Institute for Hydraulic Engineering and Hydrometry

Federal Agency for Water Management

Loose rip rap - further development by means of model tests

Client: Office of the Vorarlberg Provincial Government

Initial situation:

- A loose rip rap is used to stabilise riverbeds. Large stones are placed on the bed, which remain in place during floods. There are gaps between the stones that allow ecological permeability into the gravel gap space of the watercourse.
- This method was developed at the TU Munich (water bodies with 0.1 % gradient).
- Further development in the Federal Agency for Water Management within the framework of specific projects (Salzach, Bregenzerach) up to a gradient of approx. 1 %.

Question: Can the bottom stabilisation method “loose rip rap" be used for even steeper watercourses?

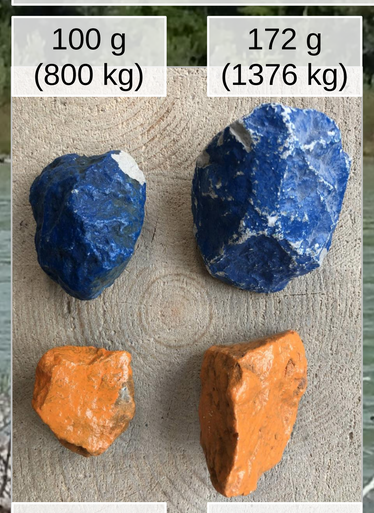
Practical example: Renaturation of a steep watercourse (approx. 2 % gradient) with a maximum of 340 Newton per square metre of bottom shear stress during a one hundred-year flood.

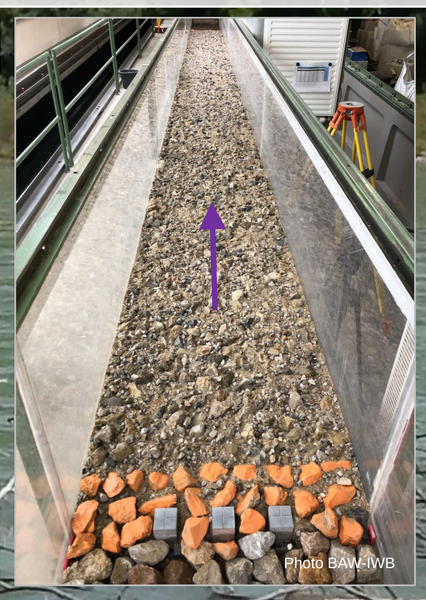
Loose rip rap: Large stones are laid loosely on the riverbed and are covered with bedload outside of flood times.

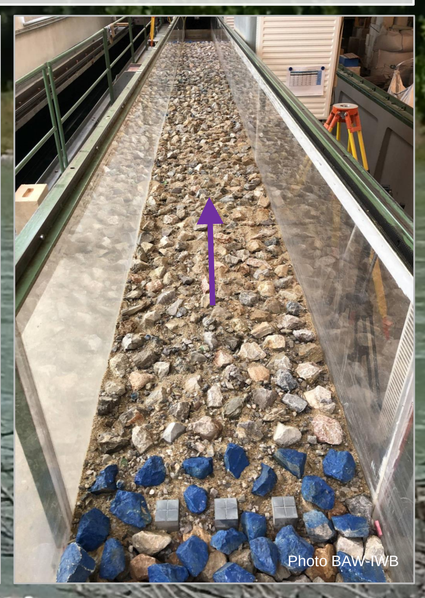
Salzach: Slope 0,2 %

Bregenzerach: Slope ~1 %

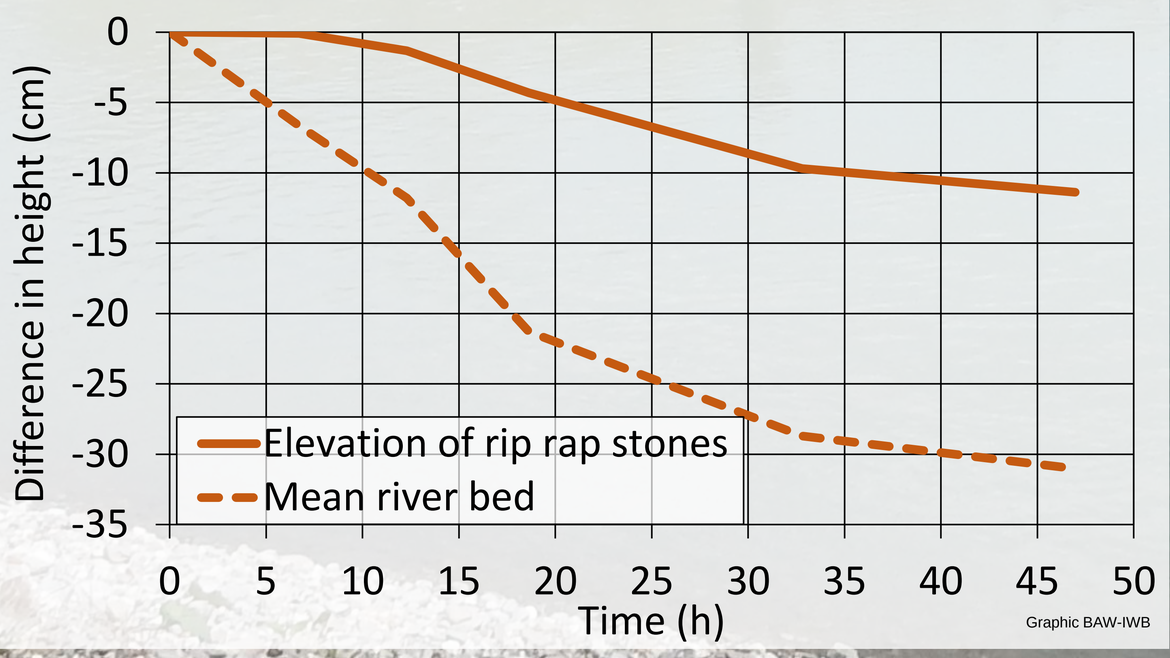
Example of a model test on a scale of 1:20, variation of stone sizes from 300 to 1500 kg, bed material from 36 to 88 mm.



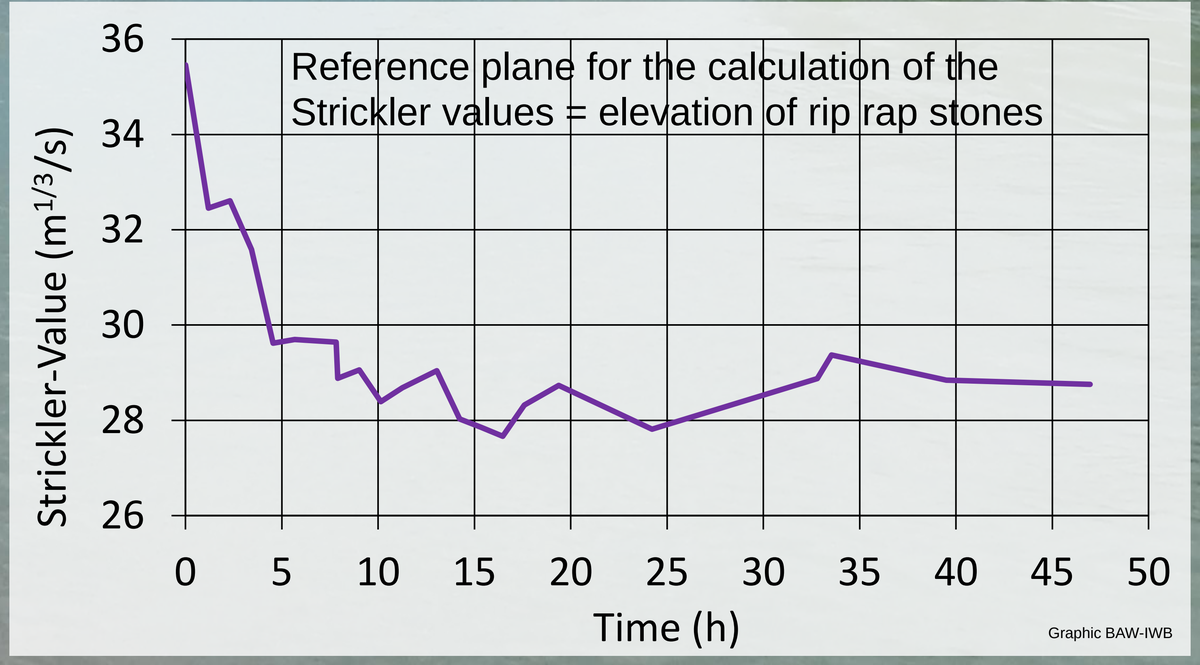




Development of mean bed elevation and elevation of the loose rip rap stones over the test period:



Development of the flow resistance of the riverbed over the test period (design discharge):



Current state of development of the method loose rip rap:

- The application for 2 % slope and bottom shear stress of 340 Newton per square metre is possible. The required individual stone masses must be between 300 and 800 kg, with an occupancy density of 40 %.
- The bed material in the subsoil must have at least a so-called d_{90} of 150 mm and an average grain diameter of 63 mm so that the stones do not sink into the subsoil.

Open Questions:

- Economic consideration of areas with locally higher stresses on the invert (e.g. in curves).
- Sounding out the lower limit of grain sizes for the subsurface material (also in connection with the natural bedload transport of a watercourse (for range of gradients from approx. 0.2 % to 2 %).

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