Effect on flow conditions of floating debris accumulation at bridges

Auteur : Dütz, Florence
Promoteur(s) : Erpicum, Sebastien; Pirotton, Michel
Faculté : Faculté des Sciences appliquées
Diplôme : Master en ingénieur civil des constructions, à finalité spécialisée en "civil engineering"
Année académique : 2022-2023
URI/URL : http://hdl.handle.net/2268.2/17400

Université de Liège - Faculté des Sciences Appliquées

Effect on flow conditions of floating debris accumulation at bridges

Master thesis for the degree of Civil Engineering by

DÜTZ Florence

Supervisors: Erpicum, Sébastien and Pirotton, Michel

Academic year 2022-2023

This work is related to the EMfloodResilience project of the Interreg Euregio Meuse-Rhine project. The main goal is to study the effect of flow conditions on the consequences of floating debris accumulation at bridges.

Therefore, an experimental campaign was carried out in the Engineering Hydraulics Laboratory of the University of Liège. Two bridge geometries are investigated as well as two different mixtures of debris and 10 flow conditions characterized by an initial water depth h_0 and an initial Froude number Fr_0.

The observed accumulation formation process are in agreement with those described in the literature. The accumulation process takes place in 2 phases. The initial debris accumulation during which the debris accumulate vertically along the pier(s) and the formation of a debris carpet, during which floating debris accumulates horizontally on the surface.

The experiments have shown that water depth increases with the volume of debris accumulated at the bridge. Once a certain volume of debris is reached, the water depth barely rises at all.

The number of bridge piers does not have a big impact on the flow conditions nor on the debris accumulation. Indeed, although a two pier bridge causes a longer accumulation than a one pier bridge, the effect on the backwater rise could not be distinguished between the two geometries. As for the debris composition, it has a significant impact on the accumulation formation and the backwater rise. The initial Froude number Fr_0 of the flow has a significant effect on both the accumulation structure and the flow conditions. The larger the Froude number, the shorter the accumulation. As a result, the accumulation is more compact and blocks more water, leading to a greater backwater rise.

The relative carpet length and the relative flow depth at the end of the test are linked to the Froude number with some fit equations The effect of Froude number on accumulation length differs according to initial water depth and debris mixtures, whereas the effect of Froude on water height depends very little on debris composition (if at all). The influence of the initial water depth depends on the position of the bridge deck in relation to the water surface. For a h_0 under the deck, it could be concluded that the higher water depth generated higher backwater rise.

The evolution of water depth as a function of accumulation volume can be approximated by a power law. To obtain a law that does not depend on scale, the normalization proposed by Schalko et al. was adapted to the present case. From this law, a characteristic volume, responsible for the primary backwater rise, can be deduced. For each Froude, bridge geometry and debris composition, a characteristic volume was determined independently of the water level.