Scour around Spur Dyke: Recent Advances and Future Researches

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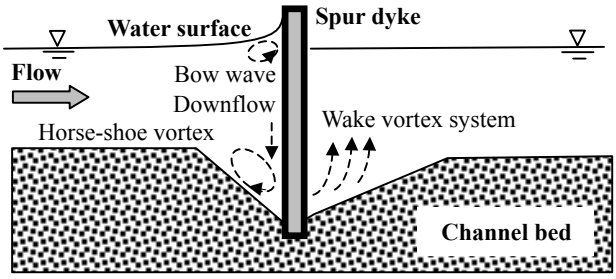
1. Introduction

Scour around spur dyke is a common phenomenon in river engineering and a challenging problem for hydraulic research. Although spur dykes have been extensively constructed in channels all over the world, scientific knowledge is still very limited on the effective use of this typical in-stream structure. Misinterpretation of the scour process is one of the major reasons for spur dyke failures in practice. This paper summarizes the current understanding on the flow structures and scour characteristics around spur dykes and reviews existing investigations conducted with methods of laboratory experiments, field measurements and numerical simulations. The recent development of numerical models has been given special attention. The directions for future researches are also discussed.

2. Recent advances

Essentially, local scour is the result of a dynamic feedback process between turbulent flow and erodible boundaries. The turbulent flow in the proximity of the scour hole around a spur dyke is extremely complex due to the generation of multiple vortices of different sizes. The intricacy is furthermore increased with the development of the scour hole. It has been well accepted that the local turbulent flow around a spur dyke may be separated into several components. In front of the spur dyke, there are a bow wave near the water surface and a downflow towards the channel bed due to the stagnation of approaching flow. As results of the flow separation, a horse-shoe vortex develops in the local scour hole and a wake vortex system forms behind the spur dyke. A schematic diagram of the flow and local scour at the longitudinal section passing the spur dyke tip is shown as below.



A lot of empirical or semi-empirical formulae have been proposed to estimate local scour holes. The scour hole around a single spur dyke is a function of the channel geometry, spur dyke shape, orientation, permeability, sediment size, flow condition and time. Compared with a single spur dyke, a group of spur dykes are more commonly used in practice and receives more and more attention. Besides the maximum scour hole depth, the diversity of channel morphology is another research endpoint. Spur dykes arranged in various ways have been investigated in laboratory flumes. Advanced numerical simulation methods are witnessed to be replacing the conventional experimental methods. However, reliable and high-accuracy experimental and field data is still very limited and numerical models themselves still await further verification and refinement.

3. Future researches

It is suggested that special attention should be paid to the following topics: 1) Local scour in non-uniform sediment bed; 2) Effect of groundwater pore pressure in the sediment substrate on scour process and 3) Effect of coherent structure of turbulent flow on sediment threshold and transport in the neighborhood of scour hole.