Influence of length of micro groins on bed morphology in a straight channel

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Abstract Micro groins are an alternative bank-protection method which uses small submerged installations in the river bed to direct the flow away from the bank. In order to assess their impact on the bed morphology, lab experiments with movable bed were designed. A reference experiment and five variants with micro groins of different lengths were conducted. Strong changes of the bed morphology with pronounced deposition along the groin's root and two erosion areas at the head of the groin and upstream its root were observed. The bed morphology became more accentuated with increasing length of the groins.

Keywords: river restoration, micro groins, hydraulic experiments, bed morphology, bank protection.

Methods

With reference to the conditions in a field project at the lowland river Alb near the Rhine port in Karlsruhe, Germany, physical model experiments with movable bed (plastic granulate) were designed in the Theodor-Rehbock laboratory in the scale 1:15 with the following testing conditions (Müller et al. 2020):

- 100-year flood
- Groins with inclination angle α of 60°, groin width w_{groin} of 7 cm and height h_{groin} of 1/10 of the water level were selected (Fig. 1)
- Five different lengths of groins l_P with ¼, ⅓, ½, ⅔ and ¾ were investigated
- Bed morphology was measured for the third groin with a Seatek Ultrasonic Ranging System
- Due to dunes the two most extreme bed levels patterns were measured: State S1 = erosion at groin's root and State S2 = deposition around groin's root
- Statistical results were averaged from S1 and state S2

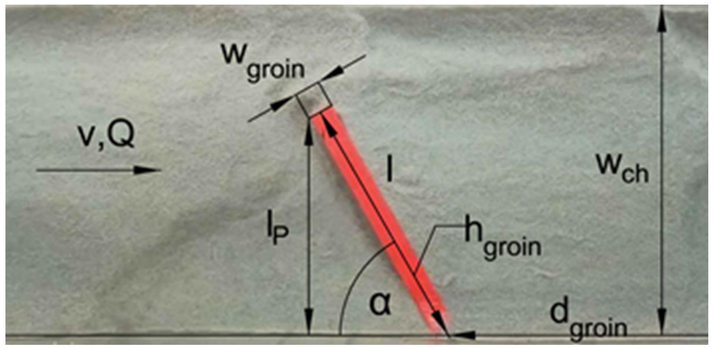

Figure 1: Design parameters of micro groins

Results

In the reference experiment the bed morphology is very homogenous and it's mainly influenced by dunes due to the fine sediment. The installation of the groins leads to the following effects:

- Reduced bank-near flow velocity leads to significant deposition along the adjacent bank (Fig. 2)
- Increase of bed level variety with increasing length of the micro groins (Fig. 3)
- Scour can be found around half of the flume width downstream of the groin's head → approves findings of Möws & Koll (2014)
- Additional deep scour upstream of the groins root → need for proper protection of structural integrity

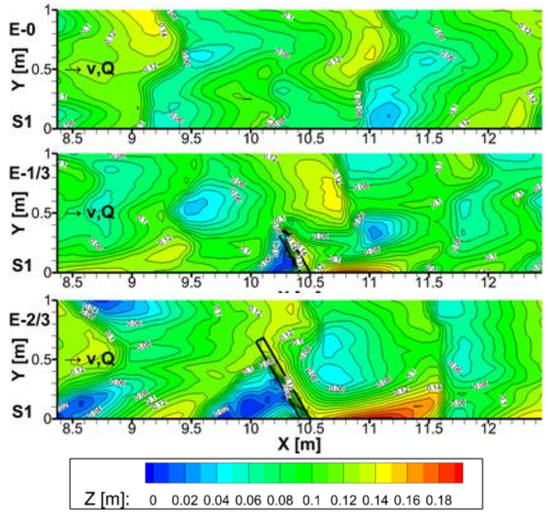

Figure 2: Bed morphology for state 1 for reference experiment and micro groin of lengths l_p = ⅓ and ⅔

Conclusions

With the presented study it could be shown that micro groins have a strong effect on the river bed structures. Because of the high variety of bed morphology during the experiments more systematic investigations and repeated experiments will have to be analyzed in order to further quantify this effect.

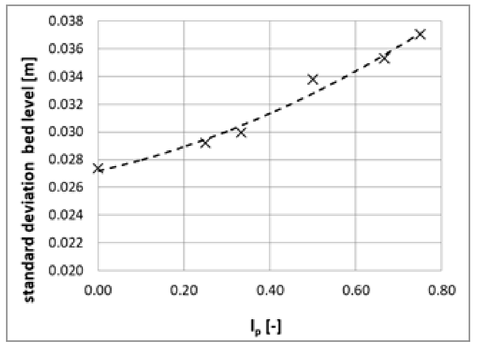

Figure 3: Statistical Analysis

Bibliography

Möws, R. & Koll, K. 2014. Influence of a Single submerged groyne on the bed morphology and the flow field. Proceedings of the International Conference on Fluvial Hydraulics, RIVER FLOW 2014. doi: 10.1201/b17133-193.

Müller, A., Seidel, F., Nestmann, F. (2020): Assessment of the effect of micro groins on riverbed structures – Comparison of the velocity distribution between experiments with fixed and mobile bed. In: River Flow 2020 – Uijttewaal et al (eds). Taylor & Francis Group, London.