HKU Debris Flow Modelling Laboratory
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Introduction:

Physical modelling of debris flows is crucial for revealing their underlying mechanisms, as the spatiotemporal unpredictability of debris flows means that their mechanisms are difficult to observe in the field. The HKU Debris Flow Modelling Laboratory encompasses three flumes for the modelling of subaerial and submarine debris flows. The flume is equipped with highly specialized sensors to capture a broad range of flow and soil bed properties.

2-m flume for modelling subaerial debris flows

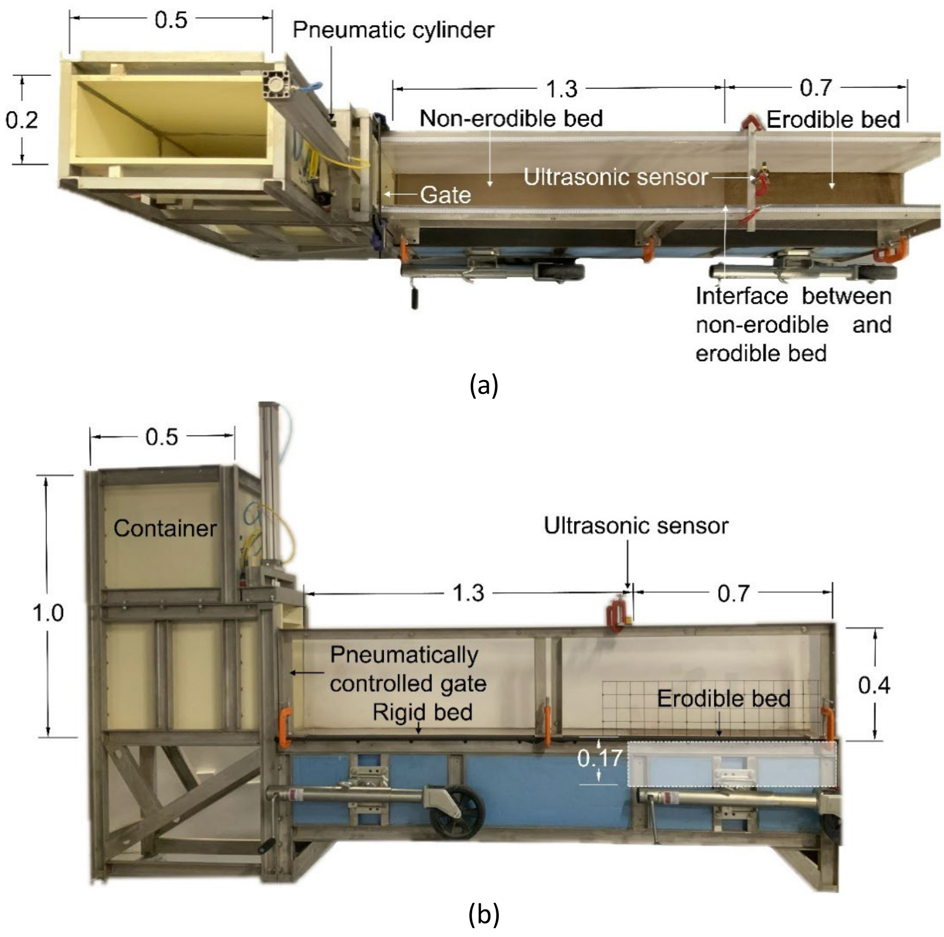

Figure 1. Laboratory-scale flume model for studying the entrainment process of subaerial debris flows: (a) top view; (b): front view.

Figure 1 is the laboratory-scale flume model for studying the entrainment process of the debris flows over unsaturated bed sediments. This model was developed to study the effects of boundary conditions under both rigid and erodible bed conditions. It is 2 m in length and 0.2 m in width and has transparent side walls to enable the observation of flow kinematics during a test. The channel bed has a 1.3-m long, smooth non-erodible section, followed by a 0.7-m long erodible section. The erodible bed was designed to be 0.17 m in depth to ensure an unlimited supply of bed material and thus fully utilize the erosion potential of the debris material in the storage container. The transition from a rigid to an erodible section in the flume idealizes the transition from a rock bed to an erodible soil bed in a natural channel.

3-m flume for modelling submarine debris flows

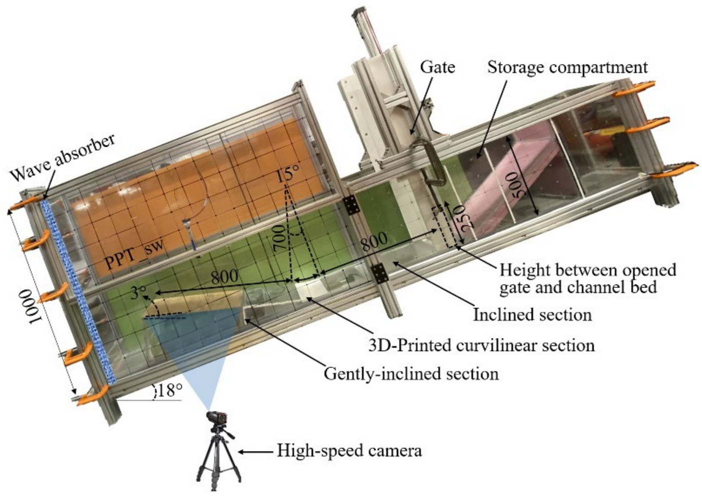

Figure 2. Side view of the flume for studying submarine debris flows

Figure 2 shows the flume for studying the entrainment of soil bed by submarine debris flows. The flume consists of a gently-inclined tank at 18°. The walls of the tank are transparent acrylic boards. The tank has a total length of 3 m, a width of 0.2 m, and heights of 1 m and 0.5 m at the downslope and upslope ends, respectively. At the upslope end of the tank, a compartment with a total volume of 0.08 m^3 is used to store the debris mixture. The retention and release of the debris mixture is controlled by a pneumatic gate. When the gate is opened, the inclined height of the opening between the gate and the channel bed is 0.25 m. A 45° wedge with respect to the channel bed is installed at the base of the compartment initially holding the debris mixture with the goal of accelerating the debris. Just downstream from the gate is a channel with a total length of 1.8 m. The channel consists of an inclined section at 18° that is 0.8 m in length, and a gently-inclined section at 3° that is also 0.8 m in length. A 3D-printed curvilinear section is installed to enable a smooth transition between the two inclined sections. Figure 2b shows the details of the 3D-printed curvilinear transition and gently-inclined section of the channel. The gently-inclined section consists of a 0.3 m-long immobile and rigid bed and a 0.5 m-long compartment where an erodible loose sand bed is prepared. The compartment of the sand bed is 0.1 m in depth at its upslope end and 0.23 m in depth at its downslope end. The depth of the compartment for the loose sand bed is designed with the goal of ensuring an unlimited supply of sand for entertainment. An additional compartment is located at the downstream end of the gently-inclined section to allow the debris to flow off the erodible sand bed with the goal of minimizing the disturbance to the incoming flow. In addition, a wave absorber is installed along the downslope wall of the tank to minimize the effects of wave disturbance.