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Numerical study on the effect of edge scouring on stability of soft mattress in the Yangtze estuary

Aofei Ji¹, Peng Hu², Zhiguo He³, and Fengfeng Gu⁴

¹Zhejiang University, Ocean college, Port, Coastal &Offshore Engineering, Zhoushan, China (21834100@zju.edu.cn)

²Zhejiang University, Ocean college, Port, Coastal &Offshore Engineering, Zhoushan, China (pengphu@zju.edu.cn)

³Zhejiang University, Ocean college, Port, Coastal &Offshore Engineering, Zhoushan, China (hezhiguo@zju.edu.cn)

⁴Shanghai Estuarine and Coastal Scientific Research Center, Shanghai, China (6737632@qq.com)

Abstract: In the Yangtze River Estuary deep-water channel regulation project, soft mattresses have been widely used to reduce bed erosion and thus improve stability of bridges/piers/levees/dikes. However, soft mattresses are also subject to failure due to the continuous and gradual scour in their edges, which have been a major risk for their stability. Here we report a preliminary numerical study on this issue. Firstly, a depth-averaged two-dimensional hydro-sediment-morphodynamic model is applied to simulate edge scour process for the submerged dike of the Jiangyanansha in the Yangtze estuary. For this purpose, physically-based sediment erosion parameterization is proposed to take account of the effect of the soft mattresses. Compared with the inner area of the soft mattress, only the edge area has stronger erodibility. Numerical comparative studies indicate that a scouring pit may develop to the vicinity of the submerged dike without the protection of the soft mattress, whereas under the protection of the soft mattress, the scouring pit can be largely controlled. Nevertheless, as the scouring process continues, the pit region and depth increase, which may finally lead to failure of the soft mattress. Finally, full 3D high-resolution simulations of the near-bed flow structure with/without edge scour are conducted using flow3D to shed light on the failure mechanisms of the soft mattresses.

Keywords: submerged dikes, soft mattress, erodibility, Yangtze estuary, edge scour, flow structure