

SEDIMENT TRANSPORT BY DAM-BREAK WAVES RELATING TO WAVE RUNUP AND TSUNAMI

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INTRODUCTION

While sediment transport under wave runup has previously been investigated (e.g. O'Donoghue et al 2016) through the 'natural', accelerated scenario on sloping beds, the present study presents data from quasi steady dam-breaks on horizontal beds, which due to greater simplicity provide a good opportunity for gaining fundamental insights.

Khezri & Chanson (2012) showed, see Figure 1, that progressing shocks are strong sediment transporters of a nature, which is probably fundamentally different from that driven by traditional boundary layer processes, e.g. under the steady law of the wall. However, their study did not enable quantification of the sediment transport. The present study is an attempt on such quantification.

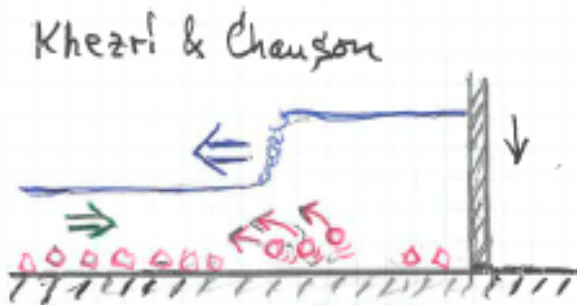


Figure 1: Khezri & Chanson observed that 'tidal-bore-like' shocks moved significantly more sediment than either of the preceding or the subsequent steady flows.

The present study used the same flume as Nielsen et al (2022), which showed the usefulness of Stoker's steady shock concept for investigating the effects of bed friction on shock propagation. A 1.5m long sand bed was added, starting at a distance from the dam, where the previous experiments indicated quasi-steady shock propagation.

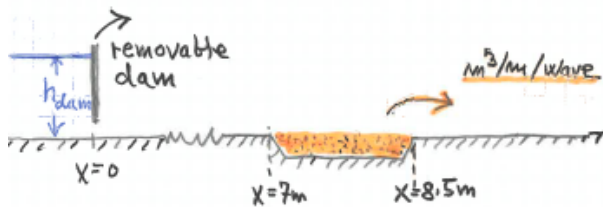


Figure 2: Experimental setup for measuring the unit sediment transport per shock passage [$\text{m}^3/\text{m}/\text{wave}$] in terms of the sediment volume transported past the downstream edge of the sediment bed.

As expected, scour occurred at the upstream edge of the sediment bed, see Figure 3, but a sufficient stretch with unchanged bed elevation followed for concluding via: $\frac{\partial q_s}{\partial x} \propto -\frac{\partial z_{\text{sand}}}{\partial t}$, that the measured 'exported' sediment volumes

corresponded to a uniform process along the downstream part of the sand-box.



Figure 3: final bed after test with $d_{50} = 3.2\text{mm}$. The flow direction was from the top towards bottom of the picture.

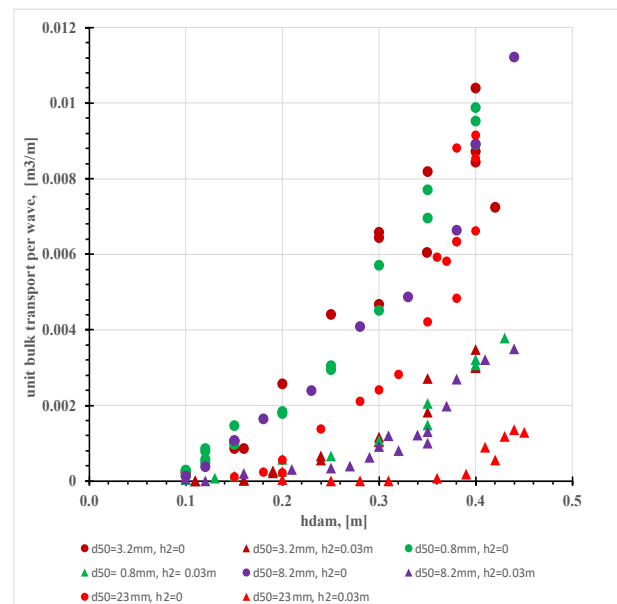


Figure 4: Measured unit sediment transport $\text{m}^3/\text{m}/\text{wave}$ as function of h_{dam} . Circles indicate drained beds while triangles indicate 0.03m of stagnant tailwater in front of the shocks.

Figure 4 shows measured sediment transport as a function of h_{dam} , ie, the depth behind the dam before its removal.

Four different, fairly well sorted, sediments all with specific gravity near $s=2.65$ were used, with median grain size in the range $0.8\text{mm}<d_{50}<23\text{mm}$.

The data in Figure 4 show that, within the experimental range $0.1\text{m}<h_{\text{dam}}<0.45\text{m}$:

- The transport rate is at most weakly dependent of d_{50} for $0.8\text{mm}<d_{50}<8.6\text{mm}$ as long as d_{50} is small compared with the shock depth (40-100mm in these experiments).
- The coarsest sediment (**red symbols**), with $d_{50}=23\text{mm}$, which is a significant fraction of the typical shock depths for $h_{\text{dam}}<0.4\text{m}$, shows somewhat lower transports for $h_{\text{dam}}<0.4\text{m}$.
- The transport rates observed with 0.03m of tailwater depth, h_2 , were significantly lower than for drained beds ($h_2=0$). This corresponds to shear-plate measurements of generally smaller bed shear stresses in the presence of tailwater in the same flume.

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