

## Technical-biological bank protection on inland waterways

### Project description

The banks of inland waterways are exposed to natural and ship-induced hydraulic loads. Most banks are sloped and, as a rule, riprap is used to protect the adjacent ground and any existing structures as well as to maintain the ease and safety of navigation. The design of riprap is based on technical codes and guidelines that have been in place for many years. These are additionally supported by decades of practical experience.

To implement the European Water Framework Directive (EC-WFD) and comply with the provisions of the German Federal Water Act and Federal Waterways Act, inland waterways need to be redesigned in a more environmentally friendly way in order to rejuvenate habitats for animals and plants and to increase biodiversity. This goes hand in hand with the objectives laid down in the federal government programmes 'Biological Diversity', 'Germany's Blue Belt' and the 'Action Programme for Insect Conservation' as well as other technical concepts and strategies.

Ecological enhancement of riparian zones can usually be best achieved by removing and not replacing existing riprap and enabling the natural succession of vegetation. However, this is only possible where river banks can be allowed to evolve naturally. In areas where bank protection is indispensable, riprap should be replaced with more environmentally friendly bank protection that use vegetation, provided that boundary conditions permit this. Examples of technical-biological bank protection are willow brush mattresses, pre-cultivated vegetation mats, vegetated gabions and vegetated riprap. The objective of these measures is to improve the bank's environmental quality while at the same time ensuring necessary bank protection.

There is nothing new in the idea of stabilising banks by using vegetation. Bioengineering techniques were used on rivers and canals as early as 100 years ago. However, as ships grew in size and their engine power continuously increased, the hydraulic loads on river banks increased to such an extent that these protections were no longer sufficient. As a result, biological stabilisation methods were slowly replaced by revetments made of riprap. Before suitably adapted biological measures can be used once again, their long-term effectiveness must first be assessed under today's boundary conditions.



*River Rhine, right bank, km 440,82 bis km 440,95  
(willow brush mattresses)*



*Weser river, right bank, km 241,55 bis km 242,30  
(willow brush mattresses and other measures)*



*River Rhine, right bank, km 440,63 bis km 440,75  
(vegetated riprap and stone wall with shallow water zone)*

In a joint research project, the Federal Waterways Engineering and Research Institute (BAW) and the Federal Institute of Hydrology (BfG) have been studying the suitability of technical-biological bank protection measures under the current ship-induced impacts and the overall ecological conditions prevailing on inland waterways for several years. The project looks into the ability of more natural bank protection measures to withstand hydraulic loads and to ensure the stability of banks; their installation and maintenance; long-term stability; ecological potential and the cost of construction and maintenance. As well as a literature search and targeted investigations on different waterway reaches, this involves laboratory tests and modelling. Moreover, field tests are conducted, in which alternative protection measures are put to test under waterway conditions. The field investigations are accompanied by extensive monitoring. Many important insights have been gained in a large-scale field test conducted in collaboration with the Waterways and Shipping Office Upper Rhine on the River Rhine at Worms since 2011. Questions relating to the long-term stability and maintenance of alternative bank protection measures in particular will be clarified in the next few years. Investigations in new test reaches are planned. In addition, research will be conducted on the root formation behaviour of relevant plant species and on the stability of bank slopes taking roots into consideration. Internationally, there is also intensive exchange between specialists, in particular within the current PIANC working group 128 'Technical-biological bank protections for inland waterways'.

The findings obtained to date provide first well-founded insights, not only into the ecological effectiveness of various measures compared to technical riprap but also about their robustness, their ability to protect banks, and the cost involved. These insights have found their way into guidelines, application recommendations and a design concept for technical-biological bank protection measures, including design software, all of which are already available to the planning engineers working at the German Federal Waterways and Shipping Administration (WSV). Thus, important groundwork has been done, which serves as a foundation for the riverbank enhancement projects planned for the next few years, for example under the 'Germany's Blue Belt' programme.

The results of the BAW's and BfG's joint research project and the guidelines will be posted on this Internet portal on an ongoing basis.



*Lower Havel Waterway, right bank, km 35,70  
(vegetation gabions)*



*River Rhine, right bank, km 441,00 bis 441,05  
(vegetation gabions and stone mattresses)*



*Mittelland Canal, left bank, km 189,50 bis km  
190,00 (reeds, protected by sheet-pile wall)*



*River Rhine, right bank, km 441,20 bis km 441,36  
(plant mats)*