Challenges in Modelling Energy Losses in Hydraulic Structures

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ABSTRACT

KEYWORDS
Modelling, Hydraulic Models, Drainage, Hydraulic Structures, Headloss, Manual Calculations

Increased rainfall intensity and variability due to climate change along with increased intensification in Auckland Region have profound effects on increased risk of flooding and operation of water infrastructure, such as stormwater drainage collection and flood management systems. Hydraulic modelling software such as InfoWorks, MIKE URBAN, MIKE11 are widely used to develop hydraulic drainage network models to assess the effectiveness and performance of the existing drainage systems, and to assist in design and planning for adequate future drainage infrastructure. The primary or formal drainage system comprising manholes, pipes, culverts, bridges, weirs and other hydraulic structures are essential components in most drainage network models. They serve both stormwater conveyance and hydraulic controls and represent key roles in flood risk management. Hydraulic modelling at Auckland Council shows that accurate modelling of hydraulic structures is a challenging issue and one of the major sources of uncertainty across all modelling software.

This presentation presents the generic problems and difficulties present in modelling drainage network systems and possible solutions based on first principles approach to develop improved schematisation and representation of energy losses within hydraulic structures in various stormwater catchments. Efficient stormwater management, design of flood control and drainage infrastructure are all directly impacted by the predictive accuracy of the drainage network model. Therefore, significant emphasis on accurate representation of conveyance and hydraulic controls in drainage network model was given.

During the development stage of the hydrological and hydraulic models of various stormwater catchments, issues around modelling energy loss parameters used with manholes, pipes, culverts and bridge representation have been identified, which resulted in model instabilities and incorrect flood predictions. Correct selection of modelling parameters when conduit full flow condition is preferred to be modelled have been suggested specifically for design purpose.

Several case studies have been done based on past modelling projects, focusing on the challenge of modelling energy loss associated with different hydraulic structures, such as complex manholes, surcharging pipes and culverts in different stormwater modelling software. The modelled energy losses at culverts and bridges have been compared with manual energy loss calculations or current industry standard software such as HY-8 or CulvertMaster. The studies indicate that the energy losses can be miscalculated by modelling software if incorrect parameters are assigned. It is also noted that there are limitations in modelling software when calculating complex nature of energy losses, such as complex flow patterns in manholes with many incoming and outgoing pipes, in this case, manual energy loss calculation is recommended and should be adopted in the model. Also, by doing manual energy loss calculations, checks

can be made on the modelling results to ensure accurate prediction of flood risk and making appropriate planning decisions.

Hydraulic models are simplified conceptualization of the complex hydraulic processes in a drainage network system. Accurate modelling of energy losses at hydraulic structures is the most important and challenging process in establishing model credibility. The model cannot be made completely flawless. All model developments and subsequent predictions are subject to uncertainty. This uncertainty can be reduced by model calibration and validation as well as through model QA/QC and accurate representation of key components of drainage network systems. This presentation demonstrates the value of cross checking the performance of hydraulic structures to establish confidence in the hydraulic model, so that the model can be used as a useful tool for its intended purposes with acceptable uncertainty and reliability.

Declaration

Topic	Accounting for uncertainty in our models
☒	Can attend in person
☒	Have permission / authority to speak on the topic
☐	Have a backup speaker if they fall ill or cannot present

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Abstract Guidelines

1. Abstract Guidelines
    - Abstracts submitted must be between 300 – 500 words, excluding title and authors.
    - Abstracts must use the template above
    - Font used should be Times New Roman or Arial size 11.

2. Call for Abstracts closes 4pm, Tuesday 31st January 2023 and submitted to Katrina Guy

3. Abstract Selection
    - Wider applicability
    - Demonstrated results and conclusions
    - Relevance to the current state of the industry
    - Content, including innovation
    - Clarity and quality

4. Abstract Acceptance
    - If accepted into the programme, you will only have to submit a presentation. No paper is required.
    - Final presentation will be due by **28th February 2023**
5. Presentation
    - Powerpoint 16:9
    - Slide Pack will be attached shortley