River scale model of a training dam using lightweight granulates

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BACKGROUND AND AIM
To manage the expected extremity in high and low river discharge, the state authority for infrastructure in the Netherlands, Rijkswaterstaat, is searching for an alternative river design. The aims of the new design are:
- Increase the water depth in the fairway during low discharges
- Decrease the water level during high discharges

This can be realized by replacing the groynes at the inner bend of the river by a training dam. Between the training dam and the bank a new channel is created. The flow into this side channel is regulated by a fixed weir (see picture below).

The results of the new design are to:
- narrow the channel at the shallow inner bend (width of fairway will not change) during low discharges
- increase the cross-sectional area, reducing the total roughness of the river during high discharges

The aim of this research is to investigate the morphological effects of the training dam on in the navigation channel, during low and high discharge, by means of a physical scale model.

MODEL DESIGN AND FACILITIES
The geometrical scale factor (n_p) of the model is 60 and the physical model is built in a 2.60 x 12.60 m flume featuring sediment recirculation. The model has a mobile bed composed of light weighted polystyrene (BAW) to simulate bed load sediment transport. The thickness of the initial sediment layer is 0.2 m and after each experiment, the bed levels are measured with a laser scanner. Half of the river including the training dam and side channel is modelled in the flume.

RESULTS AND CONCLUSIONS
Results show a dynamic pattern of erosion and deposition, including dunes and scour. Displayed bed levels represent a near-equilibrium stage.

<table>
<thead>
<tr>
<th>Proportional PARAMETERS of Bed level</th>
<th>Low discharge</th>
<th>High discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water depth (m)</td>
<td>0.30</td>
<td>0.60</td>
</tr>
<tr>
<td>Roughness coefficient</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>Froude number (-)</td>
<td>0.15</td>
<td>0.20</td>
</tr>
<tr>
<td>Reynolds number (-)</td>
<td>3750000</td>
<td>6000000</td>
</tr>
<tr>
<td>Shields parameter (-)</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Particle parameter (-)</td>
<td>25.06</td>
<td>16.23</td>
</tr>
</tbody>
</table>

- Morphodynamics is dominated by narrowing and widening of the cross-section
- During low discharge, the presence of the training dam results in a deeper navigation channel
- Polystyrene allows for dynamic similarity of bed load sediment transport
- Dunes in polystyrene scale with the water depth, and are dynamically similar to those in the prototype
- Scours near the tip of the river groynes are too deep with respect to the prototype, which may relate to slope effects
- Morphological impact of the intake section is limited

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