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MIXED® GATES

Downstream constant level regulation with upstream level control

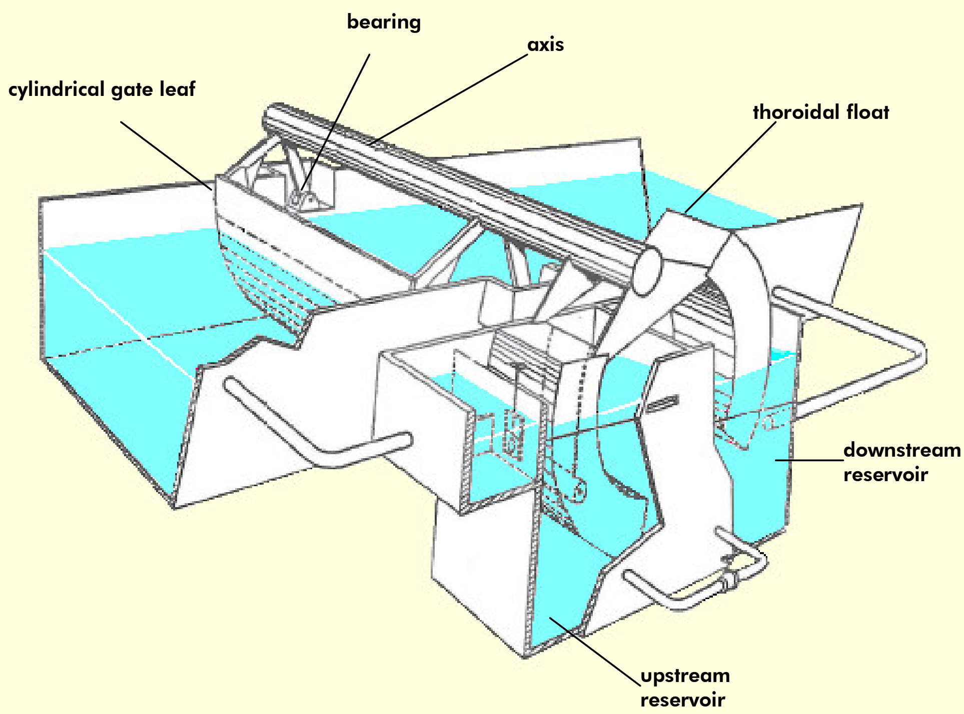
Function

The normal function of the Mixed® Gate is: to maintain a constant downstream water level; to create a reserve water volume, distributed along the channel used in case of water shortage; as well as in the cases of floods, to stop the channel overflowing.

If the supplied water quantity is higher than the demand (flood periods or no water demand), the Mixed® Gates, that in this case have the function of the constant upstream level control, open and prevent overflowing. The role of the gate in this case is as a channel Safety Siphon® with upstream level control. On the other hand, if the supplied water quantity is lower than the demand, the gate closes and avoids the upstream side of the channel to become exhausted.

Advantages

- Protection of the channel borders;
- Suppression of overflows due to flood periods or faulty operations;
- Accurate automatic operation without needs of any external device;
- Low head losses;
- Bottom flowing off debris outlet;
- Gates with a large range of sizes allowing a number of case applications.



Mixed® Gate is trademark

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Operating principle

Mixed® Gates consist of a cylindrical gate leaf with trapezoidal section and a Thoroidal float installed outside the channel in case of two reservoirs (upstream reservoir and downstream reservoir). These two elements, the gate leaf and thoroidal float, are rigidly connected by means of a metallic framework, hinged on two bearings, having its centers of rotation coinciding with the common gate leaf and float tilting axis for the gate leaf and float.

In the first step, the assembly is balanced to provide an indifferent equilibrium when the water inside both reservoirs is at the same level.

In a second step, a fall (D) is created between both reservoirs. The gate will tend to open, due to the moment created by this fall, with magnitude equal to:

$$C_0 = \rho \times g \times L \times D\left(r_1^2 - r_2^2\right)/2g$$

Where: (r_1) and (r_2) correspond respectively to the outer and inner radius of the floats, and (L) corresponds to its width.

To establish an indifferent equilibrium, the moment (Co) has to be offset with an equal absolute value moment (Cp). The latter may be easily achieved by a counterweight (P), positioned on the upstream float at a distance (r), so that:

$$r \times P = \rho \times g \times L \times D\left(r_1^2 - r_2^2\right)/2g$$

Finally, if the fall (D) decreases, so does the moment (Co). The moment (Cp) is then preponderant and the gate closes. On contrary, if the fall (D) increases, the gate opens.

In the situations where the upstream and downstream float reservoirs communicate directly with the upstream and downstream gate sides, respectively, it will move to maintain the fall (D) constant between its upstream and downstream side levels.

On the other hand, if the level in one of the float reservoirs is kept constant, the gate tries to adjust the level in the other float reservoir and, hence, in the corresponding channel side to the level fall D (cm) above or below the reference level, according to the selected float reservoir. Shortly, if a correspondence law is established between the water level in one float reservoir and its associated gate side, the gate sill reproduces this correspondence law between the gate upstream and downstream water levels with a difference closely equal to (D).

Functions

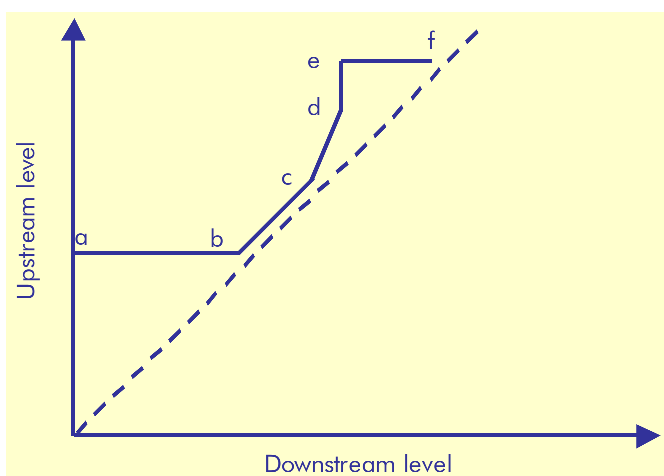
- **Minimum Upstream Water Level (a-b):**
Whenever the upstream water level is below a pre-established level, the gate closes and prevents the upstream side channel water running out.

- **Constant Head Loss (b-c):**
Between two water levels, the gate maintains a constant fall (D) between the water levels of the upstream and downstream gate sides.

- **Associated levels (c-d):**
Above a pre-established upstream water level (c), the gate creates a progressive head loss.

- **Constant Downstream Water Level (d-e):**
For a constant downstream water level, the gate works as an automatic gate.

- **Constant Upstream Water Level (e-f):**
Above a maximum upstream water level, the gate opens and prevents the water level from increasing further (Flood safety).



Hydraulic characteristics

Basic dimensions of these gates are shown in the following pages.

The Mixed® Gates are featured by:

- The vertical distance (a) of the gate axis up to the sill;
- The horizontal width of the gate measured at sill level;
- Presence or not of a mask wall upstream from the gate;
- The float shape and its angular stroke.

The first two features define the span section.

Example:

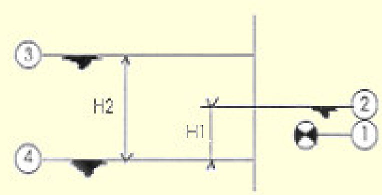
250/224	AM	$\alpha = 45^{\circ}$	GR
dimensions a/b	AM with mask SM without mask	45⁰ 55⁰ angular stroke	Radius GR=large PR= small

Equipment choice

Selecting a suitable gate for a certain function and location is imposed first by the available head loss conditions and the minimal flow pass section and second by the water level to be controlled and the gate height.

If the gate leaf opens above the water level, the minimum head loss would be that created by the civil engineering works.

The following data must be known when choosing Mixed®, Gates:



1 Gate axis
2 Maximum downstream level
3 Maximum upstream level
4 Minimum upstream level

Q : Maximum discharge (m^3/s)

S : Channel section (m^2)

V : Channel flow speed (V=Q/S) (m/s)

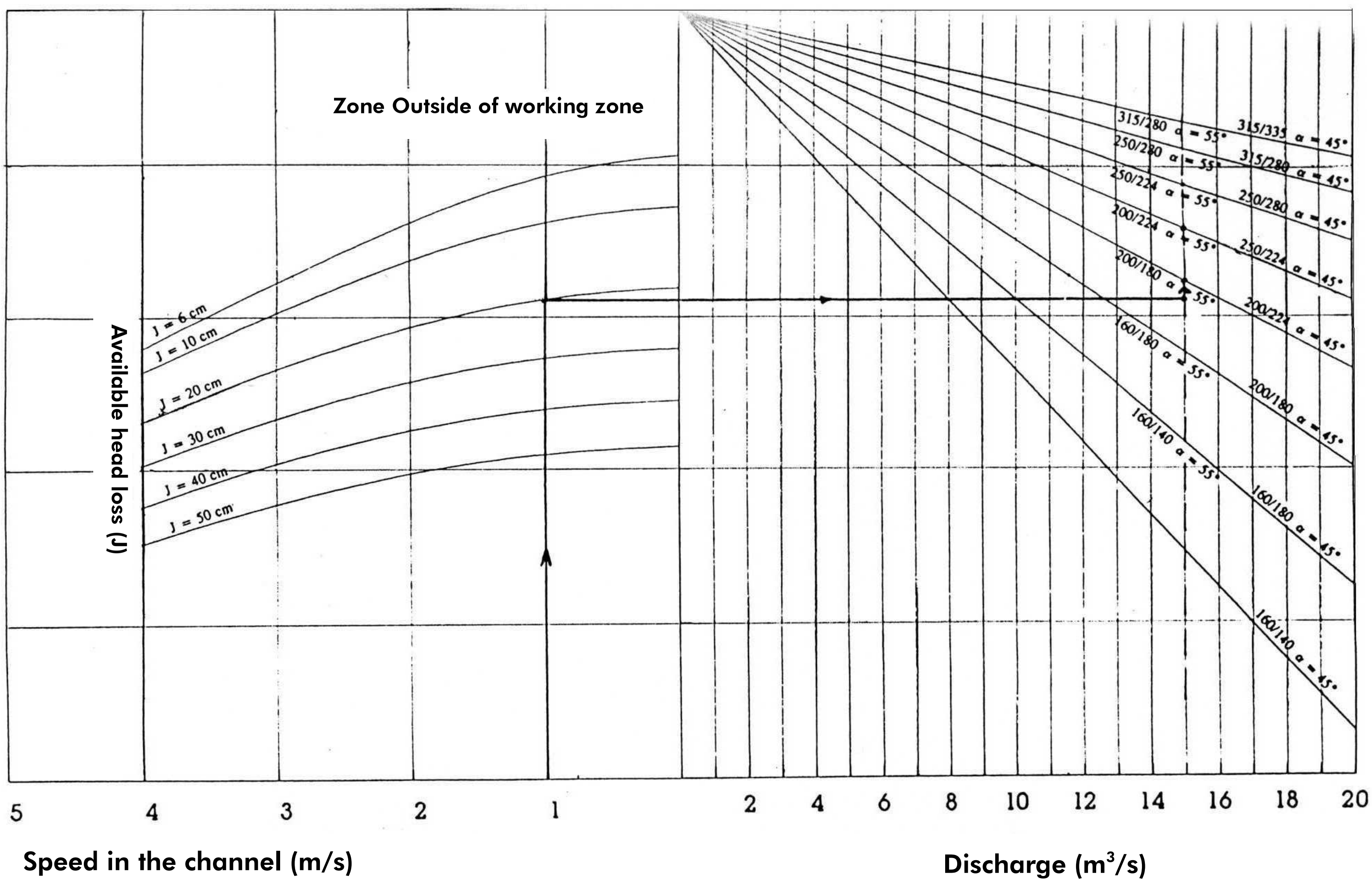
J : Available head losses (cm)

H_1 : Maximum downstream level – minimum upstream level

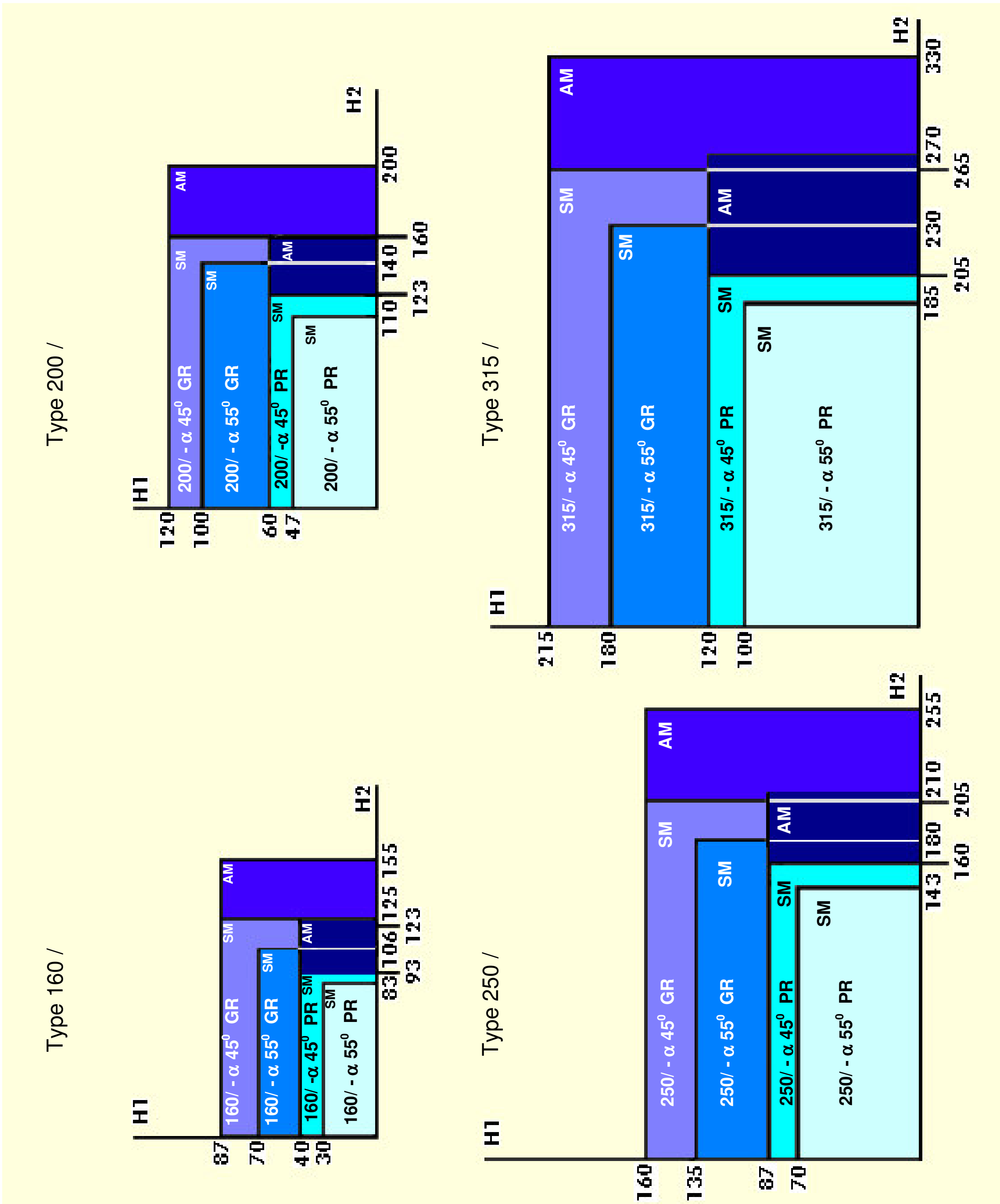
H_2 : Maximum upstream level – minimum upstream level

The sizing is achieved in two steps:

- From Graph 1 we must choose the gate that meets the discharge and available head loss values;
- From Graph 2 we must look for the smallest gate dimension, i.e., the lowest cost, which is capable to work within the desired water level range.



Graph 1: Head loss and Discharge Curve



Graph: Operation Level Ranges

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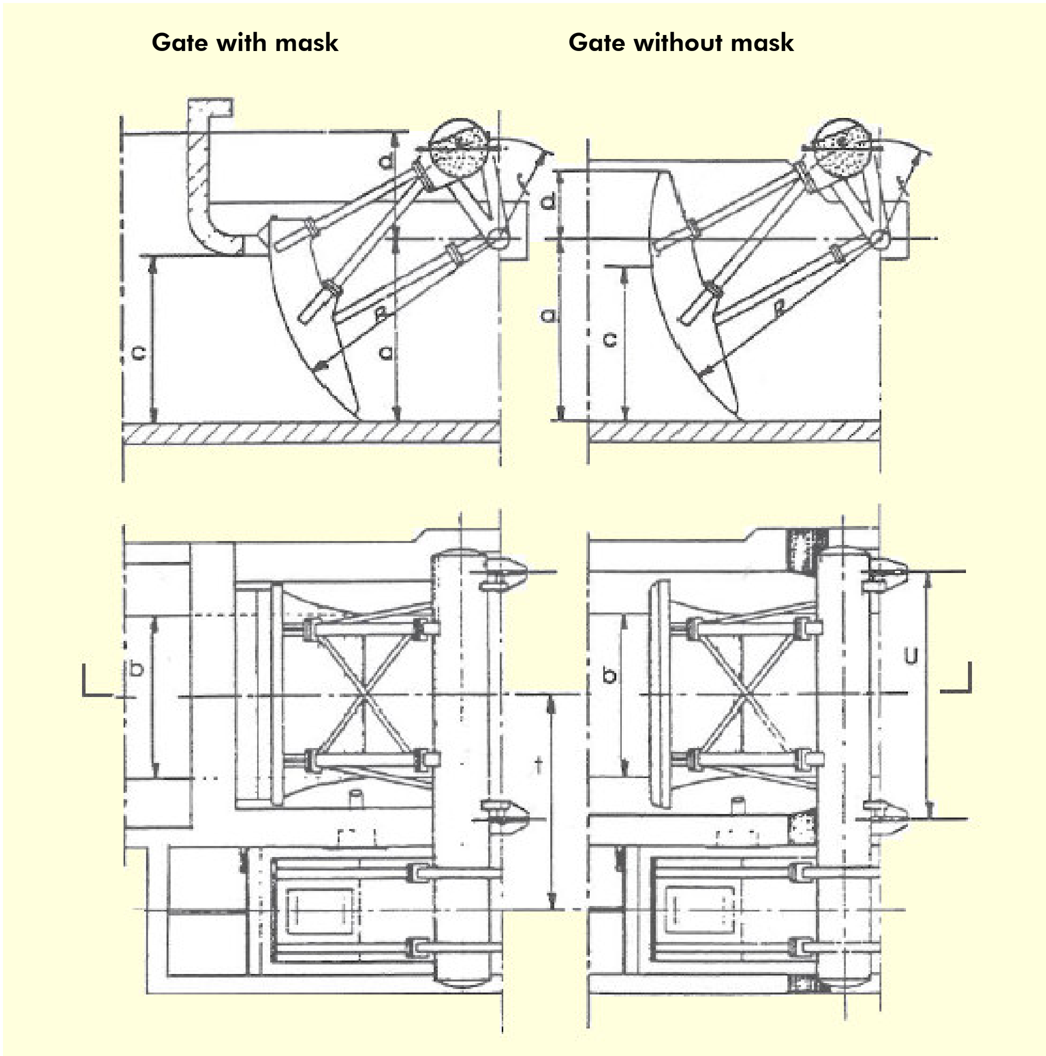
Mixed® Gates: Main Dimensions



Gate without mask

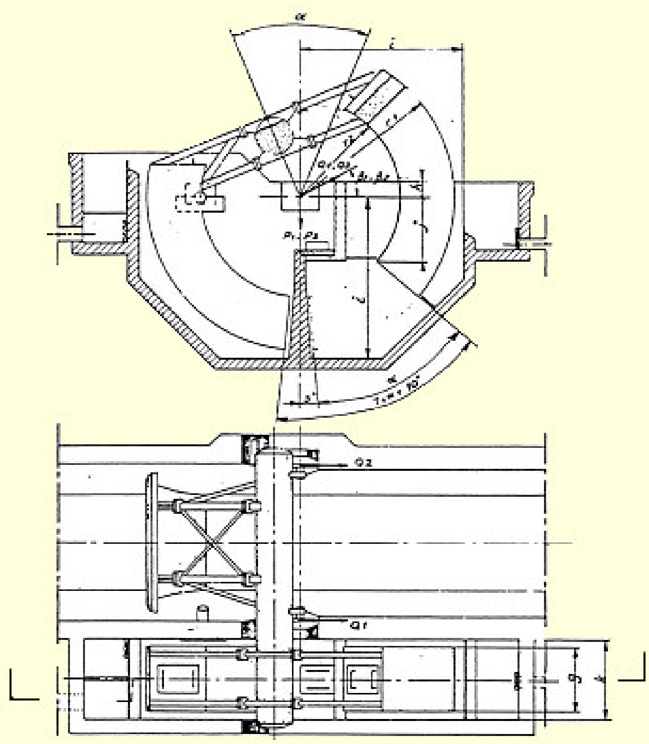
Dimensions in cm

Type a/b	Height / Section α = 45° C	S (m²)	α = 55° C	S (m²)	R	d	e	f	t	u
160/140	132	2,12	170	2,65	200	63	47,5	85	195	208
160/180	132	2,65	170	3,35	200	63	47,5	85	225	248
200/180	170	3,35	212	4,25	250	80	60	106	230	267
200/224	170	4,25	212	5,3	250	80	60	106	265	311
250/224	212	5,3	265	6,7	315	100	75	132	285	333
250/280	212	6,7	265	8,5	315	100	75	132	335	389
315/280	265	8,5	335	10,6	400	125	95	170	350	415
315/355	265	10,6	335	13,2	400	125	95	170	410	490

Gate with mask

Height / Section α = 45° C	S (m²)	R	d	e	f	t	u
132	2,12	200	95	47,5	85	195	208
132	2,65	200	95	47,5	85	225	248
170	3,35	250	118	60	106	230	267
170	4,25	250	118	60	106	265	311
212	5,3	315	150	75	132	285	333
212	6,7	315	150	75	132	335	389
265	8,5	400	190	95	170	350	415
265	10,6	400	190	95	170	410	490

Mixed® Gates: Float main Dimensions and Bearing Load



Float – Small Radius

Dimensions in cm Thrust in tf

Tipo a/b	r1	r2	g	h	J 1 (α = 45°)	J 2 (α = 55°)	j	k	P1	Q1	β1	P2	Q2	β2
160/140	170	80	170	30	50	40	180	122	4,5	2,5	30°	1	2,5	30°
160/180	170	80	170	30	50	40	180	144	5,5	2,8	30°	1,3	3	30°
200/180	212	100	212	38	63	50	224	144	8	5	30°	2	5	30°
200/224	212	100	212	38	63	50	224	172	9,5	5,5	30°	2,5	6	30°
250/224	265	125	265	48	80	63	280	180	14	10	30°	3	10	30°
250/280	265	125	265	48	80	63	280	220	17	11	30°	4	12	30°
315/280	335	160	335	60	100	80	355	220	26	18	30°	6	19	30°
315/355	335	160	335	60	100	80	355	260	31	24	30°	8	23	30°

1 – Gate with and without mask

2 – Gate without mask

Float – Large Radius

r1	r2	g	h	J 1 (α = 45°)	J 2 (α = 55°)	j	k	P1	Q1	β1	P2	Q2	β2
200	125	90	48	80	63	212	122	5,5	2,3	10°	1,3	2,5	30°
200	125	112	48	80	63	212	144	6,5	2,8	15°	1,6	3	30°
250	160	112	60	100	80	265	144	9,5	4,5	10°	2,5	5	30°
250	160	140	60	100	80	265	172	12	5,5	15°	3	6	30°
315	200	140	75	125	100	335	180	17	9	10°	4	10	30°
315	200	180	75	125	100	335	220	21	11	15°	5	12	30°
400	250	180	95	160	125	425	220	31	16	10°	8,1	19	30°
400	250	220	95	160	125	425	260	39	21	15°	10	23	30°

Construction

The gates are welded assemblies of carbon steel plate, pipes and rolled shapes with precision sheet-metal work requirements and tight tolerance margins assuring the correct operation without a hitch.

Installation

The gate leaf, in closed position, stops up the whole trapezoidal channel section. The channel trapezoidal section allow the gate opening and closing operations to be smooth, without any contact with the fixed parts and consequently without any friction force between the gate moving and channel fixed parts.

Furthermore, to avoid any locking in gate closed position, there is a small gap between the side edges of the gate leaf and the lateral concrete channel walls.

The civil engineering works dimensions in the section provided for the gate installation have to be equal to the corresponding gate leaf trapezoidal section, as well as to have the upstream and downstream side links.

In most case, the water discharge section for either a channel, river or reservoir outlet is different from the gate section, requiring the construction of a transition shape.

Conclusion

Mixed® Gates are part of a range of equipment supplied by our Group and intended to control the free surface channel levels.

These types of equipment, whose construction and function were based on a surprisingly simple hydraulic design, operate automatically without need for complex mechanical devices.

This faultless and simple equipment is bestawed with a high robustness, well suited to strong operational conditions.

In addition to all these advantages the gate operation doesn't require an external power source.

The Mixed® Gates manufactured by ***hydrostec*** with exclusivity for the Latin American market introduce a significant contribution in the rational use of the available Water resources and to explore the Water distribution systems at a lower cost.

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