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Development of CFD Simulation for 3-D Flooding Flows and Scouring Around Bridge Structures

Analysis of drag and lift forces and evaluation of scour around bridge structures are necessary to assess risk of bridge failure during storms and floods. Simulation of scour-hole formation under the bridge deck and around the bridge piers, due to sediment entrainment and transport caused by flooding flow conditions, is of significant interest to computational fluid dynamics (CFD) and hydraulics researchers. This study is focused on simulation of 3-D open channel turbulent flow over an inundated bridge deck to obtain the final shape and size of the scour-hole. This 3-D study extends the previous 2-D simulation scouring methodology. Solutions for flow field and turbulence, using an effective bed roughness value, are based on the Reynolds Averaged Navier-Stokes (RANS) equations, and a k?? turbulence closure model using a commercial CFD code. An iterative computational methodology is developed to predict the equilibrium 3-D scour-hole using a single phase model moving boundary formulation, based on an empirical correlation for critical shear stress to determine the condition for sediment removal. The computational model has demonstrated capability to reach a converged solution for the equilibrium scour-hole shape and size that agree reasonably well with experiments. The method provides a basis for implementing enhanced particle entrainment physics and other scour model improvements in well benchmarked commercial CFD software.

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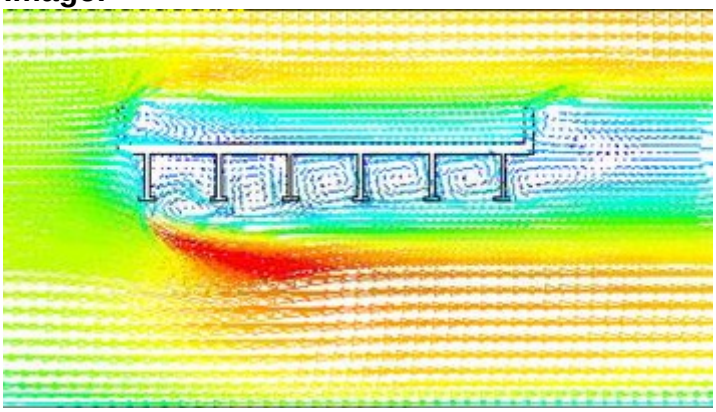
Conference Location:
Corfu Island, Greece
Conference Proceeding PDF:
WSEAS-UPT2010-19_Bhaskar_Scouring.pdf[5]
Pages:
129-135
Conference Date:
Thursday, July 22, 2010
Publisher:
WSEAS Press 2010
ISBN:
978-960-474-204-2

Conference Name:
3rd WSEAS International Conference on URBAN PLANNING AND TRANSPORTATION
Image:



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