Equipment for Engineering Education

Experiment Instructions

HM 160.33 Crump Weir
for Teaching Flume

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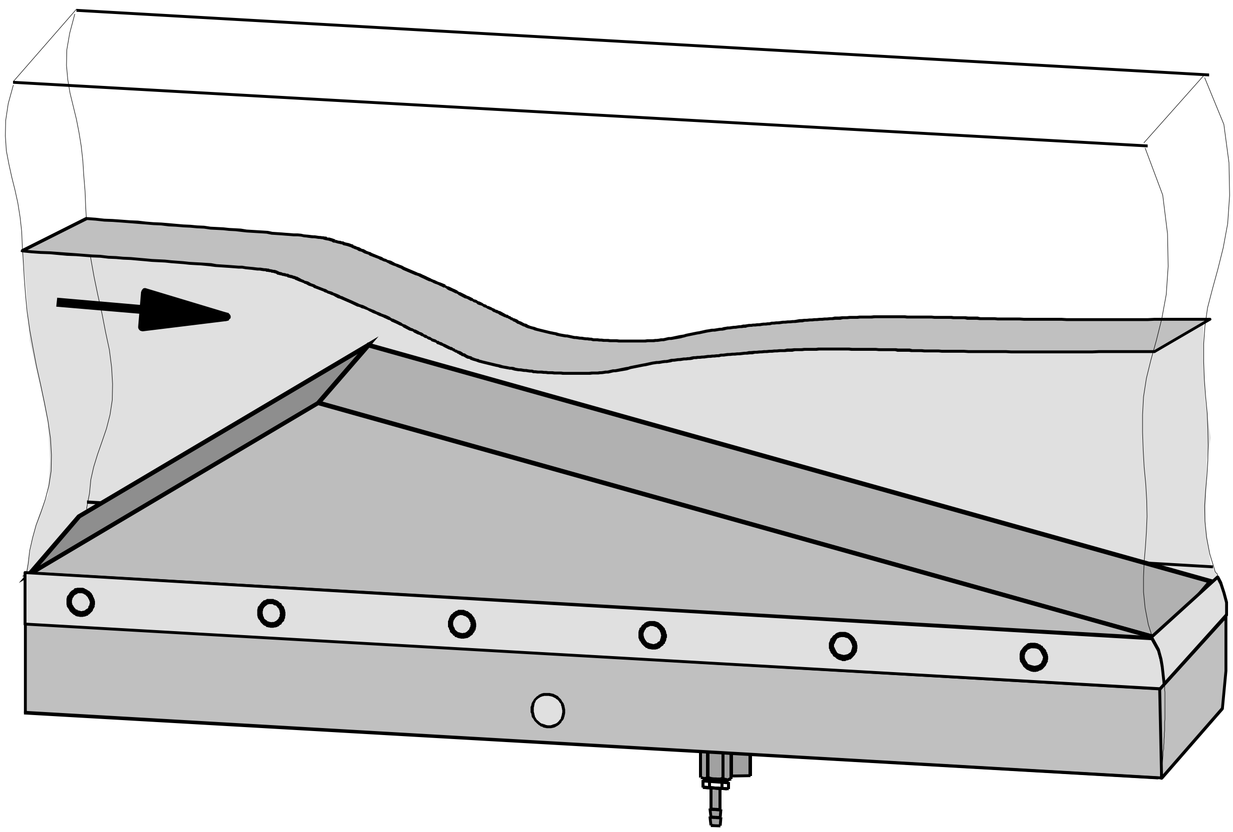
HM 160.33 Crump Weir for Multi-Purpose Teaching Flume



Experiment Instructions

Please read and follow the safety comments before the first installation!

This apparatus is ment to be used only for Education, Teaching or Research.

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HM 160.33 Crump Weir for Multi-Purpose Teaching Flume

1 Introduction

The **HM 160.33 crump weir** accessory unit is designed to demonstrate the hydraulic conditions on an overflowed underwater weir, or incomplete overflow. Depending on the flow rate, subcritical or supercritical flow can be created, or upper rollers and hydraulic jumps can be observed and investigated.

The accessory unit is made of robust plastic. It is designed for installation in the HM 160 laboratory flow channel, to which it can be attached very easily.

The following **topics** can be covered with the crump weir:

- Outflow processes over a underwater weir
- Subcritical and supercritical flow
- Energy level of flows in open flumes

2 Unit description

The **HM 160.33 crump weir accessory unit** is made from robust plastic and can be inserted very easily into the HM 160 multi-purpose teaching flume and fixed by a screw. Side sealing in the flow channel is provided by a sealing tube which is inserted into grooves in the weir.

2.1 Components

The crump weir comprises the following components:

- **Weir body** (1) with edge inclination ratios 2:3 and 2:9 respectively
- **Hexagon socket screw M6** (2)
- **Plastic sealing tube** (3)

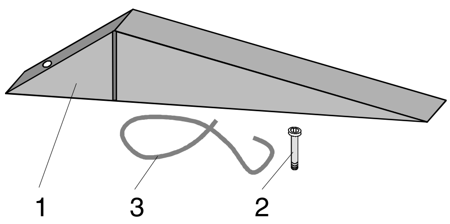

Fig. 2.1

2.2 Assembly

- Insert the plastic sealing tube (3) into the two side grooves (4); cut them to size as necessary
- Insert the crump weir (1) in the flow channel (5) (steep inclination pointing towards inflow side) and secure it on the channel bed with the M6 hexagon socket screw (2)
- The weir can be secured at a variety of different positions

Important! Do not perform the assembly when water is flowing, to prevent the screws and sealing tubes from being swept away by the flow.

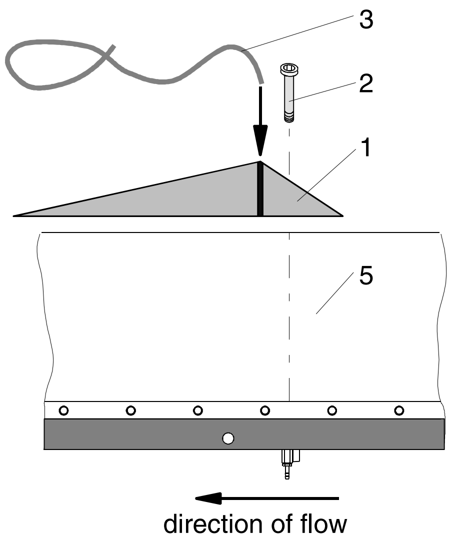

Fig. 2.2

3 Safety

3.1 Protection of the unit

ATTENTION

- **IMPORTANT!** After assembly do not leave any tools or tubes lying in the flow channel!
  They will be swept away by the flow and may get into the pump!

ATTENTION

- **IMPORTANT!** Do not perform assembly and disassembly of the crump weir when water is flowing!
  Screws or the like may be swept away by the flow and get into the pump.

4 Theory and experiments

As in the case of all G.U.N.T. instructions, the presentation of the theoretical background and possible experiments is intended as an incentive to encourage students, teachers or researchers to experiment and learn themselves. Accordingly, we make no claim to completeness, although we do of course consider the details given to be correct.

4.1 Water flow movements

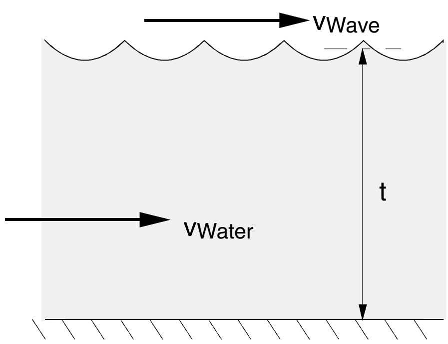

Fig. 4.1 Wave speed in flat water

A distinction is made between two basic categories of water movement:

- **subcritical** and
- **supercritical**

In **subcritical outflow** the flow speed of the water v_{water} is always less than the wave speed. This means that, in a subcritical segment, the water flows more slowly than a wave can be propagated.

The wave speed v_{wave} is, as we know, dependent only on the acceleration due to gravity g and the water depth t

$$v_{Wave} = \sqrt{g \cdot t} \quad . \tag{4.1}$$

In **supercritical outflow** the situation is reversed: the wave speed is always less than the flow speed of the water. This means that the wave in this case can **never flow upstream**, only downstream! This is a vitally important finding in water engineering terms!

4.2 Flow processes on a crump weir

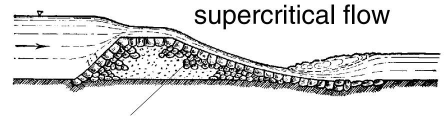

Fig. 4.2 Outflow from the weir

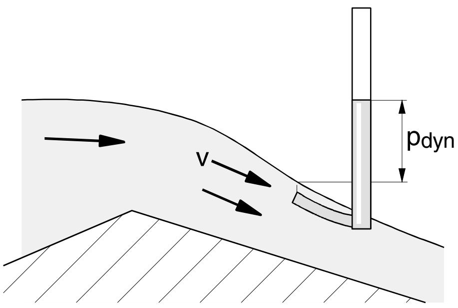

Fig. 4.3 Pitot-tube

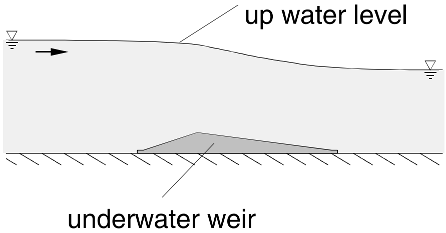

Fig. 4.4 Overflowed weir

On a crump weir both supercritical and subcritical flow can be observed. For experimentation purposes a relatively low through-flow rate should initially be set at the shutoff valve (water level only slightly above crest of weir). An outflow similar to that shown in Fig. 4.2 is produced.

In this case the weir acts as a **complete overfall** with **supercritical outflow** at the back of the weir and a short distance downstream of it. It is interesting to measure the **flow speed** in the supercritical outflow segment. It is **substantially higher** than in the subcritical segment of the channel. To measure the flow speed v a self-made **Pitot tube** can be used (Fig. 4.3), as is used for measuring the dynamic pressure p_{dyn}:

$$p_{dyn} = \frac{\rho}{2} \cdot v^2 \qquad (4.2)$$

Turning the tube round permits the flow speed v to be ascertained.

The pressure is read off in mmHOW (HOW - Head of Water). Because of the water density of $\rho = 1\ kg/dm^3$ the following applies:

$$1\ \text{cmHOW} \mathrel{\hat{=}} 1\text{mbar}$$

If the through-flow is increased at the shutoff valve, an **overflowed weir (underwater weir)** is gradually created. At very high flows a **purely subcritical outflow** is obtained, in which the curve of the banked-up water level along the channel is then only slightly downward-pointing (Fig. 4.4).

4.3 Shape of the crump weir

To prevent the severe bed erosions under the weir caused by the increased overfall speed, the tail wall is set at as flat an angle as possible, whereby the outflow stream is gradually transformed into the normal outflow cross-section.

The inclination of the back of the weir fluctuates in reality between 1:2 and 1:5, although flatter inclinations up to 1:15 also occur.

The inclination of the HM 160.33 crump weir is 2:3 on the inflow side and 2:9 on the outflow side.

5 Appendix

5.1 Technical data

Material:		PVC	
Dimensions: (L x W x H)		360 x 60 x 84	mm
Inclination,	inflow side:	2:3	
	outflow side:	2:9	