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Alternative Groyne Designs for Disaster Mitigation and Environment Restoration

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Schemes to restore aquatic habitats in alluvial rivers usually involve the installation of instream structures such as groynes to enhance channel diversities including flow patterns, bed topographies and substrate compositions. This kind of hydraulic and morphological diversities play essential roles in the life cycles of many aquatic species such as fishes and macroinvetebrates and are recognized as important estimates of riverine habitat suitability. Groynes are conventional instream structures for bank protection and navigability enhancement. Over the past several decades, however, groynes have been known to be the most successful stream restoration measures and have been achieved a wide spread use all over the world. The presence of a groyne structure, representing a disturbance to a river channel, generally increases the local flow complexities, promotes the pool-riffle morphological sequences and triggers the sediment sorting processes. An understanding on these resultant phenomena is a prior to the groyne design and any implementation action.

This paper presents an experimental study on the local flow structure and the bed variation characteristics around different types of groynes in sediment mixtures. Different from conventional impermeable and permeable groynes, alternative designs are proposed in this study to achieve the maximum benefits for disaster mitigation and environment restoration. Impermeable and permeable groynes are combined in various ways and their hydro-morphological implications are investigated.

It is found that the types of the groynes exert influence on the local scour and wake deposition properties and the variation of sediment mean diameters. Sand ribbons are observed in the downstream of the groyne in cases of sediment mixtures, mainly caused by the sediment sorting process in the transverse direction. In general, both the flow structure and the bed properties around a hybrid groyne are a combined one of that of a permeable groyne and an impermeable groyne. Therefore, desirable flow patterns and bed properties may be achieved by taking full advantages of these two kinds of groynes.

The top-blocked and bottom-open groyne, also known as Bandal-like structure, sometimes, shows much interesting hydro-morphological functions compared with other types of hybrid groynes. The Bandal-like structure seems to result in a large area of local scour but with a relatively small scour depth. Corresponding to the large scour area, it also performs well in promoting wake deposition. Concerning the structure safety, the effectiveness in bank protection and the enhancement of channel diversity, the Bandal-like structure might provide a promising solution.