engineered woven fabric with attached lifting straps for handling and installation convenience on site. They are ideal for constructing dyke structures of a temporary nature or used as core fill material in permanent dyke structures.

Properties of TenCate Geotube® Woven Geobags with Lifting Straps

Properties		Test Method	Unit	GB600 MSS1	GB600 MSS2	GB600 MSS3	GB600 MSS4
Colour				**Black**	**Black**	**Black**	**Black**
Nominal box dimensions (unfilled)							
Width			m	1	1	1.6	2
Length			m	1	2.5	1.6	3
Height			m	1	1	1.6	1.5
Lifting points							
Number of lifting points				4	6	10	10
Tensile strength per strap		ISO 10321	kN	55	55	55	55
Fabric							
Wide width tensile strength	MD	ISO 10319	kN/m	200	200	200	200
Wide width tensile strength	CD	ISO 10319	kN/m	200	200	200	200
Strain at nominal tensile strength	MD	ISO 10319	%	10	10	10	10
Strain at nominal tensile strength	CD	ISO 10319	%	10	10	10	10
CBR puncture strength		ISO 12236	kN	22	22	22	22
Abrasion resistance		ASTM D4886	% retained	80	80	80	80
UV resistance (at 500 hours)		ASTM D4355	% retained	90	90	90	90
Pore size O_{90}		ISO 12956	mm	0.35	0.35	0.35	0.35
Water permeability Q_{50}		ISO 11058	l/m²/s	20	20	20	20

Other bag sizes tailored to project requirements may be available upon request.

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MS ISO/IEC 17025 TESTING SAMM NO. 207 · ISO9001 : 2015 · Accreditation #: GAI-LAP-45-02 · BUATAN MALAYSIA

TENCATE GEOSYNTHETICS

D Geomats – TENCATE Robulon specification

TENCATE Geolon®

Robulon PP

Technical Data

TenCate Geolon® Robulon PP is a high strength geocomposite for erosion control purposes. The product is made of 100% highly durable and UV resistant PP, with a 3 dimensioral structure. The combination of reinforcement and soil retention makes Robulon the ideal mat for erosion control in a variety of applications such as protection of slopes, geomembranes, canal and river beddings, and shorelines.

TenCate Geolon® Robulon PP

Characteristics Standard]		**Unit**	**PP 40**	**PP 60**	**PP 80**
Type of product			Geocomposite made of 100% polypropylene, consisting of a high strength woven base layer featuring inseparable loops for soil, gravel or concrete retention		
Product Properties					
Mass per unit area [EN ISO 9864]		g/m²	510	580	675
Thickness under 2kPa [EN ISO 9863-1]		mm	10	10	10
UV resistance (retained tensile strength) [EN ISO 12224]		%	> 80	> 80	> 80
Base Layer Properties					
Tensile strength [EN ISO 10319]	MD*	kN/m	40	63	84
	CD*	kN/m	40	57	84
Elongation at maximum strength [EN ISO 10319]	MD*	%	17	8	8
	CD*	%	12	8	8
CBR puncture resistance [EN ISO 12236]		kN	4	6	8
Dynamic perforation [EN ISO 13433]		mm	15	10	9
Forms of supply					
Width		m	5	5	5
Length		m	45 / 50	50	50
Roll diameter		m	0.78 / 0.8	0.85	0.85
Roll weight [indicative]		kg	125 / 140	160	180

* MD = Machine Direction CD = Cross Direction

The values given are average values obtained in our laboratories and in testing institutes. The right is reserved to make changes without notice at any time..

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TENCATE GEOSYNTHETICS

E Surface reinforcement – Kedel X-Grid specification

Ground Reinforcement Grids

Introduction to X-Grid® Ground Reinforcement Grids.

X-Grid® Ground Reinforcement grid is the new recycled plastic sustainable drainage system (SUDS) compliant solution.

X-Grid® Ground Reinforcement grids are a high performance, durable and virtually maintenance free solution for use with grass or gravel.

X-Grid® is manufactured from 100% recycled Plastic and provides a lightweight ground reinforcement system for grass and gravel stabilization.

This type of surface helps to reduce the risk of potholes, rutting or grass damage. X-Grid® has been designed to support healthy grass growth providing a minimum of 3.2cm of available height to allow the grass sufficient height in which to grow.

The system design provides a lightweight strong structure making it easy and quick to install and suitable for a wide range of applications including paths, driveways, car parking areas and access routes.

Correctly installed X-Grid® has been demonstrated to withstand up to 428 tonnes per square metre.

X-Grid® offers unimpeded flow to surface water reducing the rate of run off and potentially saving the costs of drainage installation.

Benefits:

- Fully compliant with new planning requirements surrounding driveways to the front of properties.
- Environmentally Friendly
- Prevents erosion and wear on footpaths
- Interference connections creating stronger inter-grid unions
- Strengthens grassed areas
- Minimal dimensional change due to temperature
- Resistant to water, corrosion and cracking
- Holds gravel and prevents rutting
- Strong geometric design ensures high compression strength

Applications:

- Green parking
- Emergency vehicle access
- Temporary and permanent roadways
- Quick fit shed bases
- Road protection
- Embankments
- Green roofs
- Driveways
- Tree beds
- Golf walkways
- Caravan Parking
- Ménage's
- Hard standing

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01282 861325 | sales@kedel.co.uk | www.kedeltrade.co.uk

KEDEL X-Grid® Ground Reinforcement Grids

Grid Dimensions (WxL:	330mm x 330mm
Grid Depth:	40 mm
Wall Thickness	3mm
Weight per Grid:	0.57 kg
Grids / m²:	9 Grids / m²:
Weight per m²:	5.13 kg / m²
Manufactured in:	Made In UK
Material:	100% Recycled Plastic (UK Sourced)
Connection Method:	Slot & Peg Quick snap connection
Cell Profile:	Cylinders 55mm Nominal ID 63mm OD
Permeability	93% Open structure:
Load Bearing Capacity:	Up to 428 tonnes / m²:
Natural stability:	Temperature range -50°C up to 90°C
Environment Compatibility:	Environmentally neutral in accordance with DIN 38412
Solubility:	Resistant against acid and leaching, alcohol, oil and petrol, strewing salt, ammonia, acid rain etc.
Surface Finishes	Gravel up to 20mm Angular in accordance with NBS Section Q23 Grass Seeding / Turfing in accordance with NBS Section Q30
Expected Life	25 Years with 10 Year manufacturer Guarantee*
Sub-Base Preparation:	In accordance with BS7533-3
DDA Compliance:	Part M Building Regulations
Car Parking Areas:	Surfaces for Car Parking areas DIN EN ISO 124B 125
Carry Load:	Up to 30 t axle load in accordance with DIN 1072
Maximum Gradient	12%
Maximum Vegicle Speed	15 Mph
Installation:	100 m² per person per hour

XG40B-001 100% Recycled Plastic Colour Black	**XG40G-001** 100% Recycled Plastic Colour Green	**XG40N-001** 100% Recycled Plastic Colour Natural/White
		

KEDEL X-Grid®

Subgrade Assessment

California Bearing Ratio (CBR). The design CBR should be obtained either by testing or by measurement of the plasticity index of the subgrade material. In the case of CBR testing, the method described in BS1377-4:1990 +A2:2002, Clause 7 should be used.

The surface of the subgrade material should be prepared according to the Highways Agency's Specification for Highway Works.

Detailed preparation of the subgrade should be in accordance with the recommendations in BS7533-3. An acc eptable subgrade level should be free of any soft spots, reasonably parallel to the plane of construction. A capping layer may be required if the ground is structurally weak, likely to be subjected to exceptional loads or is significantly below the specified ideal formation level.

The table below gives typical values for the subgrade strengths (the CBR) normally encountered in the soils of Britain and Ireland

	INDICATOR		STRENGTH		
Consistency	**Tactile (Feel)**	**Visual (Observation)**	**Mechanical (Test) SPT**	**CBR %**	**CU kN/sqm**
Very Soft	Hand sample squeezes through fingers	Man standing will sink >75mm	<2	<1	<25
Soft	Easily moulded by finger pressure	Man walking sinks 50-70 mm	2-4	Around 1	Around 25
Medium	Moulded by moderate finger pressure	Man walking sinks 25mm	4-8	1-2	25-43
Firm	Moulded by strong finger pressure	Utility truck ruts 10-25mm	8-15	2-4	40-75
Stiff	Cannot be moulded but can be indented by thumb	Loaded construction vehicle ruts by 25mm	15-30	4-6	75-150

Notes

- If the geotextile layer is omitted, then the total sub-base layer thickness should be increased by 50%
- A Department of Transport Type 1 sub-base may be used provided that an adequate drainage system is installed. Alternatively a porous sub-base layer may be specified however this should be covered with either a geotextile filter membrane and/or suitable clean gravel blinding layer to avoid fine particles entering the sub-base layer.
- Drainage details; 100mm diameter perforated pipe drain laid at a minimum gradient 1:100 bedded on gravel trench backfilled with suitable drainage aggregate, covered or wrapped with a suitable geotextile fabric and leading to a suitable outfall or soakaway. For specific advice contact the manufacturer.
- Rootzone bedding and grid fill must be free draining,structurally sound proprietary blend of sand/soil or sand/compost, this is normally identified as a 60:40 or 70:30 ratio blend and in-situ blending is not recommended.
- Max advised gradient for traffic applications is 12%.
- Pegging may be required.
- X-GRID® complies with BS8300:2001
- The preparation of the subgrade, the construction of the sub-base and the construction and type of roadbase (if present) should generally be in accordance with relevant current practice as described in the Highways Agency's Specification for Highway Works.
- It is essential that the sub-base compaction is thorough, using a vibrating plate compactor or vibrating roller.
- The thickness of the laying course after final compaction of the surface course should be 40 - 50mm, within an accepted surface level tolerance. All areas of prepared laying course material should be protected and not left exposed overnight.
- The laying course may be placed and screed using a mechanical device.
- It is necessary to include a substantial edge restraint when constructing X-Grid® See Ancillary Items:

Calculations for Quantities

Hardcore/Broken Stone required for the base layer

For cars = 300kg of hardcore/broken stone per m² (providing 150mm depth)

For trucks = 400kg of hardcore/broken stone per m² (providing 200mm depth)

Sand or Fine Chippings required for the levelling layer

For all grid types = 25kg of sharp sand (grass or gravel finish) or fine chippings (gravel finish only) per m^2

Topsoil required for a grass surface (per m2)

For 40mm grid = 65kg of topsoil

Aggregate required for a gravelled area (per m2)

For 40mm grid = 70kg of gravel

X-Grid® Specification

Bedding Layer	30mm thick of 5 – 20mm angular aggregate (BS EN 13242)
Grid Fill	To top of grids using 5 – 20mm crushed aggregate (BS EN 13242)
Sub-base Layer	DoT Type 3 or modified porous sub-base layer. DoT Type 1 with drains

Typical Sub-Base Thickness

The table showing sub-base thicknesses is intended as a general guide in accordance with BS7533. For further details on permeable paving design refer to BS7533 Part 13; for installation refer to BS7533 Part 3. The design for pavements should satisfy two parts - to support the traffic load and to manage the surface water effectively.

Application Load	CBR (%) Strength of Subgrade Soil (See Chart)	DoT Sub-Base Thickness (mm)
Fire Engine and occasional HGV Access	>=6 =4<6 =2<4 =1<2	100 120 190 380
Light Vehicle access and overspill car parking	>=6 =4<6 =2<4 =1<2	100 100 135 260

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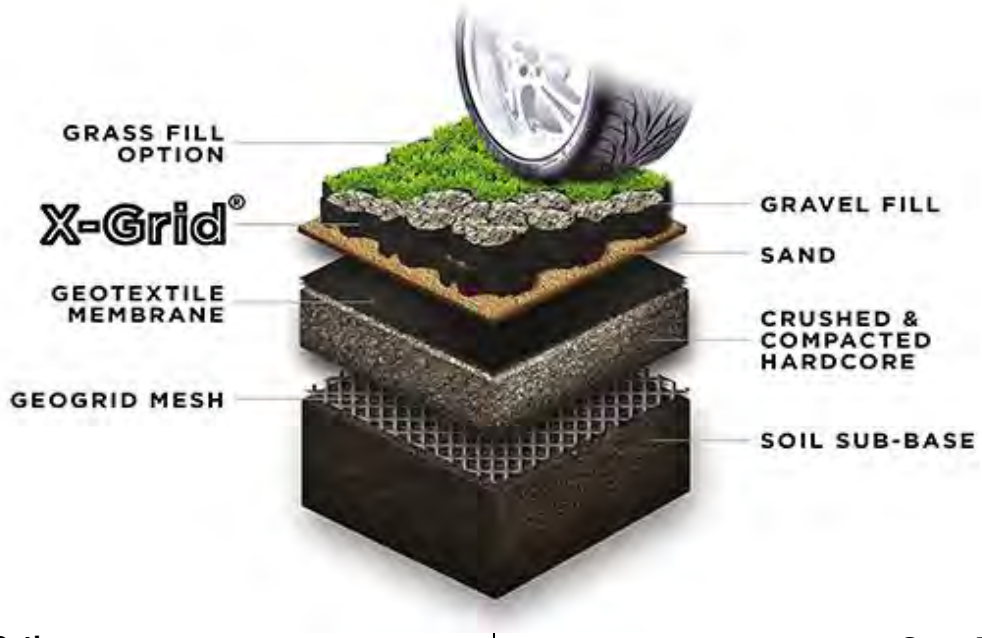
KEDEL X-Grid® Ground Reinforcement Grids



Gravel Fill Option

1. Cut the grass closely to the surface or where necessary remove the turf and topsoil to a depth of <75mm and dispose of all debris. Level the formation layer and lightly consolidate.
2. Install edge restraint.
3. Place a layer of GeoGrid stabilisation mesh or Geotextile fabric on the formation layer and ensure that it is flat to the surface by pinning as required. An optional geotextile fabric layer can be placed on the formation layer prior to the GeoGrid installation to prevent migration & contamination.
4. Place a 5-10mm thick layer of sharp sand blinding the area to level out and even the GeoGrid. The GeoGrid must not be allowed to become exposed above the gravel / aggregate layer.
5. Place the X-Grid® ground reinforcement grids onto the sharp sand layer. Connect the X-Grid® panels using the slot and peg snap connection.
6. X-Grid® can be cut using a hand or power saw fit around obstructions and curves. Cut pieces which are less than half the original size should be avoided where possible. X-Grid® can be firmed in place using a light vibrating whacker plate if required.
7. Fill X-Grid® with the specified gravel or aggregate. Preferably a clean, well graded angular material within the range of 5-20mm diameter. Fully rounded 'pea gravel' is not recommended.
8. Consolidate the surface using a light vibratory whacker plate if required.
9. Refill any localized low areas with gravel and repeat consolidation until satisfied with the final compacted finish.
10. The surface can be trafficked immediately.

Grass Fill Option

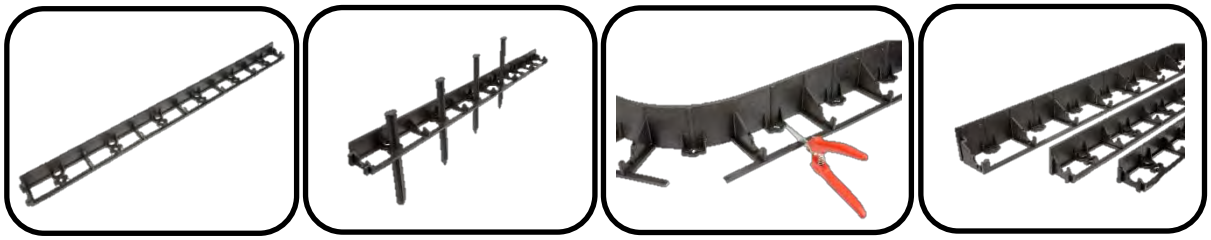
1. Follow steps 1-3 as for gravel. Note: It is not necessary to install the optional Geotextile fabric layer as stated in Step 3(gravel).
2. Place a 35mm thick layer of compacted RootZone layer evenly over the geogrid. The geogrid must not be allowed to become exposed above the gravel / aggregate layer.
3. Fill X-Grid® pavers with the specified propriety Rootzone. A light vibrating plate can be used to consolidate the pavers and to settle the Rootzone infill if required.
4. Rootzone must be a free-draining structurally sound sand/compost or sand/soil blend. This is a nominal propriety blend of 60:40 or 70:30 ratio. Self blending is not recommended.
5. Carry out a normal seeding, fertilising and watering programme. A very light top dressing may be applied to just cover the seed and to provide adequate germination conditions. Do not overfill the paver cells. Alternately thin-cut turf can be rolled into the surface if required.
6. The surface may be trafficked immediately, but it is preferable to allow the grass to fully establish prior to use.

X-Grid® Ancillary Items

GeoBorder™ Edge Restraint

It is necessary to include a substantial edge system when installing X-Grid® Ground Reinforcement Grids with grass or gravel finishes. GeoBorder recycled plastic edging system is a suitable edge restraints system for most applications. Made from Recycled plastic Geoborder is a restraint system which is sufficiently robust to withstand thermal expansion, vehicular movement, and prevent loss of laying course material. Other alternatives could include kerbs, channels, existing structures, and rigid abutments such as securely fitter paving blocks.

GeoBorder is a recycled plastic edging system which provides suitable edging restraint in areas where alternative support is missing. Geoborder is made from recycled plastic and can be used for straight edges, curves and bends.



Parking Delineators

X-Grid® laid for car parking surface may require the car parking bays be marked out. X-Grid® Delineators are a white plastic cap which quickly and easily insert into the cylinders visibly denoting the car parking areas.

Typical car parking bays are 2.4m x 4.8m. We recommend that 5 Delineators are evenly spaced down the length of the car parking bay line to create a clear denotation between parking bays.

For more information contact:
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F Flood gate – Demountable barrier by Flood Control International

SPECIFICATION FOR DEMOUNTABLE FLOOD BARRIERS

May 2020

1 GENERAL

1.1 - The demountable flood barriers are to be a temporary defence system which is erected prior to an expected flooding event and removed afterwards to leave the site in its original state. They shall be simple and quick to install and require a maximum of two people.

1.2 - The system shall generally comprise sectional aluminium beams that fit between fixed end supports and fully removable intermediate posts. Fixings for removable posts to be flush with surrounding surfaces when the system is not erected.

1.3- The demountable system is to be certified to a national standard such as to BS851188-2 or FM Global 2510.

1.4 - The allowable leakage through the demountable defences and their seals shall be in accordance with BS851188-2 which allows for 40litres per metre of seal per hour.

1.5 - The demountable beams are to be lightweight aluminium and each beam is to be a minimum of 300mm high to reduce the number of components required.

1.6 - Where required cast in fixings and baseplates shall be marine grade stainless steel.

1.7 - There shall be no trough or groundbeam allowed on the barrier line that may fill up with debris. The system shall be suitable for concrete surfaces.

1.8 - The design life of the system is to be in excess of 50 years (excluding seals) and the seals are to have a design life of 25 years.

1.9 - The flood barrier system is to have a proven track-record of performance and the flood barrier manufacturer is to have a minimum of five years' experience in supplying flood barriers.

1.10 - All flood barriers shall retain water to the 'flood protection level' as shown on the drawings / as specified. The flood barriers shall be designed to withstand impact loads and wave loads as required

1.11 – Each span shall have a maximum of two clamps to secure the beams in place. The requirement to secure each individual beam will not be permitted.

1.12 - The flood barrier system shall be inherently vandal resistant, utilising vandal resistant fastenings where appropriate. Particular care shall be taken to ensure that seals are protected from vandalism and accidental damage. Seals shall be provided with removable seal covers when barriers are not in place.

1.13 – Seals shall be easily field- replaceable.

2 DESIGN

2.1 – The flood barrier system shall be designed to withstand the water levels and loads as required for the project. These shall include loading from water levels at the full height of the barrier

2.2 – The flood barrier system is also to be designed to withstand the given wave impact loads.

2.3 – The flood barrier system is to be designed to remain stable in winds with a peak velocity pressure of 1.14Kn/M2

2.4 – The flood barrier system is to be designed to withstand impact loads of 10Kn acting half way up the structure caused by floating debris.

2.5 – The flood barrier is to be able to withstand an impact load from the dry side of 10.88Kn acting at any point on the barrier.

2.5 – Calculations for a 'worst case' loading condition are to be provided with each system to show that beams, posts and fixings operate within their design limits.

3 MATERIALS

3.1 – The demountable barrier system shall utilise heat treated aluminium extruded beams to 6063 T66

3.2 – Aluminium beams are to be able to span 2.5metres minimum at 1.5m high, where geometry allows. This is to reduce the number of components required.

3.3 – Aluminium beams are to be in minimum 300mm increments to reduce the number of individual components required.

3.4 – Maximum aluminium beam weight is to be 25kg, allowing safe handling by one person where required.

3.5 – Steel posts shall be manufactured to EN 10027.

3.6 – Fabrications shall be hot-dip galvanised to ISO 1461:1999.

3.8 – Cast in baseplate shall be manufactured from marine grade stainless steel.

3.9 – Baseplates larger than 0.06m2 are to have anti-slip coating applied where in an access area.

3.10 – Exposed/ vertical seals shall be Ethylene Propylene Diene Monomer (EPDM).

3.11 – Where beams are generally to be stored, beam seals are to be manufactured from a highly compressible resilient material.

3.12 – Base seals are to be able to operate on surfaces with a +/- 5mm level tolerance, for where systems are to be erected over existing concrete / impervious surfaces.

3.13 – All fixings to be used are to be load-rated Fixings suitable for the base materials identified on the drawings.

3.14 – The sealant between the end channels and any adjacent structures shall be a fast curing one-component polyurethane sealant/ adhesive with permanent elasticity. Elasticity to be +/- 5% of average joint width at time of sealing.

4 PERFORMANCE

4.1 - The allowable leakage through the demountable defences and their seals shall be in accordance with BS851188-2. The specified leakage rate is 40litres/ metre of seal/ hour.

4.2 – The operating temperature shall be at least -20 to +40 degrees Celsius

4.3 – The system shall allow be operable by a minimum of two operatives. The beams for a 2.5m width and 1.5 metre height barrier are to be able to be installed within 3 minutes by two operatives, including removal of any seal covers, and compression of base seals – 1.25m2/minute.

4.4 – The system shall be designed for minimum maintenance. All seals and gaskets shall be field replaceable without specialist tools.

4.5 – Where specified, storage shall be designed to store all components such that seals are not compressed.

4.6 – Sealing shall be mechanical, and not rely solely on hydrostatic pressure. Sealing shall be 'on-seating' such that seals are compressed further during flood events when hydrostatic pressure is applied.

4.7 – Cast in items are to be flush with finished surfaces to prevent any trip-hazard when the system is not in use.

5 CERTIFICATION AND TESTING

5.1 – The flood barriers shall be certified to a recognised standard such as BS851188-2 or FM Global 2510. Certificates shall be provided with submittals

5.2 – Selected flood barrier lengths shall be tested to ensure satisfactory performance of the unit and sealing arrangements.

5.2 – Testing shall be carried out on sample sections of barrier – number, but not location, to be specified. Where multi-span barriers are used, the test panel shall include at least one of each component (end channel/ centre post/ beams).

5.3 – Testing is to be undertaken with water retained at full designed flood protection level for a minimum of one hour. The amount of leakage through the barrier is to be quantified, and the leakage rate calculated. The test will be considered to be passed if the leakage is less than compliant with the specification. Should the test fail, then remedial works and further tests shall be undertaken

6 OPERATION AND TRAINING

6.1 - Two sets of tools to operate and maintain the barriers shall be supplied with the system.

6.2 – Two copies of an Operations and Maintenance Manual shall be supplied, including installation instructions, a full component list and a user-guide.

6.3 – A video sequence shall be provided to show installation/ removal of barrier components for future training.

6.4 - Components shall be identified using clear and durable labelling on each component, identifying its installed location. A plan of installation locations shall be provided at storage locations to assist in speedy erection.

FLOODCONTROL INTERNATIONAL

INSTALLATION INSTRUCTIONS



Multi Span Demountable Flood Barriers

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Before installing equipment, please read the following instructions carefully.
They contain important information for the installation and operation of the equipment. Keep these instructions in a safe place.

Flood Control International Limited reserves the right to alter product specifications without notice.

INSTALLATION OF MULTI SPAN DEMOUNTABLE FLOOD BARRIERS

1. INTRODUCTION

These Installation Instructions are intended for Flood Control International's multi span demountable flood barriers. The demountable flood barrier system comprises interlocking aluminium 'dam boards' which slot into steel end channels and intermediate support posts to create a watertight barrier across openings. In operation, the dam boards are clamped into position using galvanised steel clamps to compress the base seal and to secure the system. The system is able to be padlocked with special padlockable clamps if required.

Although the components of the system are not heavy, it is recommended that two people install the barrier system.

2. TOOLS AND MATERIALS REQUIRED

- Masonry drill (SDS) with 10mm drill bit
- Impact Driver with TX50 bit for countersunk fixings and 15mm hex socket for bolt head fixings
- 6mm allen key if handles are required for the aluminium beams
- Air blower or vacuum to remove dust from holes
- Spirit level
- Fixings and tools as listed in component list shipped with barrier, including 8mm allen key, 24mm spanner
- Sikaflex-11FC waterproof sealant and sealant gun.

3. TYPES OF BARRIER MOUNT

Demountable flood barriers can be mounted against wall openings in two ways; recess mount or surface mount. The type of mount affects the installation. Ensure you identify the correct procedure for the type of barrier mount to be installed. Generally, recess mount fixings are countersunk, surface mount fixings are bolt head.

3.1 Recess Mount

Recess mount is when the end channels are parallel to the wall as is illustrated in Figure 1.

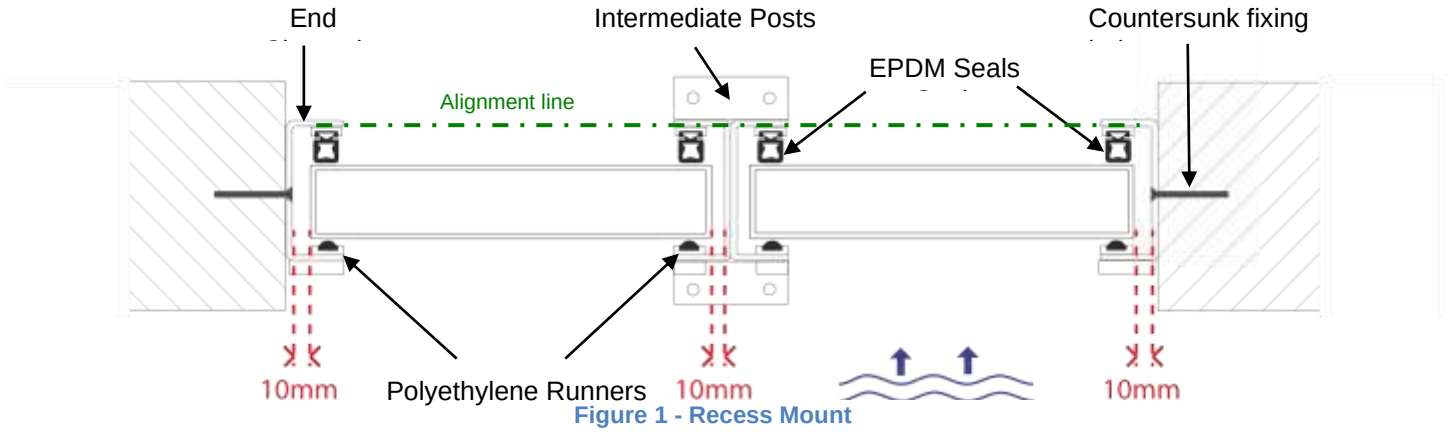
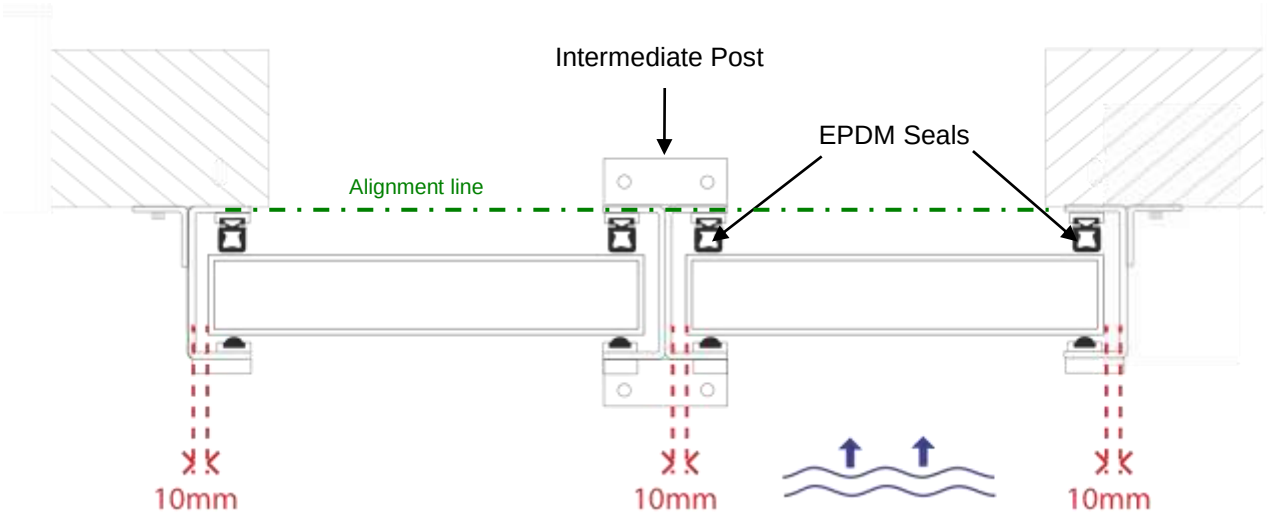


Figure 1 - Recess Mount

3.2 Surface Mount

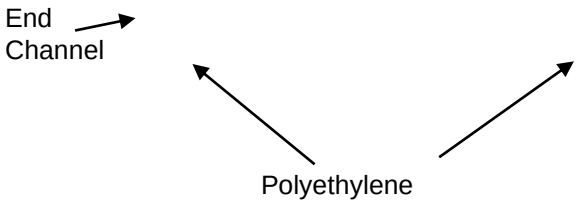
Surface mount is when the end channels are perpendicular to the wall as is illustrated in Figure



2.

Figure 2 - Surface Mount

Please note that the surface mount configuration can be designed so that the barrier sites on the 'dry' side of the wall. Please check the individual drawings for correct location.



4. PREPARATION

4.1 Set out and check all components and fixings according to the components list shipped with the barrier before beginning installation and check which mount configuration is applicable for the barrier.

4.2 Check the dimensions of the opening are in accordance with the flood barrier drawings.

4.3 Loose or flaking areas must be cleaned back to sound material and made good.

4.4 The ground surface must be smooth, level and impervious to water.

4.5 All surfaces must be free from dirt and grease.

4.6 Intermediate post components (supports, braces, compression bars) require the installation of ground anchors. These anchors are usually chemically fixed anchor sleeves and bolts must be installed in accordance with the CAD drawings shipped with the barrier system.

NB Do not attempt to apply the Sikaflex-11FC in temperatures below 5°C or above 40°C.

5. INSTALLATION

The handles for the aluminium beams may have been packed separately to assist with shipping. The beams have threaded inserts already in place – simply screw the handles to the beams using the small bolts provided and seal with a dab of Sikaflex-11FC.

5.1 Offer up an end channel, ensuring that it is vertical and at right angles to the ground surface (Figure 3). All fixing points provided on your system MUST be utilised. Systems that are higher than 1200mm may have extra fixing points.

NB For recess end channels with optional security cover plates, see Section 7 before installation.

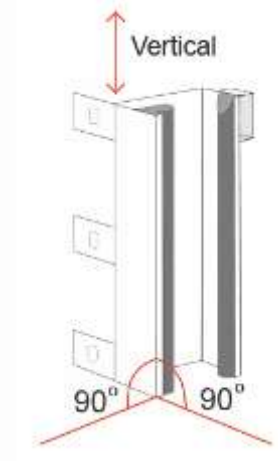


Figure 3

5.2 Use a good quality masonry bit to drill out the hole for the top fixing, ensuring that the hole is dust free. It is imperative that the drilling depth is sufficient to allow the bolt or screw to be fully tightened. For specialised fixings, the manufacturer's instructions MUST be followed.

5.3 Position the end channel to the wall, rechecking alignment. Loosely insert a fixing bolt through the end channel into the top hole. Drill through the remaining fixing holes to ensure that they all align correctly.

5.4 Fix the end channel to the wall, rechecking alignment.

5.5 Use a string line or equivalent to set out the alignment of each intermediate support and the second end channel so that they are precisely aligned - see green alignment line. (Figures 1, 2 and 4)

Alignment line

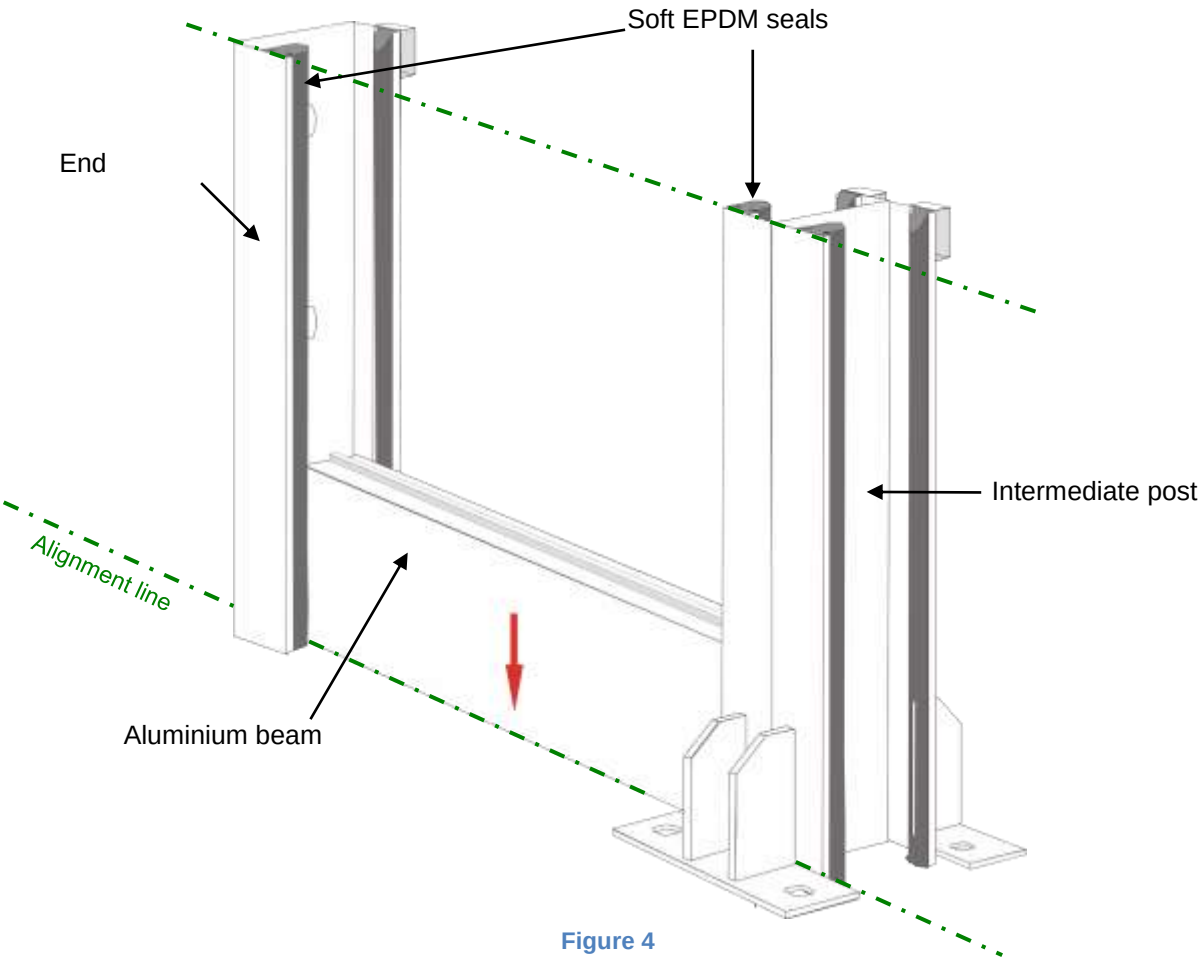

Soft EPDM seals
End
Intermediate post
Alignment line
Aluminium beam

Figure 4

5.5 Insert an aluminium beam into the end channel and intermediate support as a guide. Ensure that there is 5mm - 10mm clearance between the end of the beam and the inner wall of the channel. (Figure 5)

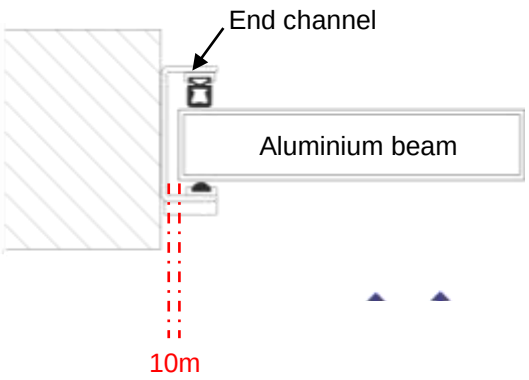


Figure 5

5.6 Ensure that the intermediate supports are correctly spaced apart. Use aluminium beams as guides as necessary, leave a gap of 5mm - 10mm between the end of the beam and the inner wall of each support channel. (Figure 6)

5.7 Position the second end channel using an aluminium beam as a guide, making sure that it is vertical and at 90° to the ground surface (Figure 3). This should leave a 5mm - 10mm gap between the end of the beam and the inner wall of the end channel. The end channels should be aligned. (See Figures 1 & 2)

5.8 Use a good quality masonry bit, drill out the holes as described in Section 5.2 and 5.3.

5.9 Fix the end channel to the wall, rechecking alignment.

5.10 Remove aluminium beams from between the channels.

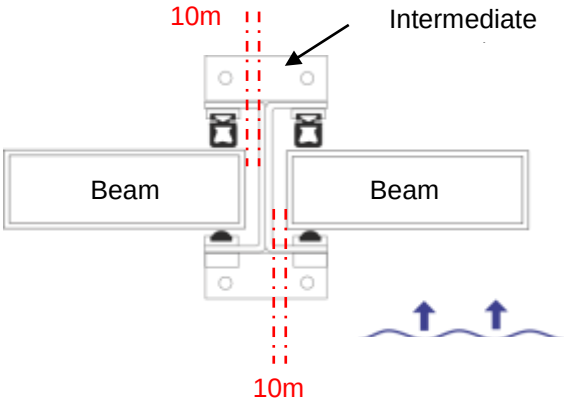


Figure 6

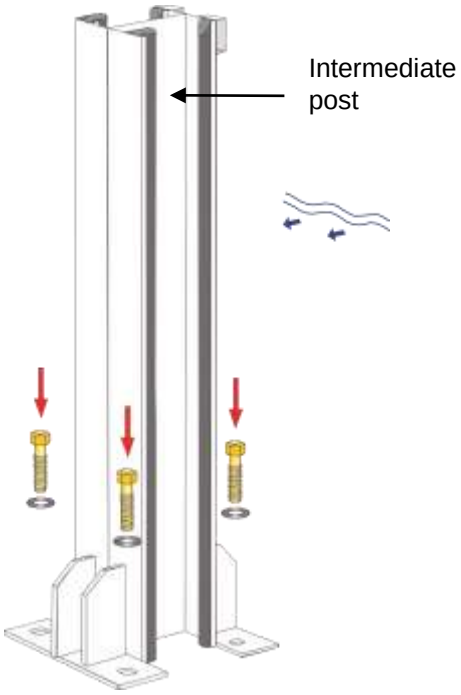
5.11 Ensure the intermediate supports are vertical before marking out and carefully drilling pilot holes for the final fixing anchor bolts through the fixing holes. Depending on the system, a drilling template may be supplied.

5.12 Remove the intermediate support and use a good quality masonry bit to drill out the holes in the ground (Figure 7). Follow the manufacturer's instructions for drilling dimensions. It is imperative that the drilling depth is sufficient to allow bolts to be fully tightened.

5.13 If the intermediate support post anchor bolts go through paving, the hole diameter will change in accordance with whether an anchor socket is required. The drilling template provides a drill bit centre guide to allow precise location of the deeper, smaller diameter holes in the reinforcement.

5.14 Clean out the holes using an air blower or vacuum.

5.15 Insert epoxy and socket into each hole using the tools detailed in the manufacturer's instructions. Ensure that all of the fixings fit correctly by loosely bolting the post in place before the epoxy sets.



5.16 When the epoxy has hardened, fix the intermediate posts to the ground using the washers and anchor bolts provided. (Figure 7)

Figure 7

5.17 Apply a 5-10mm bead of Sikaflex-11FC to the back of the end channels before final tightening, as shown in Figure 8. The sikaflex should also run along the base of the channel to the underside of the soft EPDM seal.

5.18 Adjust fixing screws to final tightness.

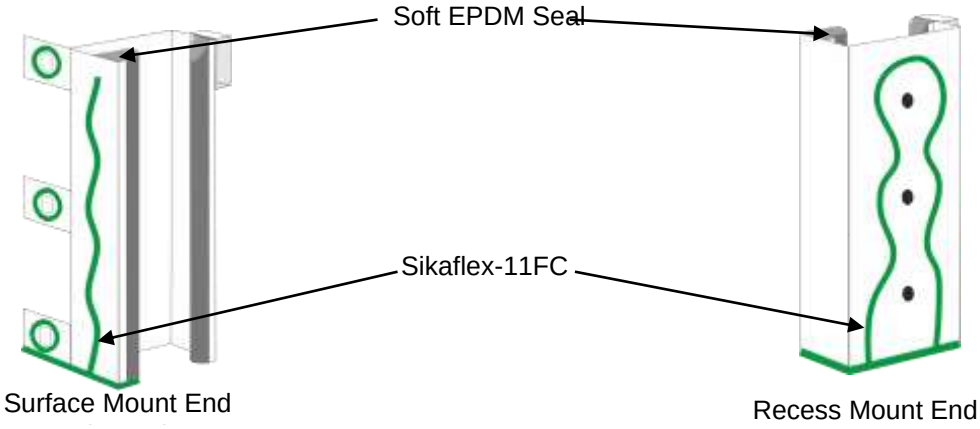


Figure 8

5.19 Now use Sikaflex-11FC sealant to create an additional watertight seal around the edges of the end channels; apply it to:

- All gaps between the end channels and the walls
- The base of the channels where they meet the ground surface
- ANY gaps between the EPDM vertical channel seals and the ground.

NB Sikaflex-11FC must not be applied in temperatures below 5°C or above 40°C.

5.20 Use sufficient sealant to ensure a watertight seal. Figure 6 illustrates where to Sikaflex the surface mount end channels. Figure 7 illustrates where to Sikaflex the recess mount end channels.

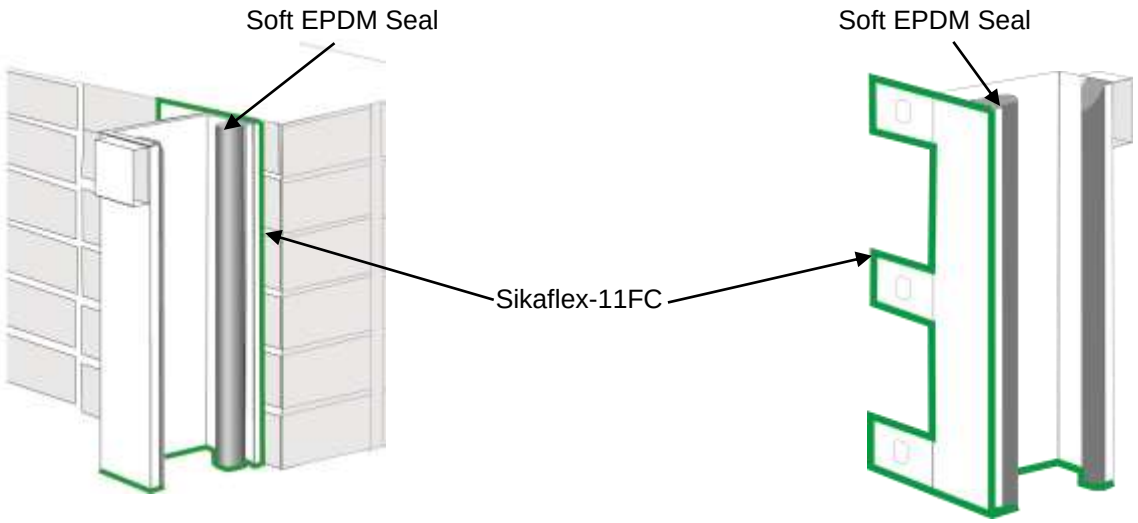


Figure 9 - Sikaflex for Surface Mount End Channels

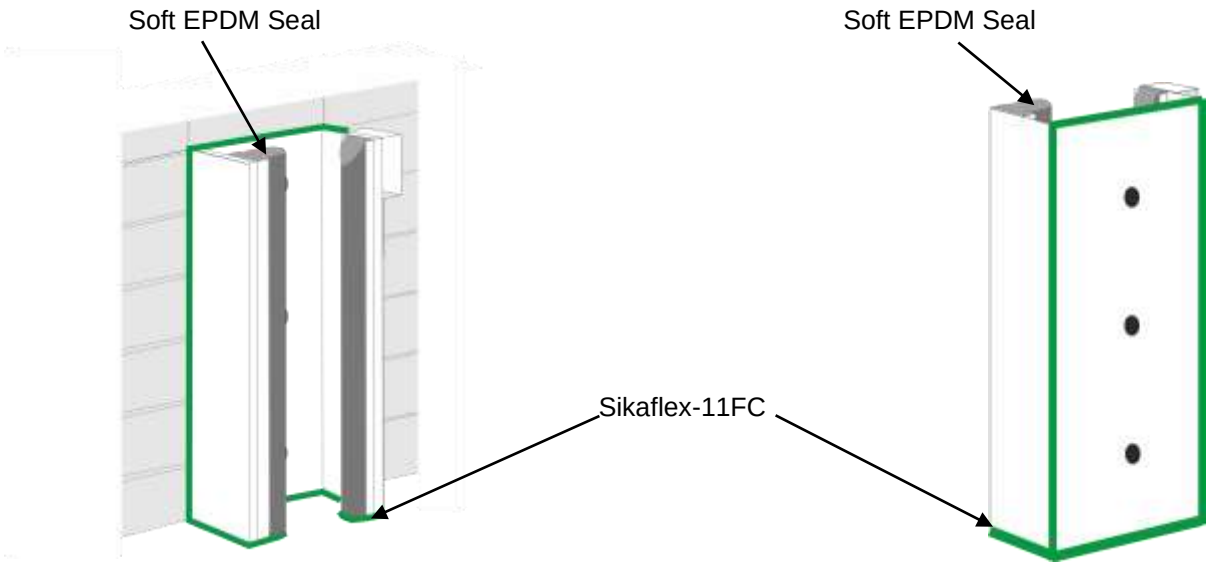


Figure 10 - Sikaflex for Recess Mount End Channels

5.21 For flood barriers over 1.8m high, treating channel seals with a fine application of silicone spray will allow the beams to slide easily into position. (Silicone spray ONLY.)

6. AFTER INSTALLATION

Allow the sikaflex to dry for 24 hours before operational use. This ensures that the soft base seal does not adhere to the sikaflex when installed, and ripping when the bottom beam is removed.

Operating and Maintenance Instructions are supplied in a separate document, shipped with the barrier.

7. ADDITIONAL WORKS FOR SECURITY COVERS

If the flood barrier you are installing has optional security covers, the recess mounted end channels have domed nuts welded onto the back of the channel to allow fixing of the cover plates. To accommodate these domed nuts, a short clearance hole needs to be drilled into the wall for when the end channel is positioned flush against the wall.

7.1 Position the end channels as normal.

7.2 Mark the location where the domed nuts meet the wall.

7.3 Drill a 15mm (minimum) hole 20mm deep into the wall at the domed nut locations.

7.4 Reposition the end channels as before and then drill for the fixing holes.

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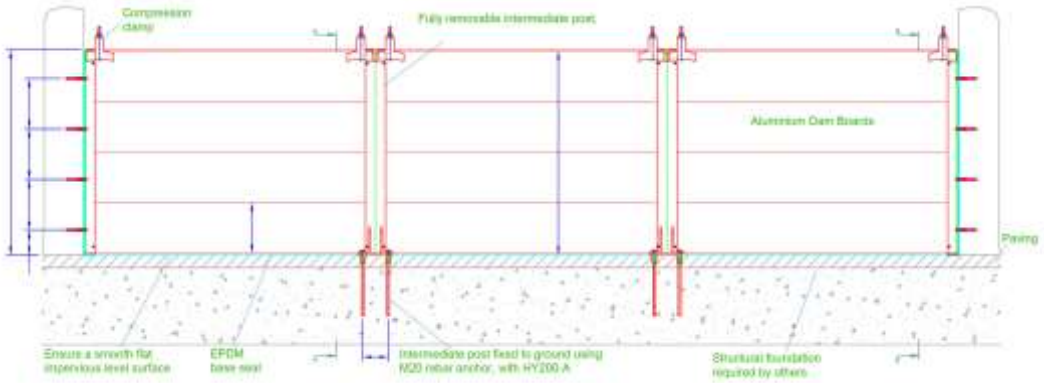
FLOODCONTROL INTERNATIONAL

OPERATION & MAINTENANCE INSTRUCTIONS



Fully Removable Multi-Span Slot-In Flood Barriers

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CONTENTS

Before operating the equipment, please read the following instructions carefully.
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OPERATING & MAINTENANCE INSTRUCTIONS FOR FULLY REMOVABLE MULTI-SPAN SLOT-IN FLOOD BARRIERS

1. TOOLS REQUIRED

- Allen Key No 8 to tighten or loosen the compression clamps.
- 24mm spanner for clamps
- 17mm spanner for M10 bolts
- 30mm spanner to tighten the M20 bolts to install and remove the intermediate posts.
- a wide flat screwdriver to remove the blanking bolts.

2. OVERVIEW

These Operation and Maintenance Instructions are intended for Flood Control International's Fully Removable Slot-In Flood Barriers.

The barriers have their own unique drawing giving the dimensions and any special details. These drawings will be in the handover documentation that accompanies this Operation and Maintenance Manual.

The flood barrier system comprises interlocking aluminium 'dam boards' which slot into fully removable steel end support channels and removable intermediate support posts to create a watertight barrier across openings. Once the dam boards are positioned, they are clamped into position using galvanised steel clamps to compress the base seal and to secure the system.

The seals have excellent resistance to UV, weathering and floodwater. Tests have shown water tightness with a leakage rate of 6-10 litres per metre per hour. The flood barriers are manufactured to BS EN1090.

An overview of the barriers is shown in Figure 1.

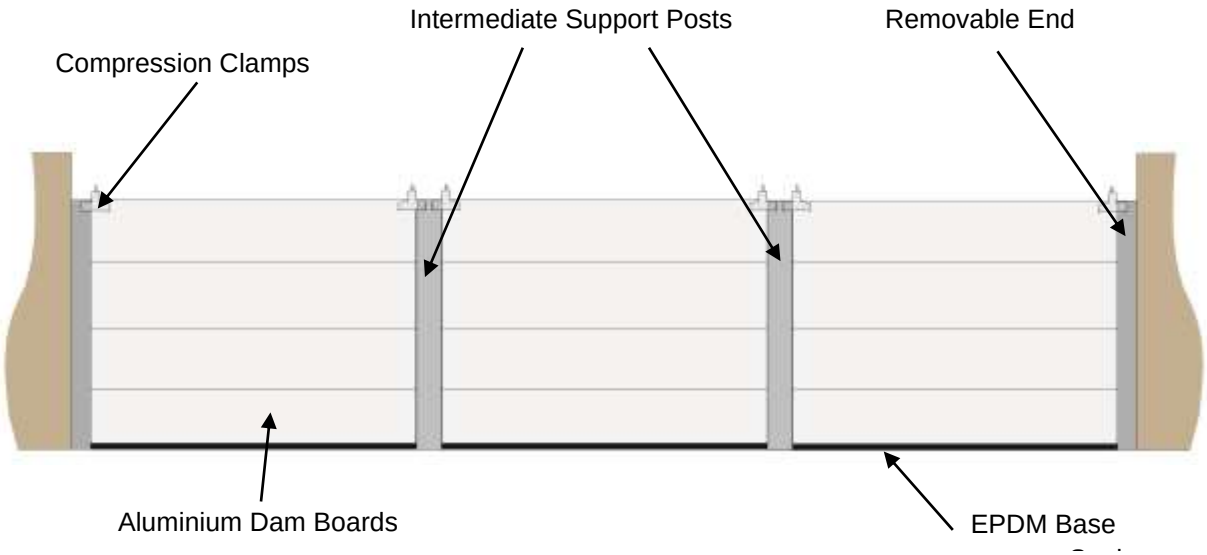

Figure 1 - Elevation

3. COMPONENTS

3.1 Removable End Supports

These are galvanised steel channels with vertical seals and polyurethane running strips. At the top of the end supports there is a 'clamp box' welded to the side of the channel for the compression clamp to fit into. (Figure 2) The back of the end channels are fitted with seals so that when installed correctly, a watertight seal is achieved.

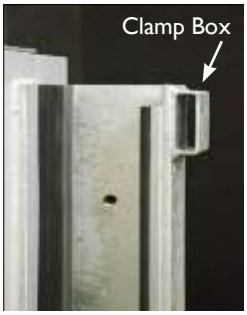

Figure 2

3.2 Dam Boards

Aluminium dam boards are 300mm high, 57mm wide, with lengths to suit the opening. The dam boards interlock, and the bottom dam board has a squashy seal at its base.

3.3 Intermediate Support Posts

Galvanised steel intermediate support posts are used to support the ends of the dam boards. The posts are fixed into cast-in sockets using four M20 bolts each. The posts have a vertical EPDM rubber seal and a vertical polyurethane 'runner' either side (Figure 3). At the top of posts there are 'clamp boxes' welded to the sides of the post for the compression clamps to fit into. When not fitted, the cast-in sockets are protected against dirt etc by blanking bolts. (Figure 4)

Figure 3

Figure 4

3.4 Compression Clamps

Galvanised steel compression clamps (Figure 5) comprise a short box section fixed to the clamp bolt, which is threaded through the main plate of the clamp.

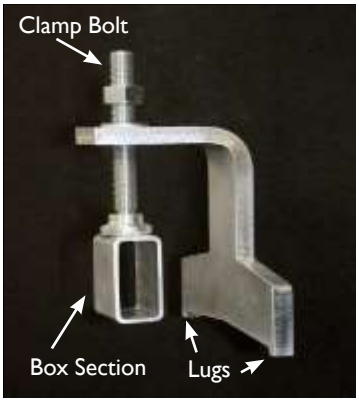

Figure 5

4. INSTALLING THE REMOVABLE END SUPPORTS

4.1 Remove and retain the M10 domed blanking bolts from the wall where the end channel is to be positioned.

4.2 Offer up an end support into its position, ensuring that it is vertical and at right angles to the ground surface.

4.3 Once positioned, use the M10 countersunk bolts to fix the channel to the pre-installed Hilti HIS-RN socket anchors in the wall (as detailed in the component list and drawings). Ensure that the fixing bolts are tightened so that the seal on the back of the channel is sufficiently compressed to form a watertight seal.

4.4 Repeat for the other end support.

5. INSTALLING INTERMEDIATE POSTS

5.1 Using a wide flat screwdriver, remove the four M20 domed blanking bolts from the post sockets and retain. (Figure 4)

5.2 Position the intermediate support post over the sockets. The rubber seal MUST be on the same side as the rubber seals in the end channels ie if the rubber seals are on the 'wet side' of the barrier at the end channels, then the rubber seals on the post need to be on the 'wet side' of the post, when positioned.

5.3 Bolt the intermediate support post to the floor using the M20 rebar anchors with HY-200A bolts and tighten.

5.4 Repeat for all intermediate support posts in the system.

6. INSTALLING ALUMINIUM DAM BOARDS

6.1 The first dam board to be installed has a large squashy seal at the bottom (Figure 6). Position the dam board into the slots of the steel end supports / intermediate posts and push vertically downwards until it reaches the floor.

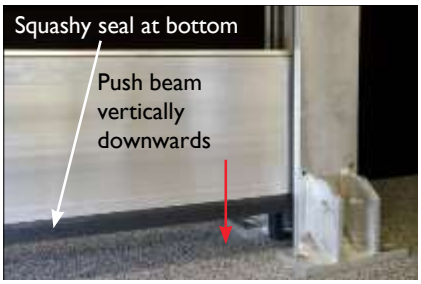

Figure 6

6.2 Install subsequent beams in a similar manner so that they interlock. (Beams the correct way up have the small horizontal seals at the top).

6.3 When all beams are installed, fit the compression clamps to either end. This is done by lowering the box-section at the end of the clamp bolt into the groove at the top of the aluminium dam board, with the main body of the clamp hanging down on the same side as the clamp box which is welded on the end support / intermediate post. (Figure 7)

Figure 7

Figure 8

Figure 9

6.4 The compression clamp is now slid sideways so that the end of the clamp slides into the clamp box, and the 'lug' on the end of the compression clamp clears the far side of the clamp box.

6.5 Tighten the compression clamp by using the No 8 allen key and turning the clamp bolt until the box section on the end of the threaded clamp bolt is pushing the aluminium beams down. (Figure 8)

6.6 Repeat the clamping to both sides for each span.

6.7 Fully tighten the clamp bolts with the allen key provided so that the bottom seal is compressed along its entire length evenly.

6.8 To 'lock off' the clamps, now tighten the clamp nut with the 24mm spanner (Figure 9).

8. REMOVING ALUMINIUM DAM BOARDS AFTER USE

8.1 Unlock the compression clamp using the 24mm spanner on the nut. Loosen off the clamp bolt using the No 8 allen key that fits into the top of the bolt.

8.2 Once the compression clamps for each span have been loosened, slide out and remove the clamps from the end channels / intermediate posts.

8.3 Remove the aluminium dam boards one at a time by lifting them out of the channels. Ensure that the dam boards are placed upside down in storage so that the bottom dam board is stored with the squashy seal uppermost.

9. REMOVING INTERMEDIATE SUPPORT POSTS

9.1 Remove the M20 bolts that fix the bases of the intermediate posts using a 30mm spanner.

9.2 Using a wide flat screwdriver, place the four blanking bolts into the holes left by the M20 bolts.

9.3 Remove all equipment to its dedicated storage.

10. MAINTENANCE GUIDELINES

10.1 After experiencing a flood event it is recommended that all seals are rinsed down with a very mild disinfectant and hosed with fresh water as floodwaters can often carry contaminants.

10.2 Under normal circumstances the barriers do not need any maintenance. A general inspection

should be undertaken annually.

10.3 *Seals* - an inspection of the vertical seals, main horizontal seal and small horizontal beam seals should be undertaken annually. Where seals have been damaged, these should be replaced.

10.4 *Clamping Mechanism* - the threaded rod element of the clamp should be tested for ease of use. A general lubricant may assist in the easy operation of the threaded bar.

10.5 *Intermediate Post locations* - the stainless steel grub screws located within the cast-in sockets should be cleaned, checked and tested for operation.

11. SUGGESTED SPARES

Spares should include seals for where any mechanical damage has occurred to existing seals:

11.1 Vertical EPDM seal to end channels – 10 linear metres

Expected Operational Life:	15 years
Suggested Replacement Time:	10 years

11.2 Horizontal small seal between aluminium beams – 10 linear metres

Expected Operational Life:	15 years
Suggested Replacement Time:	10 years

11.3 Horizontal large seal to base of bottom barrier beam – 4*2.5m lengths

Expected Operational Life:	15 years (stored) 5 years (permanently installed)
Suggested Replacement Time:	10 years (generally stored 3 years (permanently installed)

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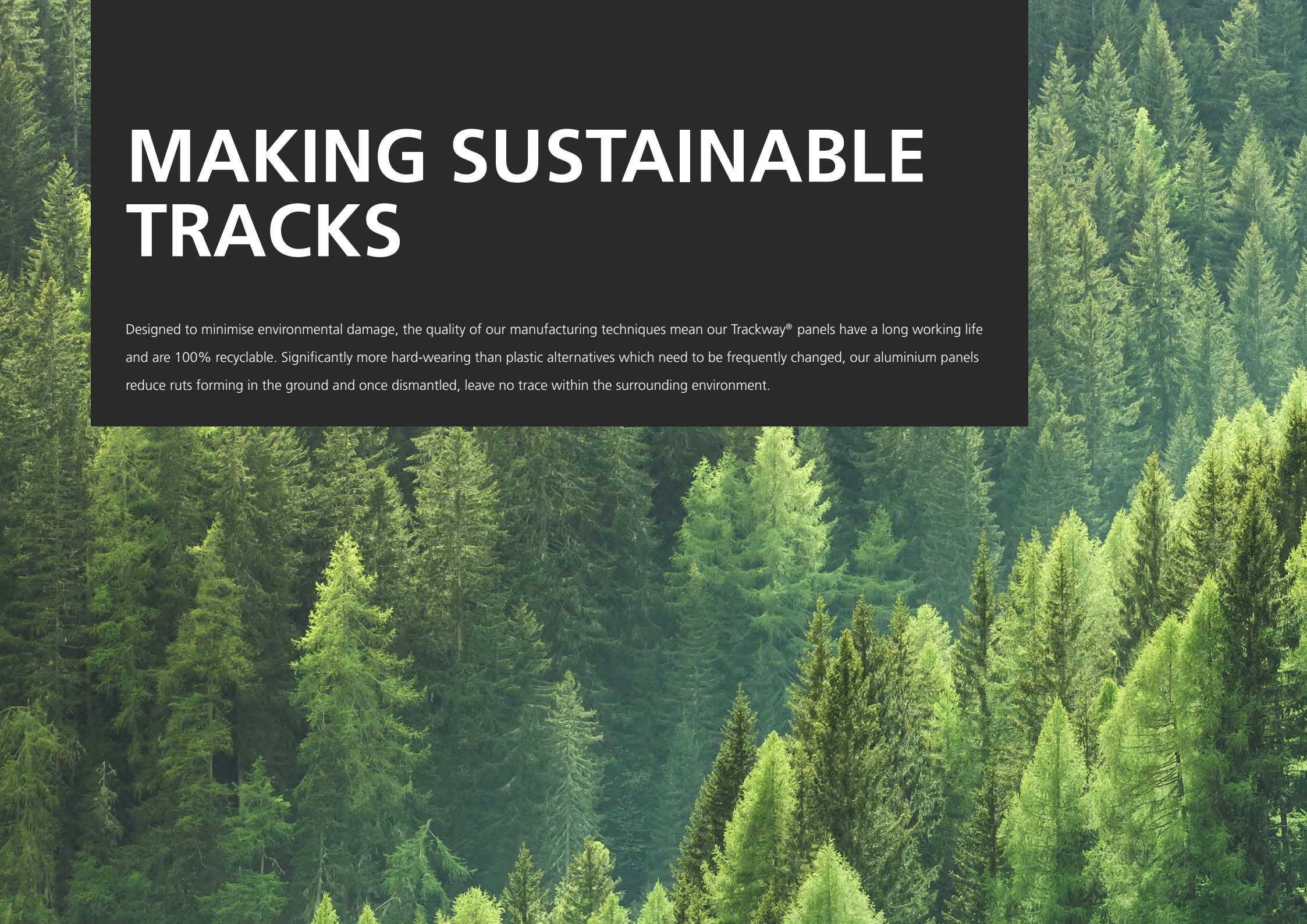
G Removable slipway – Faun Trackway Ltd.

TRACKWAY® ACCESS

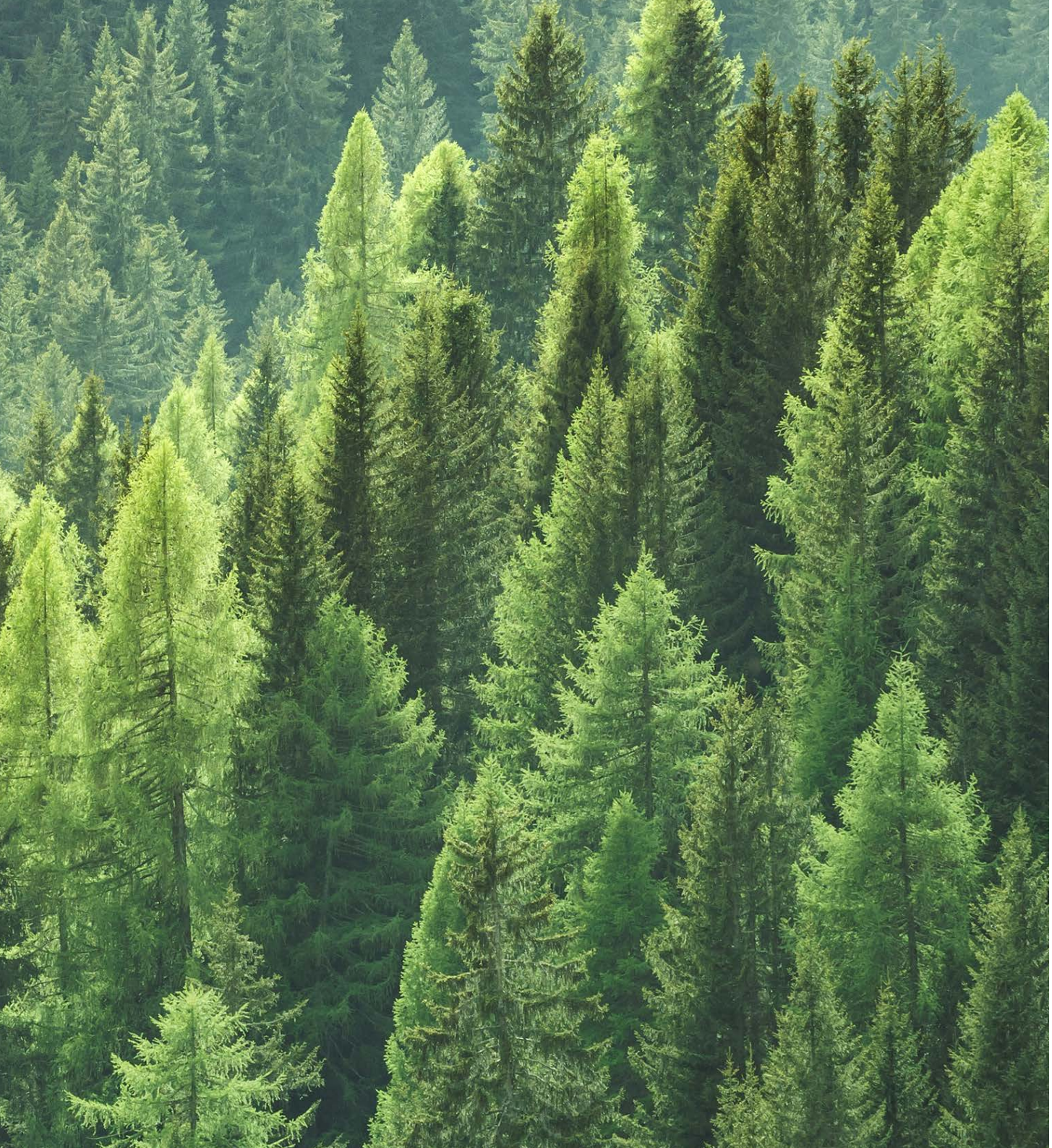
BOAT RAMP KIT

FAUN TRACKWAY



MAKING SUSTAINABLE TRACKS

Designed to minimise environmental damage, the quality of our manufacturing techniques mean our Trackway® panels have a long working life and are 100% recyclable. Significantly more hard-wearing than plastic alternatives which need to be frequently changed, our aluminium panels reduce ruts forming in the ground and once dismantled, leave no trace within the surrounding environment.



Portable Trackway® to maximise the mobility of boats and other watercraft

The Boat Ramp Kit facilitates the easy launch and recovery of watercraft and vehicles. Used as a temporary access route, or a more permanent solution, the Boat Ramp Kit can be used in areas where it is not suitable for conventional boat ramp structures such as tidal areas, freezing waters, and marsh. This cost effective solution comprises of a Trackway® panel of choice, and an array of deployment options and accessories - getting your boat to shore has never been easier!

TRACKWAY® SOLUTIONS

CAPABILITY

Suitable for wheeled vehicles, boat trailers, and marine equipment;

Used for as little as a day or a more permanent installation;

Ensures ground / environmental protection;

Provides a high traction surface;

Laid and recovered quickly and efficiently.

Foot protection is required for walking on all Trackway® aluminium products.

SPECIFICATION

Aluminium panels, joined together by a tongue and groove joint, with locking bolts to secure;

Designed to be constantly reused, has a long operational life and is recyclable;

Withstands ambient temperatures ranging from -40°C to +60°C;

Does not float and is suitable in flowing water;

Anodised as standard;

Easily cleaned due to open nature of profile;

Half panels every 5m (16ft 4in) for easy splitting and joining.

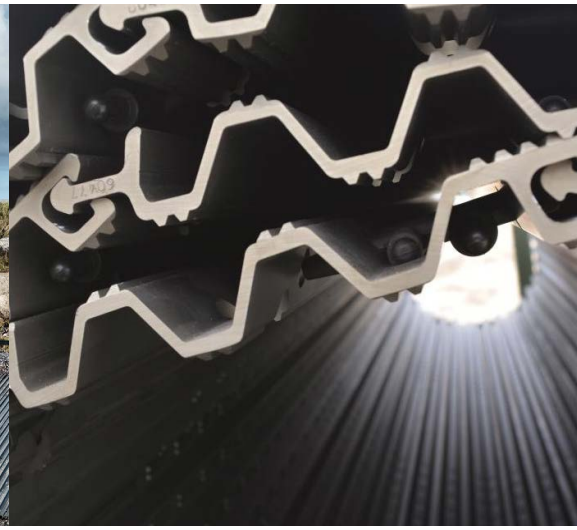
C40 TRACKWAY®

C40 Trackway® is designed to withstand repeated passes of vehicles with a gross weight of up to 100 tonnes (220,500lbs), with a maximum axle load of 13 tonnes (28,665lbs). Available in two widths, the C40 Trackway® can be deployed by either a Pushframe, a Pushbar, Parbuckling Straps, or by hand.

DIMENSIONS PER PANEL

	Item	Width Option 1	Width Option 2
✓	Width:	3,354mm (11ft)	4,200mm (13ft 9in)
✓	Length:	214mm ($8^{7/16}$in)	214mm ($8^{7/16}$in)
✓	Effective Length:	194mm ($7^{5/8}$in)	194mm ($7^{5/8}$in)
✓	Height:	31mm ($1^{3/16}$in)	31mm ($1^{3/16}$in)
✓	Weight:	15.4kg (34lb)	19.2kg (42lb)
✓	Weight / Area:	23.7kg/m^2 (4.85lb/ft^2)	23.7kg/m^2 (4.85lb/ft^2)



C90 TRACKWAY®

C90 Trackway® is designed to withstand repeated passes of vehicles with a gross weight of up to 150 tonnes (330,700lbs), with a maximum axle load of 18 tonnes (39,683lbs). Available in one width, the C90 Trackway® can be deployed by either a Pushframe, a Pushbar, by Parbuckling Straps or by hand.

	Item	Measurement
✓	Width:	4,572mm (15ft)
✓	Length:	230mm ($9^{1/16}$in)
✓	Effective Length:	214mm ($8^{7/16}$in)
✓	Height:	32mm ($1^{1/4}$in)
✓	Weight:	31.9kg (70.3lb)
✓	Weight / Area:	33.3kg/m^2 (6.82lb/ft^2)

DEPLOYMENT OPTIONS

PUSHFRAME

Manufactured from steel, and painted as standard, the Pushframe is designed to roll out and recover up to 50m (164ft) of C40 Trackway® or C90 Trackway® by use of a compatible host machine with a quick hitch, or suitable hitch.

	Item	Measurement
✓	Width:	1,311mm (4ft $3^{5/8}$in)
✓	Length:	853mm (2ft $9^{9/16}$in)
✓	Effective Length:	1,113mm (3ft $7^{13/16}$in)
✓	Height:	260.4kg (574lb)

Dimensions are host machine dependent.
Above dimensions based on JCB 3CX, 4CX, 436

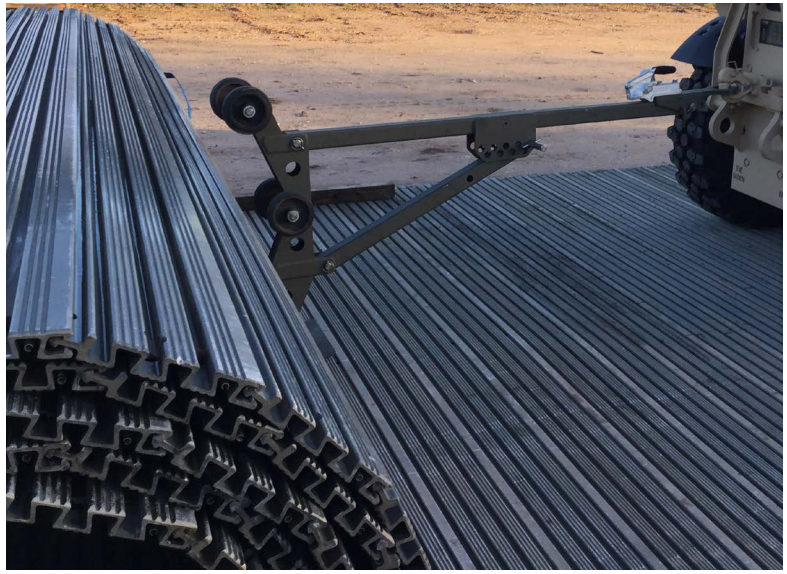
PUSHBAR

The Pushbar is a galvanised steel device with plastic wheels, designed to roll out and recover up to 40m (131ft) of C40 Trackway® or 30m (98ft) of C90 Trackway® by use of a vehicle with a minimum of 3,500kg (7,716lb) tow capacity, and either:

1. A towing hitch or pin suitable for a 3in diameter towing eye;

2. 50mm (2in) trailer towing hitch ball.

	Item	Stowed	Deployed
✓	Width:	518mm (1ft $8^{3/8}$in)	518mm (1ft $8^{3/8}$in)
✓	Length:	2,225mm (7ft $3^{5/8}$in)	2,256mm (7ft $4^{13/16}$in)
✓	Effective Length:	366mm (1ft $2^{3/8}$in)	975mm (3ft $2^{3/8}$in)
✓	Height:	63kg (139lb)	63kg (139lb)



PARBUCKLING STRAP

The Parbuckling strap assists with the recovery of C40 Trackway® or C90 Trackway®. Positioned underneath the roll of Trackway® as it is laid out, the Trackway® can be later recovered by attaching a Parbuckling Strap(s) to a vehicle's centre tow point, and driving forward in a slow and controlled manner.

FAUN TRACKWAY

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HR Wallingford
Working with water

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