



This equipment is designed to study the behavior of fluids in open channels, and allows to perform a wide range of experiments and training.

#### **HIGHLIGHTS**

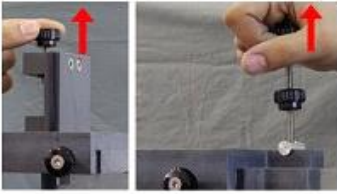
- Standalone operation, as long as it is connected to the power supply.
- Choice between negative and positive channel slope.
- A range of devices for reading different parameters, manometric gauges, limnimeter, Pitot tube, etc.
- Wide range of accessories to study multiple phenomena.
- It includes a valve to regulate the appropriate flow rate at any moment.
- The flowmeter provides readings of the workflow rate at any time.

#### **IMPORTANT NOTE**

- We can provide a range of flow channels in various sizes. Consult without compromise.

FL 05.4 CANAL HIDRODINÁMICO CON BANCO 5M

**NOTA IMPORTANTE:** Si comenza el riesgo de que se produzca un desbordamiento hasta con nivel de la ruleta superior de los componentes verticalmente para liberar el agua.



FL 05.4 CANAL HIDRODINÁMICO CON BANCO 5M

4.7. DETERMINACIÓN DE LA PENDIENTE DEL CANAL

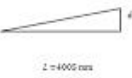
- Para establecer una pendiente en el canal, giramos el volante (17) del soporte con regulación de altura (18) observando cómo la ruleta sube o baja según el sentido de giro.



- La pendiente del canal la obtenemos con la lectura de la elevación de la ruleta en el apoyo (bajo el volante) donde se encuentra la regla con el porcentaje de inclinación con el que estamos trabajando:

$$\alpha = \arctg\left(\frac{Z}{L}\right)$$

$$\alpha = \frac{Z}{L} \cdot 100\%$$



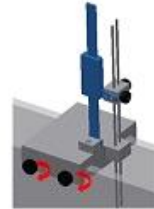
Z = 4000 mm



FL 05.4 CANAL HIDRODINÁMICO CON BANCO 5M

4.8. USO DE CONJUNTO LÍMITE Y PÍCOT

- El conjunto tiene unos orjes en su parte superior con cuatro muelitas, lo apretamos sobre las paredes del canal y aproximamos con las muelitas como el caso de las compuestas anteriormente descritas.



- Ajuntando los mandos mueleados que sujetan tanto el Límite como el Pícot realizamos una primera aproximación a las distancias con las que queremos trabajar.



- Para posicionar en altura el Pícot con precisión desplazamos el calibre verticalmente.

The user manual clearly shows and with a large number of images, the entire process to be followed to operate the equipment.

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5.2.- FLUJO UNIFORME

5.2.1.- FUNDAMENTO TEÓRICO

El flujo uniforme es aquel con profundidad y velocidad constantes. Este tipo de flujo sólo puede ocurrir en un canal prismatico recto con una pendiente en el fondo constante. Cuando el líquido entra en el canal, existe una región de desarrollo de flujo gradualmente variada, llamada zona transitoria. La profundidad correspondiente a un flujo uniforme en un canal particular se denomina profundidad normal "y<sub>0</sub>", ésta es constante, por lo que la superficie del líquido es paralela al fondo del canal.

Plantando la ecuación de Bernoulli entre dos secciones transversales, tenemos:

$$\frac{V_1^2}{2g} + z_1 + \frac{V_1^2}{2g} = \frac{V_2^2}{2g} + z_2 + \frac{V_2^2}{2g} \quad (1)$$

La ecuación de continuidad es:

$$Q = A_1 V_1 = A_2 V_2 = b_1 y_1 V_1 = b_2 y_2 V_2$$

Como es flujo uniforme  $y_1 = y_2$  y en nuestro caso  $b = \text{cte}$ , tenemos que  $V_1 = V_2$  Sustituyendo en (1) nos queda que:

$$z_1 = z_2$$

Por lo tanto la línea de nivel energético es paralela al fondo y a la superficie libre.

El caudal para flujo uniforme y permanente, aplicando la fórmula de Manning viene dada por la siguiente expresión:

$$Q = A V = b y \frac{1.49}{n} R^{2/3} S^{1/2}$$

$$n = b y \frac{1.49}{Q} R^{2/3} S^{1/2}$$

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donde:

- b: Ancho del canal (m)
- y: Profundidad del agua
- R: Radio hidráulico

$$R = \frac{A}{P} = \frac{b y}{b + 2y} \quad (m)$$

- S<sub>0</sub>: Pendiente del canal
- Q: Caudal (m<sup>3</sup>/s)

5.2.2.- MÉTODO

Lo práctico que se propone es el cálculo del factor de rugosidad para el revestimiento del canal utilizando la fórmula de Manning. Sin embargo, se pueden realizar otras prácticas como son el cálculo de caudales a partir de expresiones como las de Bazin, Kutter, Manning, Bazin, Powell, etc., y los factores de rugosidad experimentales obtenidos por ellos, comparándolos entre sí y con nuestros resultados experimentales en el canal.

- Establecemos una pendiente determinada en el canal
- Leemos el caudal
- Medimos la profundidad normal "y<sub>0</sub>" alcanzada por el agua
- Realmente calculamos el radio hidráulico y el factor de rugosidad "n"

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5.2.3.- LECTURAS Y RESULTADOS

Lectura nº	Profundidad y	Radio hidráulico R <sub>h</sub>	Pendiente S <sub>0</sub>	Caudal Q	Factor rugosidad n
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

The practical manual shows and explains all the theoretical foundations, as well as the mathematical formulas used for the realization of all the experimentation.



Optional Accessory: HD.Z.01 - 4 TUBE MULTIMANOMETER  
Multimanometer of 4 tubes for flow channel.

Characteristics:

- Height 300mm
- Connections with double obturation
- Coupling channel with adjustable tilt angle



Optional Accessory: HD.Z.02 - INCLINED MANOMETER  
Inclined manometer to flow channel.

Characteristics:

- Maximum height 300mm
- Regulation of the angular tilt of tube manometer.
- Connections with double filling.
- Coupling channel with adjustable tilt angle



Optional Accessory: HD.Z.05 - PITOT + LIMNIMETER (For Flow channel)

Accessory composed by a Pitot tube and a clinometer, connected to a gauge, allowing a great accuracy in the readings.

Characteristics:

- High accuracy caliber.
- Easy coupling to the channel walls.



Optional Accessory: HD.Z.10 - THIN PLATE WEIR (For Flow channel)  
Thin plate rectangular weir without contraction.

Characteristics:

- Rubber profiles on the side of the spillway, to seal.
- Easy placement on the flow of the channel.
- Top of the spillway sharp.
- Height of the spillway 150mm.



Optional Accessory: HD.Z.11 - VERTICAL GATE (For Flow channel)  
Vertical gate for hydrodynamic channel.

Characteristics:

- Gate lift system allows a quick opening to prevent overflows or a controlled opening for an easy adjustment to desired height.
- Easy placement on the walls of the channel.
- Rubber profiles on the sides of the gate, for seal.



Optional Accessory: HD.Z.12 - RADIAL GATE (For Flow channel)  
Radial gate for flow channel.

Characteristics:

- Gate lift system allows a quick opening to prevent overflows or a controlled opening for an easy adjustment to desired height.
- Easy placement on the walls of the channel.
- Rubber profiles on the sides of the gate, for seal.
- Manufacture in stainless steel.





Optional Accessory: HD.Z.15 - BROAD CRESTED WEIR (For Flow channel)  
Broad crested weir for flow channel.

Characteristics:

- Easy placement on the bottom of the channel.
- Rubber profiles on the sides, for seal.
- Dimensions (Length x Height): 250 x 150 mm.
- Radios on one extreme of 25 mm, and the other with sharp crest.



Optional Accessory: HD.Z.16 - CRUMP WEIR (For Flow channel)  
Crump weir for flow channel.

Characteristics:

- Easy placement on the bottom of the channel.
- Rubber profiles on the sides, for seal.
- Dimensions (Length x Height): 273 x 50 mm.
- Angles in extremes of 15° and 30°.



Optional Accessory: HD.Z.17 - OGEE CRESTED WEIR (For Flow channel)

The HD.Z.17 equipment allows a study of the behaviour of the ogree crested weir and to analyze the flow discharge that it originates.

Characteristics:

- Easy placement on the bottom of the channel.
- Rubber profiles on the sides, for seal.
- Weir height 150mm.

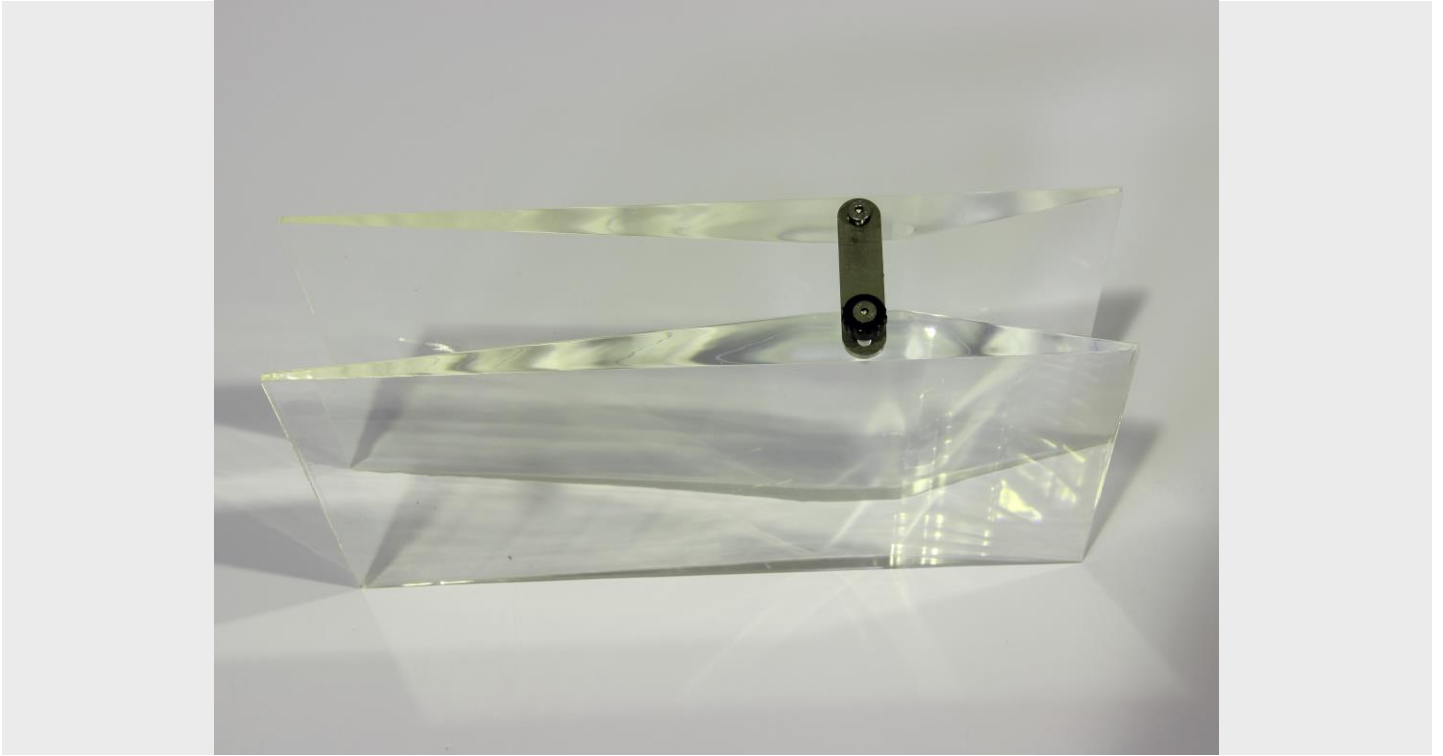


Optional Accessory: HD.Z.20 - SIPHON WEIR (For Flow channel)

The Siphon weir accessory for the flow channel, is placed easily in the bottom of the channel. Built with transparent methacrylate, it forms a closed channel that allows a bigger flow of water than an open channel, due to the suction effect.

Characteristics:

- Rubber profiles on the sides of the weir, for seal.
- Easy placement on the bottom of the channel.
- Complete manufacture in transparent methacrylate.

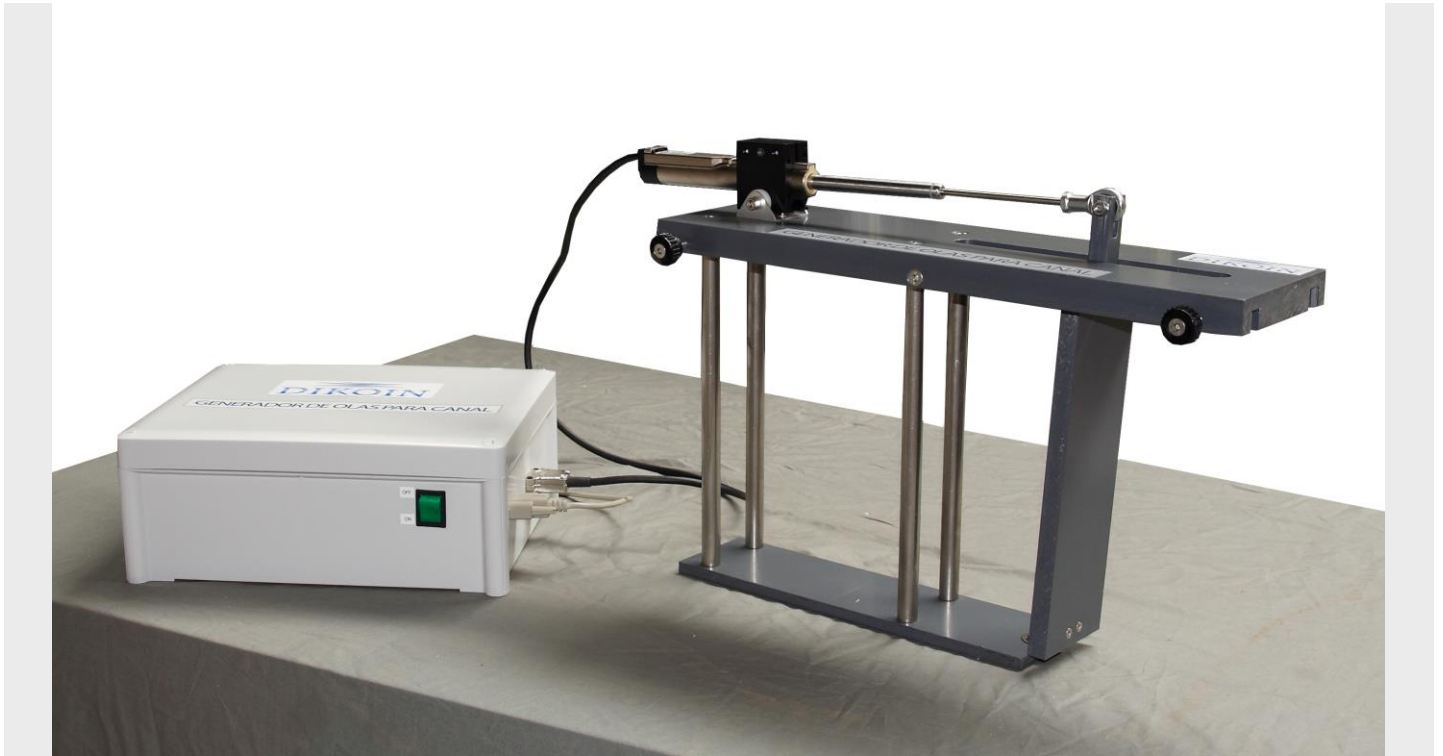


Optional Accessory: HD.Z.21 - VENTURI (For Flow channel)

The Venturi accessory for flow channel, is colocated easily in the bottom of the channel. Built with transparent methacrylate, it forms a narrowing in its horizontal section. With the Pitot tube, experiments can be performed according to the Bernoulli equation.

Characteristics:

- Easy placement on the channel.
- Complete manufacture in transparent methacrylate.



**Optional Accessory: HD.Z.50 - WAVE GENERATOR**

The wave generator HD.Z.50 is designed for its use in 80mm hydrodynamic channels in all lengths, in order to be able to study the behaviour of waves in a controlled environment.

The equipment has an electric engine that generates a smooth movement of swinging on a plate that moves the water, with variable speed.

It is a compact equipment, of easy placement and fixation in the channel.



**Optional Accessory: HD.Z.51 - VARIABLE TILT PLAIN BEACH**

The HD.Z.51 accessory, is intended to be used in flow channels, along with the HD.Z.50.

It allows to vary the inclination of the beach in an easy way, which helps to observe how the wave is formed in the shore in different work conditions.

The surface of the beach is waterproof and is made of stainless steel.



Optional Accessory: HD.Z.03 - MULTIMANOMETER 10 TUBES  
Multimanometer of 10 tubes for flow channel.

Characteristics:

- Height 300mm
- Double seal connections
- Coupling to the channel with tilt angle adjustment.
- Includes level for fully horizontal placement.



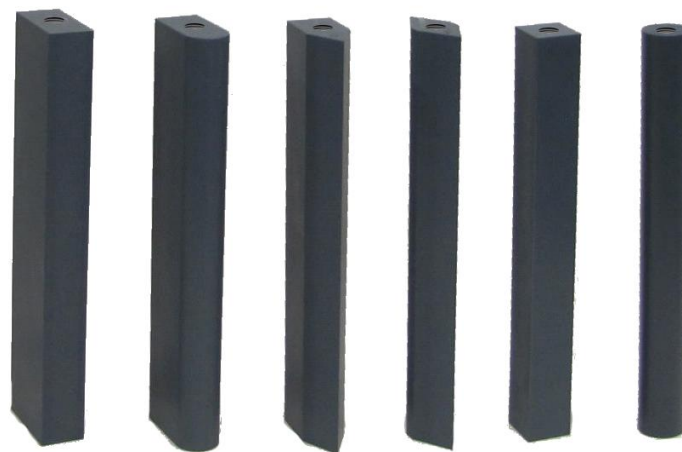


**Optional Accessory: HD.Z.06 - SPEED METER IN WATER**

The HD.Z.06 water speed meter provides a digital display and a probe, which immersed in water, will not show the speed of flow in its path.

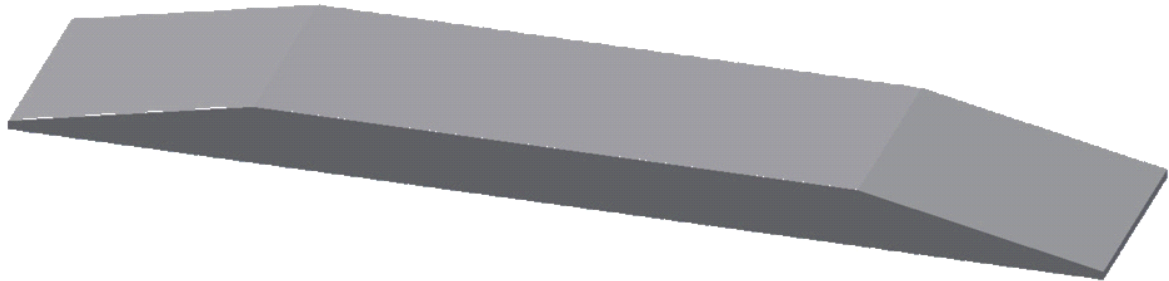
Perfect element for the study of flow channels.

Totally portable and easy to use.



**Optional Accessory: HD.Z.30 - 7 PILLARS FOR FLOW CHANNEL**

Set of 7 interchangeable pillars of different geometric shapes, for placement and study in hydrodynamic channels.



**Optional Accessory: HD.Z.40 - SILL**

This accessory for the flow channel, is a sill with an entry and an exit at an angle, in which the behavior of the water and its disturbances can be clearly verified.



**Optional Accessory: HD.Z.07 - LEVEL GAUGE**

Accessory composed of a limnimeter, attached to a gauge, which allows great accuracy in the readings.

**Characteristics:**

- High accuracy gauge.
- Easy coupling to the walls of the channel.



Optional Accessory: HD.Z.19 - PLATE WEIRS (TRIANGULAR, RECTANGULAR AND CIPOLETTI)  
Set of 3 plate weirs: Triangular, rectangular and Cipolletti.

Characteristics:

- Rubber bands for tightness.
- Easy placement on the channel floor.
- Sharp top of the weirs.
- Height of the weirs 190mm.

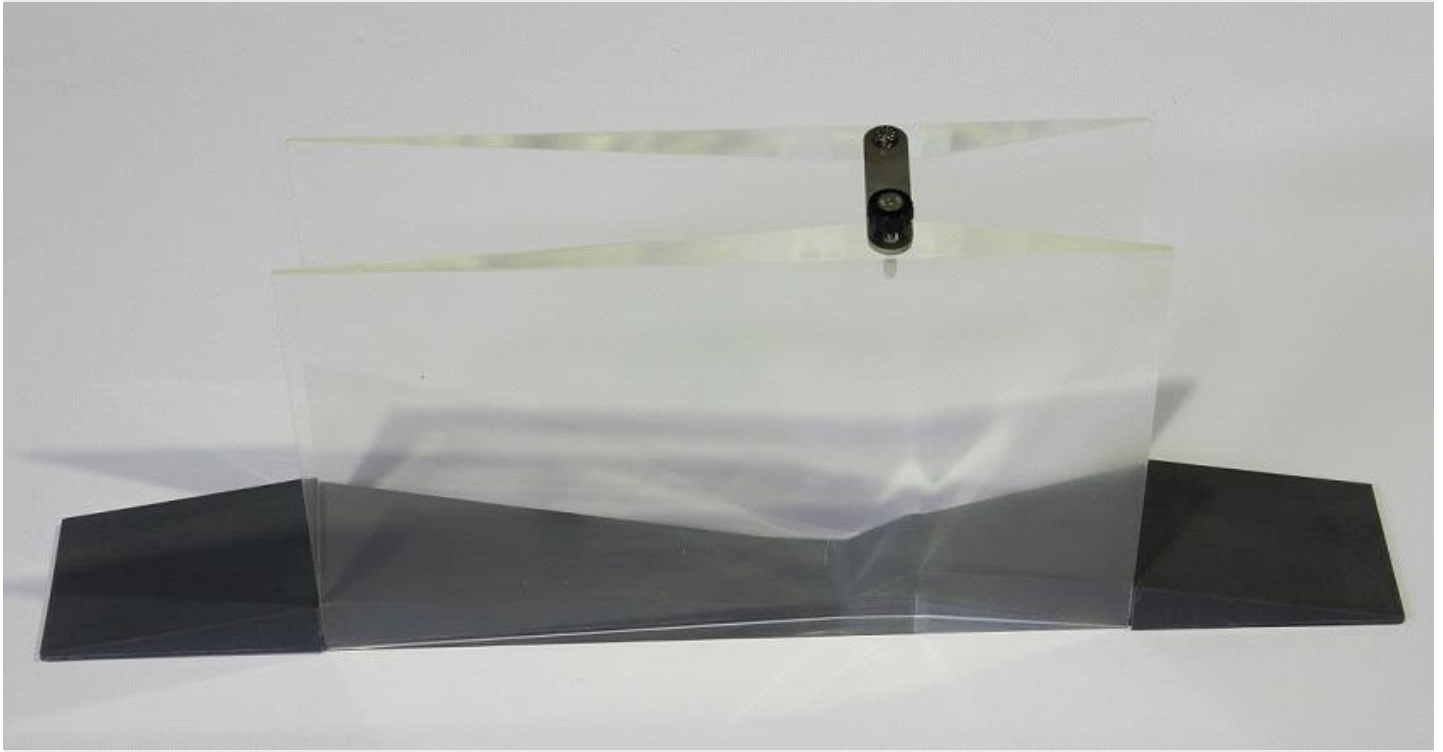


Optional Accessory: HD.Z.22 - CULVERT FITTING, SQUARE AND ROUNDED EDGE

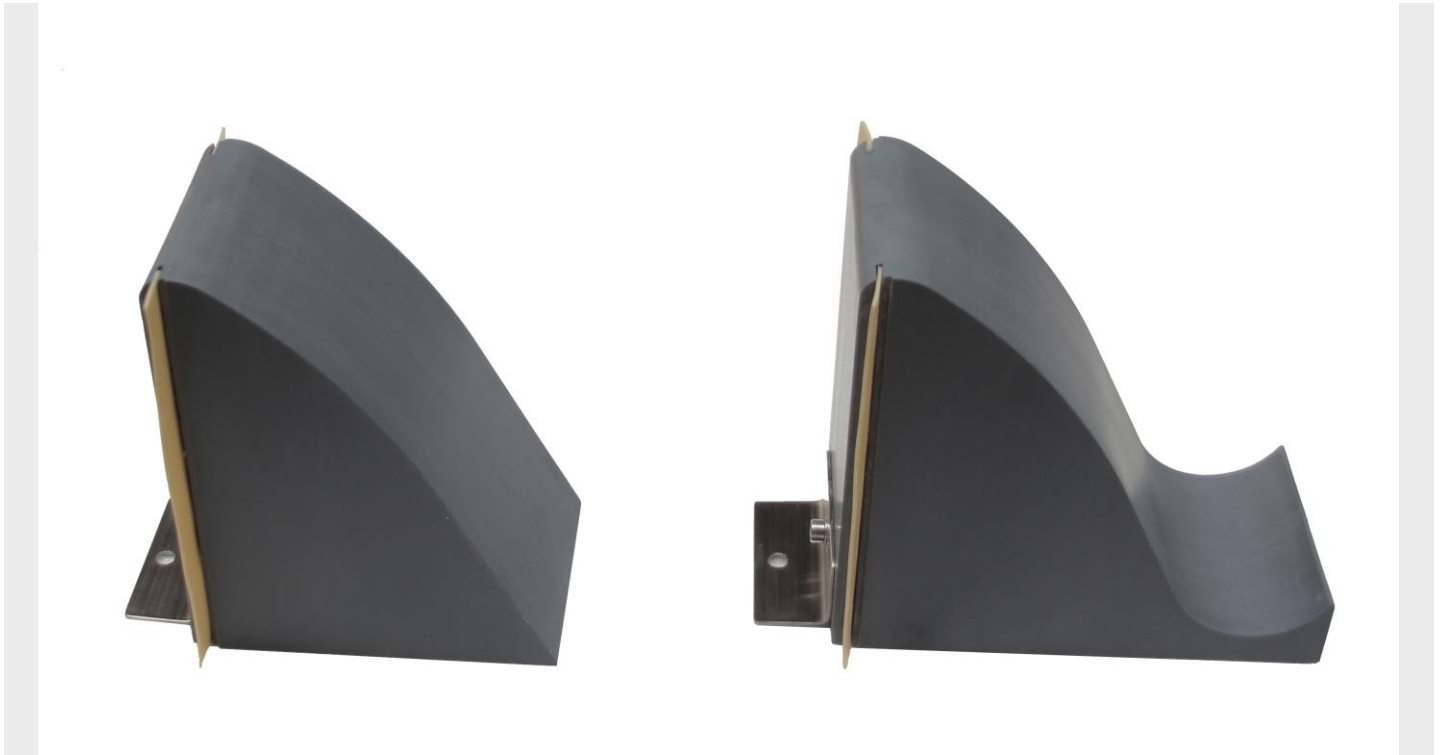
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Optional Accessory: HD.Z.24 - PARSHALL`S DEVICE



Optional Accessory: HD.Z.25 - OGEE CRESTED WEIR WITH TWO DIFFERENT OUTLETS

The ancillary HD.Z.25 allows to study the behaviour of the ogee crested weir with two different outlets, chute only and chute with ski jump.

Characteristics:

- Easy placement on the bottom of the channel.
- Rubber profiles on the sides, for seal.
- Weir height 150mm.

**LEARNING OBJECTIVES**

- Study of flow through open channels , measuring variables such as:
    - Height of water.
    - Speed at different points of a cross section .
  - Study of uniform flow , gradually varied flow and behavior of surface profiles .
  - Study and use of landfill sites for the thin-walled flow measurement.
    - Rectangular weir without lateral contraction .
  - Using dumps and study of thick wall for flow measurement .
    - Rectangular weir .
    - Triangular weir .
  - Study and use of Venturi channel .
  - Analysis and study of flow under doors .
    - Vertical gate .
    - Radial gate .
  - Study of the hydraulic jump .
  - Analysis of flow over spillways of dams .
- \* Some of the experiments require optional accessories.

**TECHNICAL DATA****Composed by:**

- Channel, support structure, storage and pumping system.
- Flow regulation.
- Flow stabilization system composed by a honeycomb at the entrance, to minimize turbulence.

**Materials:**

- All the materials used are resistant to corrosion, especially in areas in contact with water.
- Channel: Treated stainless steel.
- Channel walls: 10mm thick laminated, tempered and bevelled glass.
- Tanks: Treated stainless steel.
- Legs: Treated and painted steel.

**Pumping, storage and recirculation system:**

- Located on a single level, it does not require high tanks.
- Tank capacity: 300 litres.

**Section of work:**

- Section of work (high/wide): 300 / 87 mm.
- Length: 5.000 mm.

**Slope:**

- Adjustable -1%+3% of its length.

**Pump:**

- Power: 1,5 hp (1,1 kW)
- Maximum flow : 24 m<sup>3</sup>/h
- Maximum height: 14,3 mwc
- Stainless steel impeller.
- Type: Centrifugal.

**Flowmeter:**

- Scale 1.500-15.000 l/h.

**REQUIREMENTS**

- Electrical input: 230V / 50Hz. (Others available, please ask).
- To carry out some of the experiments, accessories of the HD.Z.xx range are required.

*NOTE: The show image could not correspond exactly with the product.*