



BITUMINOUS GROUTED ROCK

Material Description:

Grouted rock is using either new or existing rock and filling the interstices with a grout, either bituminous or cementitious to form homogenous or partially homogenous groups of rock therefore increasing the mass and the resistance to hydraulic loads. Bituminous grout is made of a mastic comprising bitumen, sand and filler with 10/20mm aggregate added if required. It is placed hot as a low viscosity fluid and cools to form a robust flexible layer.

Design:

There are three main techniques - Surface Grouting, Pattern Grouting, and Fully Grouting.

For a new rock armour revetment, the specified rock can be reduced by a factor of 5-7 times when combining the rock with pattern bituminous grouting. (e.g., a layer of pattern grouted 2t rock will have the same resistance to hydraulic loads as a layer comprising 10-14t rocks). By adding grout to areas of maximum hydraulic loading a new revetment's rock size may be designed to resist 'normal' loads rather than 'maximum' loads.

For existing rock erosion protection, bituminous grout can be targeted to reinforce damaged areas or areas where hydraulic loads have increased since initial design, avoiding the need to replace entire structures.

It can also be used to target discrete points where scour on the sea or riverbed is most likely/harmful, e.g., upstream faces of piles and piers, boat thruster locations and slipway/revetment toes.

Suitable to be used in remote locations and can be placed at depths of up to 20m below water level.

Using asphaltic grout has the benefit of being flexible and therefore will follow settlement and deformations.

Asphaltic grout is non-polluting in a marine environment and does not bleed or leach harmful compounds into the water.

Primary Uses:

- Increase the mass of existing rock
- Reduce the design needs of rock armour
- Repairing damaged areas on existing rock
- Underwater scour protection

Constituents:

- Rock and stone
- Mastic (bitumen, sand and filler)
- 10/20mm aggregate added to mastic

Common Alternative to:

- Large rock armour
- Replacing existing rock armour and riprap
- Overdesign of rock armour to maximum requirements
- Cementitious grouting

Properties:

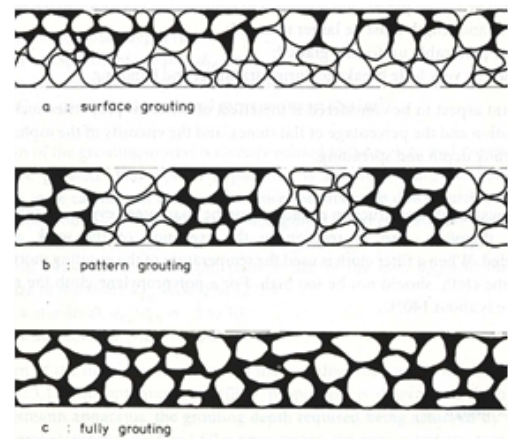
- Flexible & robust
- Can be porous or non-porous
- Pattern grouting is resistant to wave heights of 5m
- Grout is impermeable however the level/depth of grouting will determine the permeability of the structure



Full depth grouting to gabion stone

Production & Installation:

- Produced centrally in the UK or batched on site for remote locations
- Delivered in tankers or in block form for small quantities
- It can be either heated on site or brought to site at the required temperature
- Placed with cranes, excavators or skips
- Can be placed below water up to 20m depth
- Adaptable for minor works down to 2m² in remote locations



Three main techniques of Grouted Rock from 'Communications - The use of asphalt in hydraulic engineering'

Durability:

The mastic is very durable according to Technical Advisory Committee on Water Defences therefore the durability of the structure is determined by the durability of the rock and the integrity of the edges/toe. On Megget Dam's upstream face, damage occurred from impounding. HEP upgraded the rock using pattern grouting in 1997/8 and no damage has been noted since despite the increase in severity and number of annual storm events.

Maintenance:

Grouted rock usually requires very little or zero maintenance. There is no history of maintenance in 27 years at Megget Dam. Should maintenance repairs be needed, it is a simple exercise requiring cleaning with bituminous mastic added and some more rock if the repair requires it.

Environmental Compatibility:

Asphaltic mastic does not harm water quality and is inert when cured. Asphaltic mastic allows for smaller rock to be used, lowering the transport and plant requirements and therefore reducing the CO2 impacts.

Key Performance Information

- Can be used for new structures, to upgrade existing structures or target specific high impact locations
- Can be placed above or below water
- Able to be delivered pre-mixed and heated or can be batched on site making it suitable for remote locations
- Flexible and resistant up to 5m wave height attack
- Uplift forces need to be considered when using fully grouted rock
- Minimal if any maintenance required



Megget Dam – pattern grouted in 1997-98, no maintenance needed – photo taken Oct 2025

Design Guidance

Design guidance is available in the Rijkswaterstaat publication 'Communications - The use of asphalt in hydraulic engineering'. (p 139 for wave impacts, p 142 for water flow).

For resistance of grouted rock against wave impacts the Hudson formula may be used. The damage coefficient k_D can be increased by a factor of 1-1.5 for surface grouting, and 5-7 for pattern grouting. For resistance to high water flow Pilarczyk's equation for rock may be used with modified parameters. (See PIANC Report 180-2015)

Sources:

PIANC Report No. 180 - 2015. Guidelines for protecting berthing structures from scour caused by ships

Communications – The Use of Asphalt in Hydraulic Engineering by Technical Advisory Committee on Water Defences (Rijkswaterstaat – Netherlands Government).