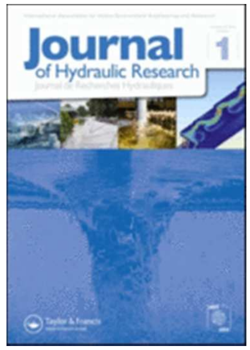

Closure to the discussion about "Impact of sediment transport formulations on breaching modelling"

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Reply to the discussion

Impact of sediment transport formulations on breaching modelling

By S. VAN EMELEN, Y. ZECH and S. SOARES-FRAZÃO, *J. Hydraulic Res*. 53(1), 2015, 60−72

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The authors would like to thank the Discussers for their interest in their work and the questions they raised. Breaching is certainly a field of research that deserves a lot of attention in order to improve the prediction of the discharge through the breach and the time evolution of the dike profile.

Experimental work is one possible way to improve the knowledge in this field, but of course, due to the limited setup size that can be achieved in the laboratory, scale effects are an issue that needs to be considered. However, in the case of the experiments presented here, the intention was not to investigate the possible extension of the measurements to larger scales. So, the tests were not meant to represent a given real phenomena at scale. Rather, the tests are considered as prototype tests and were performed to collect experimental data to validate numerical simulation results. Therefore, the question of scale effects was not raised in the paper. The Discussers mention that in their previous experiments (Schmocker et al., 2011) they observed scale effects when $h_0 < 0.05$ m in terms of a reduction of the discharge coefficient compared to theoretical formulae. As only one geometrical configuration was considered here, we have no means to discuss this point with more details. We are however aware that scale effects may be present due to the limited size and that the present experiments should be considered very carefully if they have to be used to upscale the results.

As suggested by the Discussers, we compared the discharge measured using the method described as the Water-Balance Method (WB) of Coleman et al. (2002) with the predictions using (a) a constant discharge coefficient $C_d = 0.043$ in Eq. (1), (b) the discharge coefficient of Eq. (2) proposed by Hager (1994), taking into account the relative crest curvature defined as $\rho_k = H / R$ with R the crest radius and (c) the improved SH method for the determination of C_d combining Eq. (2) and a new definition of the relative crest curvature (3) proposed by Schmoker and Hager (2012) to account for the upstream and downstream weir face angles (expressed in degrees) α_u and α_d, respectively.

$$Q_b = C_d\, b\sqrt{2gH^3} \tag{1}$$

$$C_d = \frac{2}{3\sqrt{3}}\left(1+\frac{3\,\rho_k}{11+4.5\,\rho_k}\right) \tag{2}$$

$$\rho_k = \frac{H}{R}\left(\frac{\alpha_u+2\alpha_d}{270}\right)^{1/3} \tag{3}$$

In our tests, the initial time t_0 was defined as the time when the upstream water level reaches the crest level, and so the overtopping phenomenon starts. The results of the discharge comparisons are illustrated in Fig. 1: the predictions using Eq. (1) overestimate the discharge, while both Eqs. 2 and 3 provide good results, with however a slight improvement for Eq. (3).

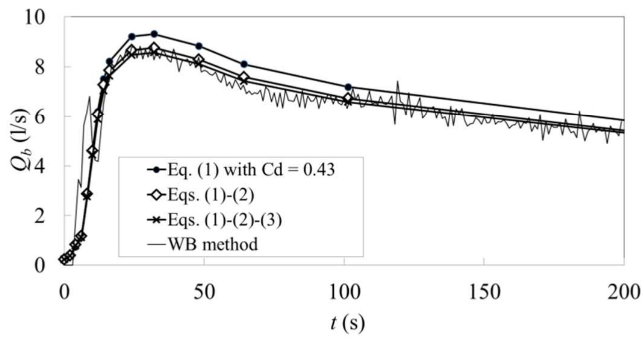

Figure 1. Comparison of the measured (WB method) and calculated breach discharges

As regards the discrepancies mentioned by the Discussers regarding the measured and predicted peak discharge of their Fig. D1, the authors think that a difference of 8 % is reasonable when considering empirical formulae for the predictions. Such empirical formulae are of course really to obtain a quick estimate of the peak discharge. However, we also believe that numerical simulations can help in both the prediction of the peak discharge and in the improvement and validation of simplified empirical approaches by providing additional data sets to validate the simplified empirical expressions. Therefore, in order to investigate the capabilities of numerical simulations, the paper focused also on the use of sediment transport formulations in the numerical simulations. We are also convinced that working in both directions will allow improving the knowledge and description of breaching phenomena.

Finally, concerning the three-dimensional breaching experiments of Spinewine et al. (2004), we agree that the WB method might produce more inaccurate discharge predictions, especially if the reservoir has large dimensions, inducing larger spatial fluctuations of the water level and if the water level is measured only at one single location. Therefore, in the tests by Spinewine et al. (2004), four gauges were used in the upstream reservoir and still, a standard deviation of 5 l/s was observed (Fig. 10a of the original paper). It must be noted that no filtering was applied to the measurements.

In order to improve the breaching discharge measurements and thus also the predictions, especially in three-dimensional cases, we believe that digital imaging techniques allowing to monitor the breach width evolution during the tests and possibly the flow velocity through the breach could help improving the accuracy of the measured discharge. Work is in progress in that direction.

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