ETH zürich

Bed Morphology and stability of steep open channels

Fig. 1: step-pool sequence in the flume.

Steep headwater streams are often characterised by alternating steps and pools (Fig.1). The specific pattern can be seen as image of the complex interaction between topography, hydrology, geology and vegetation of a river catchment area. As bed roughness is large relatively to flow depth, the flow field and thus flow resistance and stability are largely influenced by bed morphology.

The purpose of the present research project is to investigate the bed morphology and the stability in steep open channels in order to enlarge the physical background for hazard assessment. A better knowledge of bed morphology and stability is also required for the design of stable and nature-orientated man-made structures.

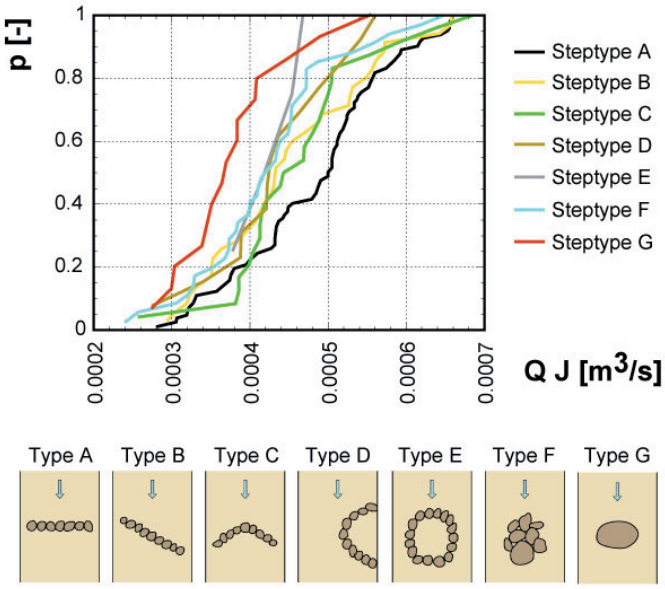

Fig. 2: occurance of step types depending on streampower.

Flume experiments with a widely-graded sediment mixture are being performed to simulate the formation and destruction processes of step-pool systems. Laser profiling is used to provide digital elevation model data that allows for the detailed recording and analysis of the bed topography. Visual observation and classification of step geometry provides additional information (Fig.2)

First results concerning bed morphology show that within the typical step-pool geometry the predominant structures are steps that are orientated transverse to the direction of flow. The formation of ring-structures, clusters and oblique or curved steps depend on flume width, slope and discharge. The rising frequency of transversely orientated steps with increasing slope can be attributed to the adaptation towards a more stable structure (Fig.2).

In the experiments different failure mechanisms could be identified. As the stability of step-pool systems is primarily determined by the stability of the large boulders the destruction processes are initiated by loss of their support by inner erosion, scour at the step toe or by direct erosion of the large boulders. However, the collapse of a single step does not trigger the collapse of a step-pool system, because single destabilized boulders could even enhance the stability of the following step. As a result the definition of stability in conjunction with the significant destabilizing processes needs further investigation to assess hazards of mountain torrent quantitatively.

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