Vegetation Gabions (Reed Gabions)

Specification (status: February 2018)

Vegetation Gabions

(Reed Gabions)

1) Overview

Description	wire baskets lined with geotextile, filled with small armour stones and lava rock granules or soil, are installed on the slope; the baskets are made of corrosion-resistant, galvanized and drilled steel wire – alternatively plastic nets – with a pre-grown plant mat **desired vegetation:** native and habitat-adapted bank line consisting of reeds, tall forbs, grass and herbs (*installation in zones depending on the tolerance range of the respective plants according to site properties)*
Bank protection	immediately effective areal slope protection against surface erosion induced by currents and waves after area-wide installation and providing filter properties; structural stability is guaranteed through the deadweight of the gabions in the reach of ship-induced drawdown only applicable if the existing mass per unit area of the reed gabions corresponds at least to the mathematically necessary mass according to GBB (2010)[1)] in the long-term, bank protection can only be ensured if the installed plants feature properties which correspond with the available boundary conditions (e.g. plants that tolerate sufficiently flooding in areas with longer surface-flooding periods at simultaneous hydraulic loads); vegetation dieback may pose a risk to long-term gabion stability
Ecological potential *in comparison with riprap*	structural and ecological habitat enhancement (for animals and plants) only if the development of vegetation is undisturbed experiences from the test stretch at the river Rhine [2) to 6)] show that large water level fluctuations with long lasting flooding in combination with ensuing dry phases impair plant growth seriously, resulting in a major loss of vegetation (→ decrease in number of plants as well as in botanical biodiversity); a high amount of non-degradable materials (wire, plastic) becomes very dominant considering the boundary conditions at the river Rhine [2) to 6)], vegetation gabions cannot be recommended from an ecological perspective
Advantages/ Disadvantages	**Advantages** - immediate guarantee of bank stability - good stability against sliding through deadweight (*no or only marginal securing devices necessary*) **disadvantages** - high percentage of artificial construction material (*wire, plastic*) - long-term preparations due to the necessary pre-cultivation of plant mats alone or in combination with gabions (*at least one growing season*) - overall success depends to a great extent on the right choice and delivery quality of pre-cultivated plants, quality assurance is necessary - died-off plants cannot be replanted - if necessary, additional filter towards the subsoil required - limited installation period (*weather, growing seasons*) - labour and cost intensive production and installation (*hoisting technology, cross beam*)

2) Components and installation

Components **Gabion**	**wire basket** galvanized and multiply mechanically drilled wire mesh (*galvanic alloy*) mesh size of wire mesh: 6 x 8 cm (adapted to the stone sizes), wire diameter: 2.2 mm, reinforced edge and frame wires gabion dimensions (L *x W x H*): 2.0 m x 1.0 m x (*max.*) 0.3 m (*variable dimensions*) **or plastic net** highly tear-proof, non-knotted plastic net with UV-stabilizer, mesh size adapted to the size of the interior stones (45 mm for stone size: $CP_{45/125}$) **lining** (*on all sides between wire basket and filling*) geotextile that is easily pierceable for roots *(preferably biologically degradable as usage only during the initial period of approx. 3 years)* for the purpose of retaining finer interior material **filling** frost-resistant natural stone material (stone size $CP_{45/125}$ according to TLW, (2003)[12)]), gravel-topsoil mixture or lava rock granules (2 to 8 mm, *dense filling*), plant mat on the top side
Plantmat	pre-cultivated, consisting of a base mat (*e.g. coir*), planted with 20 - 25 plants/m^2 (*with different plantation for different bank zones, e.g. reeds, tall forbs, grass and herbs if necessary*) 2 options are possible: on-site-installation of the pre-cultivated plant mat or propagation of the mat in combination with the gabion at the manufacturer
Filter	an additional filter between the vegetation gabions and the subsoil (*corn filter if possible, dimensioning according to MAK[8)], MMB[9)]*) is only necessary if the filter stability in the underground cannot be guaranteed only with the aid of the installation of the gabions alternatively, an entirely biologically degradable geotextile can be installed (*necessary only during the initial period of 3 years; afterwards, roots fulfil the filtering function (MAG[7)])*)
Connections	**metal ring/C-ring-staples** (*for gabions*) diameter: approx. 4 mm
Cover	usually not necessary
Pre-cultivation and installation period	**pre-cultivation** pre-cultivation of the entire reed gabions or only of the plant mats (*at least one growing season*), fully covered by plants and penetrated with roots (*continuous quality management by purchaser necessary*) **installation period** (*during dormancy period, on frost-free days)* ideally: March/April (*root growth immediately after installation*); depending on location and weather, until May also limited suitability: October/November *(root growth starts following spring)*

Boundary conditions for installation	**distance to water level** lower edge of reed gabions: usually approx. mean water level, normal water level in case of water level fluctuations depending on the flooding tolerance of the used plants **slope inclination** ≤1:3 **lighting** sun or partial shade
Installation instructions	**Tight area-wide installation** (see Appendix 1) longitudinal installation with crane and cross beam in direction of the flow; installation offset by half of the length in order to avoid cross joints (*tight connection without gaps or joints, maintain the correct order on the bank for planting zones*). **water supply** irrigation after installation and if needed (*e.g. during low water and dry periods*) **connection** connection of the gabions with metal rings/C-ring-staples at the edges at a distance of approx. 20 cm **procedure** (see Appendix 2) 1) preparation of subgrade 2) construction of an abutment consisting of armour stones at approx. MW (*abutment might already be ensured due to an existing riprap below MW*) 3) if necessary, application of a mineral filter layer (layer thickness 30 cm) or a geo-textile 4) installation of vegetation gabions, starting at the upper edge of the armour stones at the slope toe, then place all-over the slope 5) connection of gabion elements 6) irrigation of vegetation gabions entirely after installation **ensuring filter stability** dimensioning of mineral or geotextile filter in case of potential loss of soil (*fine-grained soil*) and install if needed (*geotextile filter must additionally be easily penetrable by roots and preferably biodegradable*)

3) Mode of action and load-carrying capacity

Mode of action

protection against surface erosion induced by currents and waves

right after installation — through an area-wide, filter-stable cover made of gabion bodies with their own weight, if necessary with additional filter

in the long term — additional protection through network of roots of the growing, pre-cultivated plants close to the surface and of their aerial shoots

protection against slope-sliding due to drawdown/excessive pore water pressure

right after installation — through sufficient mass per unit area and filter-stable structure of the gabions

in the long term — additional protection through increasing root penetration of the gabions and the subsoil *(increasing shear strength within the gabions and the in-situ soil (cohesion due to roots))*

protection against hydrodynamic soil displacement due to drawdown/excessive pore water pressure

right after installation — through sufficient mass per unit area and filter-stable structure of the gabions

in the long term — additional protection due to an increasingly dense network of roots within the gabions and in the in-situ soil *(cohesion due to roots)*

in general

sufficient mass per unit area of the gabions: calculation according to *GBB 2010*[1)]

filter-stable structure: verification according to MAG[7)], MAK[8)], MMB[9)]

Tolerance to hydraulic loading

basis: present experiences gained at navigable waterways[2) to 6) , 13) 15) 16)] **and watercourses without navigation**[14)]

- drawdown: necessary mass per unit area through reed gabions (verification according to GBB[1)])

restricted applicability due to limited layer thickness (approx. 30 cm)

- wave height: 1.0[*)]m *(derived from experiences gained at watercourses without navigation for waterbodies with navigation)*[14)]

0.5m *(derived from the successful application at the Untere Havel Wasserstraße – lower Havel waterway (UHW), km 35.7, at regulated flow and minor water level fluctuations)*[15)]

affected by a measured ship-induced load of 0.25m at the test stretch at the river Rhine and very high water level fluctuations at the same time, the reed gabions have not proven to be stable (*plant dieback was caused by flooding over a period of several weeks*)[4) 5)]

Tolerance to hydraulic loading *(continued)*	- flow velocity close to the bank: 2.6*) m/s *(derived from experiences gained at water-courses without navigation for waterbodies with navigation)*[14)] 1,0 m/s *(derived from the successful application at the Untere Havel Wasserstraße – lower Havel waterway (UHW), km 35.7, at regulated flow and minor water level fluctuations)*[15)] affected by a measured ship-induced load of 0.25m at the test stretch at the river Rhine and very high water level fluctuations at the same time, the reed gabions have not proven to be stable (*plant dieback was caused by flooding over a period of several weeks*)[4) 5)] **) values are valid for the stability of gabions; there are no sufficient experiences on the load-carrying capacity of the plants installed in the gabions available yet* [14)]
Flooding tolerance	depending on the plant species high flooding tolerance of sedge species[2) to 5)] acute sedge (*Carex acuta*) and greater pond sedge (*Carex riparia*) under simultaneous hydraulic load, determined at the Rhine test stretch – regenerative capacity after approx. 12 weeks of flooding lower flooding tolerance under conditions observed at the Rhine test stretch[2) to 5)]: Creeping bentgrass (*Agrostis stolonifera*), reed canary grass (*Phalaris arundinacea*), tall fescue (*Festuca arundinacea*), yellow flag (*Iris pseudacorus*), lakeshore bulrush (*Schoenoplectus lacustris*), gypsywort (*Lycopus europaeus*), purple loosestrife (*Lythrum salicaria*), tufted hairgrass (*deschampsia cespitosa*) additional influence on flooding tolerance by: flood height, flow, plant height, flooding period (*during growing season or dormancy*), plant vitality
4) Miscellaneous	
Maintenance	- reeds and tall forb communities are generally to be excluded from maintenance measures - if necessary, irrigation during months with low precipitation (*especially during the initial phase*) - regular control of neophyte growth; occurrences are to be removed (*completely with roots*) and disposed of immediately - control with regard to possible damages of the gabions (*e.g. wire mesh or geotextile lining*), if necessary, repairing, especially in the first few years (*damages to the gabions may lead to local failure of the construction!*)
Examples at German Waterways	- test stretch at the river **Rhine** near Lampertheim, km 440.600 - 441.600, right bank, - (test section 5a), installation finished at the end of 2011[2) to 6)]; affected by the boundary conditions of the Rhine test stretch, by very high water level deviations and the long flooding period in particular, the reed gabions have not proven to be stable for the long term (*plant dieback was caused by flooding over a period of several weeks and simultaneous hydraulic load*)[4) 5)] - **lower Havel waterway** (UHW), km 35.7, right bank, near Ketzin, installation finished in 1994 (*positive development under given boundary conditions until today, bank protection without restrictions*)[13)16)] - flood channel near Rees at the river **Rhine**, km 833.5 - 839.0, left bank between Kalkar-Reeserschanz and Xanten-Obermörmter (*under given boundary conditions* (*no navigation!*) *positive development until today, bank protection without restrictions*)

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5) Institutions / link	
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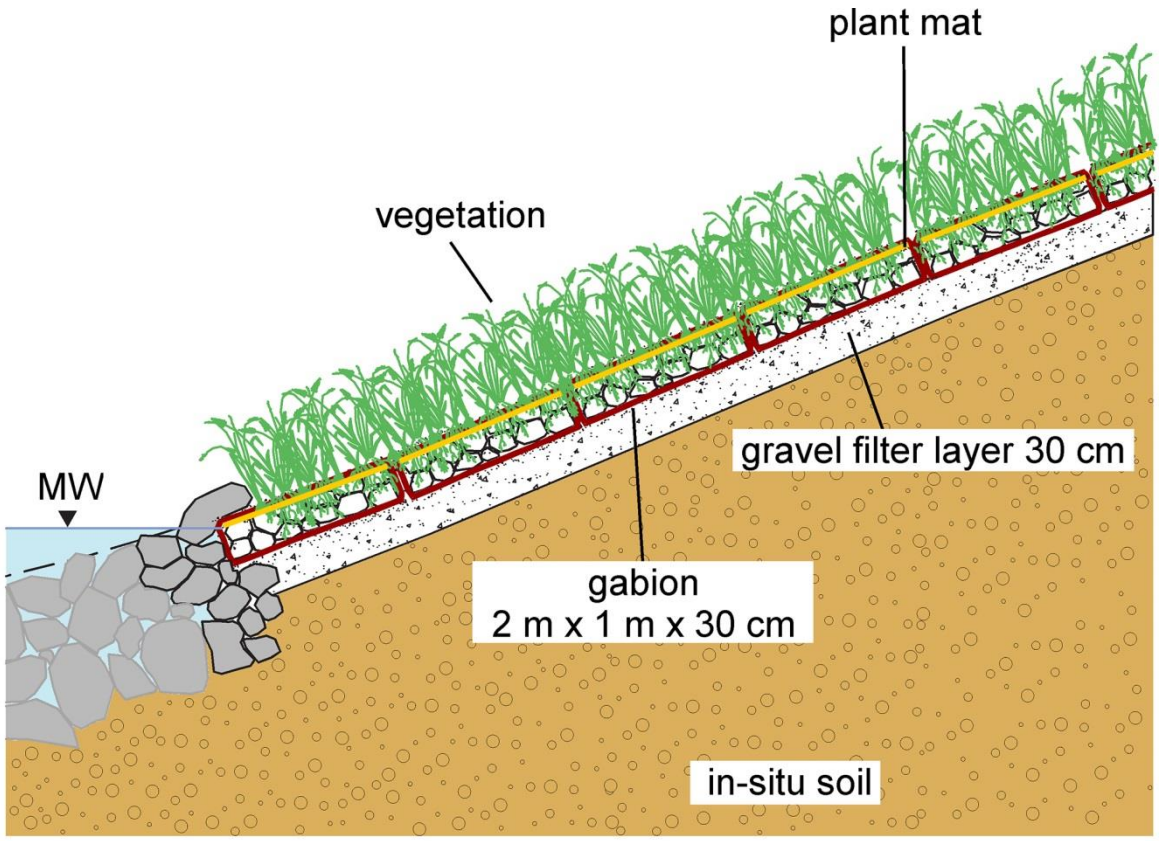
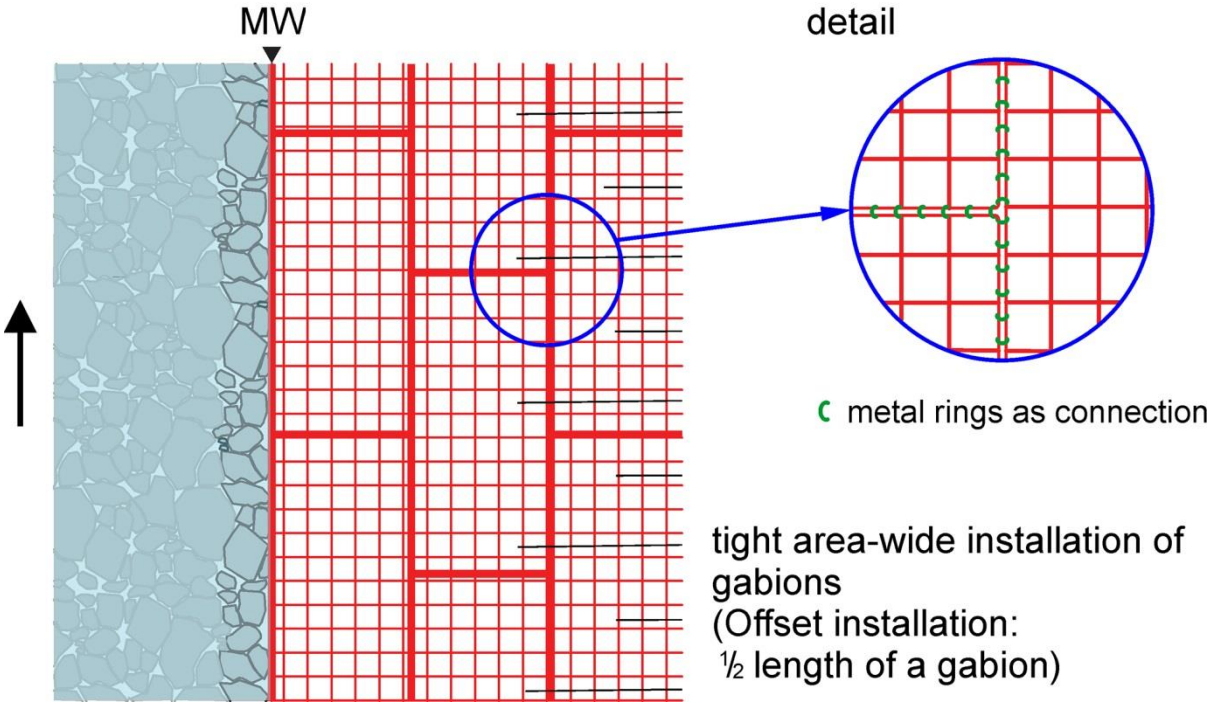
Link	For further information, please see: http://ufersicherung.baw.de/de

Appendix 1 — Sketch



installation pattern (plan view)



tight area-wide installation of gabions
(Offset installation:
½ length of a gabion)

Appendix 2 — Sample photos

Source: Test Stretch Lampertheim/Rhine[2) to 6)] (lower Havel waterway) — photos: BAW/BfG

photos 1 – 5 | photo 6

(1) 30 cm mineral granular filter on the subgrade adjoining the abutment of armour stones; Oct. 2011

(2) pre-cultivated reed gabions (one growing season) after delivery, Oct. 2011

(3) gabion body fully covered by plants, with roots of approx. 30cm depth, Oct. 2011

(4) installation of a reed gabion with cross beam, Oct. 2011

(5) finished bank section with reed gabions; Nov.

(6) positively developed reed gabions, 8 years after installation at UHW, km 35.7 (2001)