Accepted Manuscript

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PII: S1570-6443(16)30391-4
DOI: http://dx.doi.org/10.1016/j.jher.2017.08.003
Reference: JHER 403

To appear in: *Journal of Hydro-environment Research*

Received Date: 14 December 2016
Revised Date: 18 July 2017
Accepted Date: 24 August 2017

Please cite this article as: M.N.A. Beg, R.F. Carvalho, J. Leandro, Effect of surcharge on gully-manhole flow, *Journal of Hydro-environment Research* (2017), doi: http://dx.doi.org/10.1016/j.jher.2017.08.003

Effect of surcharge on gully-manhole flow

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Abstract: In an urban drainage system, surface system and buried system are connected through several linking elements like gullies and manholes. To model an urban flood through a 1D or 2D routing model, proper representation of these linking elements is mandatory. This paper focuses on the effects on inline manhole head loss coefficient and gully flow due to change in manhole surcharges to get knowledge of their characteristics, flow patterns and influence in the overall flow. The solver *interFoam* with VOF capability under open source CFD toolbox OpenFOAM® is used for the numerical simulations. The CFD model created is a real scale model following the experimental setup installed at the University of Coimbra. The CFD model results were compared with discharge and water depth data at the manhole and velocity data at the gully, measured from the physical model. The manhole head loss coefficient was found very high at low surcharge level and reaching a constant value of 0.3 for higher surcharge levels. The gully flow was found to follow typical orifice flow equation with different discharge coefficients for different water depth conditions of the manhole. Three different surcharged zones were identified at the manhole on which discharge coefficients are dependent. The shear stress pattern at the manhole floor is also found varying due to surcharge depth as well as the gully flow. The variation showed distinctive configuration at different surcharge zones.

Keywords: Computational Fluid Dynamics (CFD); Urban drainage; OpenFOAM®; Gully-Manhole; Head-loss coefficient

1 INTRODUCTION

The Urban drainage system is termed as the main conveyance route for draining extensive rainfall and flood in a busy city. The system is composed of many linking elements that convey the flow during a rainfall event from the major or surface system to the minor or buried system. Manhole and gully are two very common drainage structures where the flow is normally complex, highly turbulent and possibly multiphase. When entering to a manhole or gully, the drainage flow undergoes a sudden expansion and/or contraction with several hydraulic losses, which are important in flood routing simulations. Most urban flood routing models are one or two dimensional and therefore cannot represent the complex flow pattern of these structures (Leandro et al., 2009b). These structures usually are not modelled but connected as a point entity and translated by discharge and head loss coefficients calculated using empirical equations (Leandro and Martins, 2016). State-of-the-art routing models in urbanised areas are Dual Drainage (DD) models as they simulate both