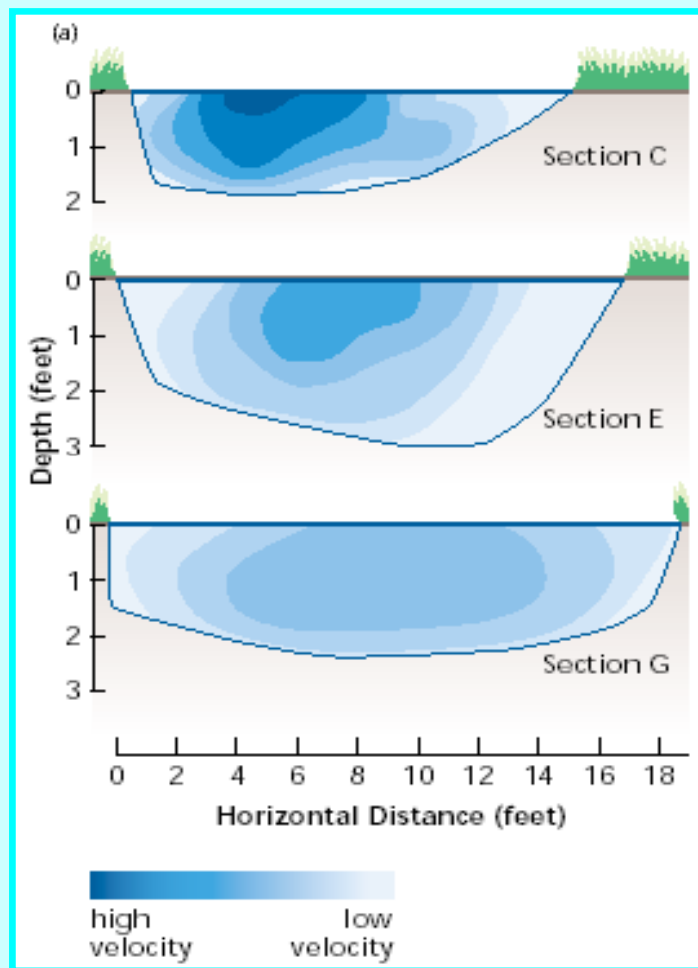
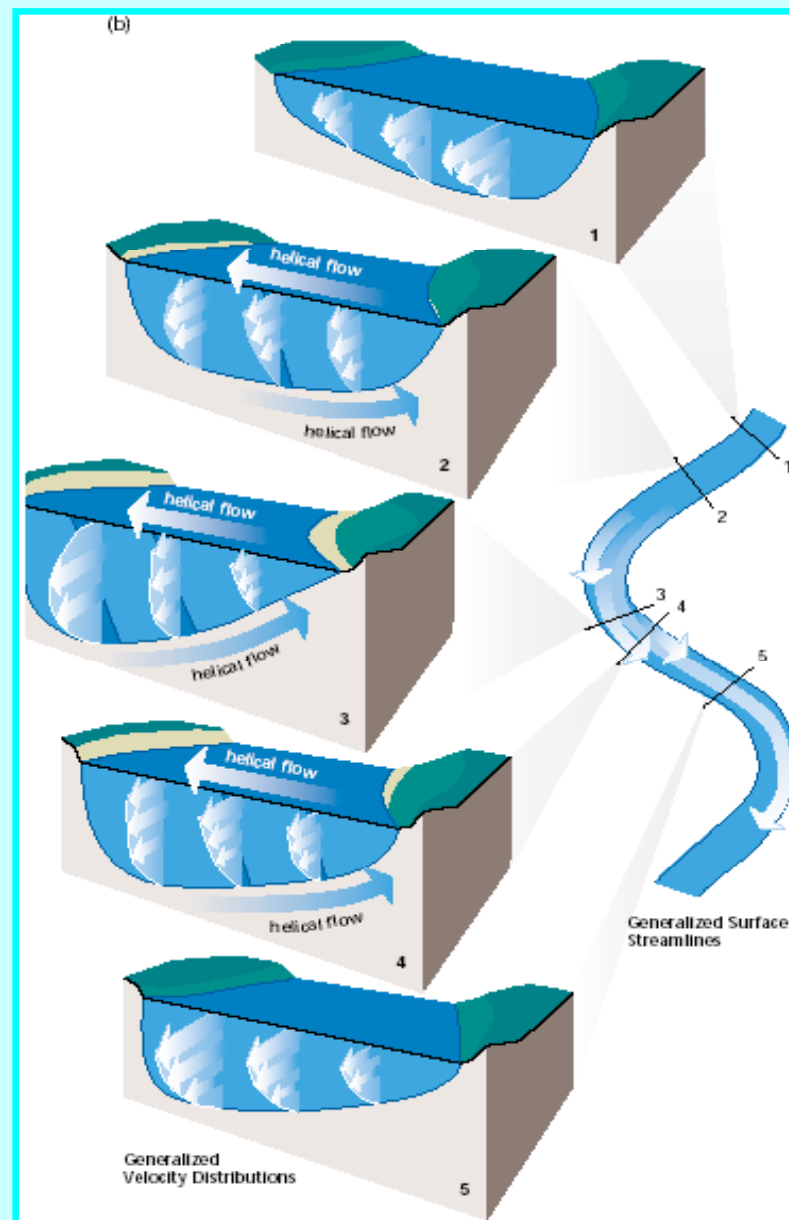


MJERENJE BRZINA TEČENJA I PROTOKA

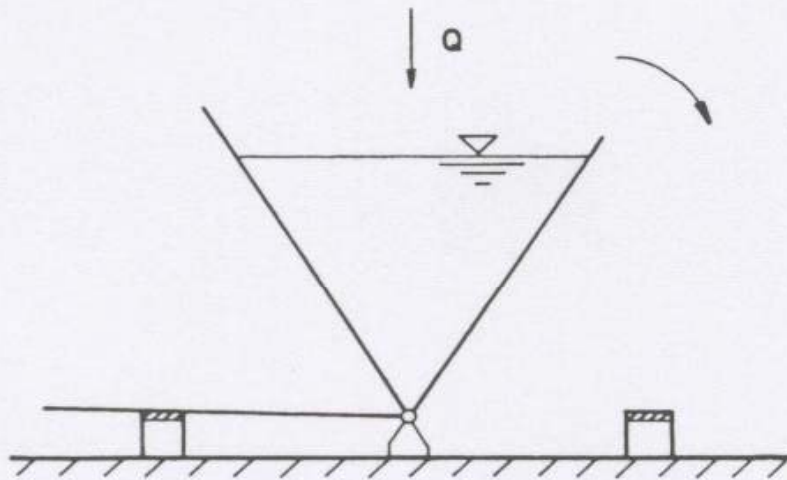


razdioba brzina u
koritu vodotoka

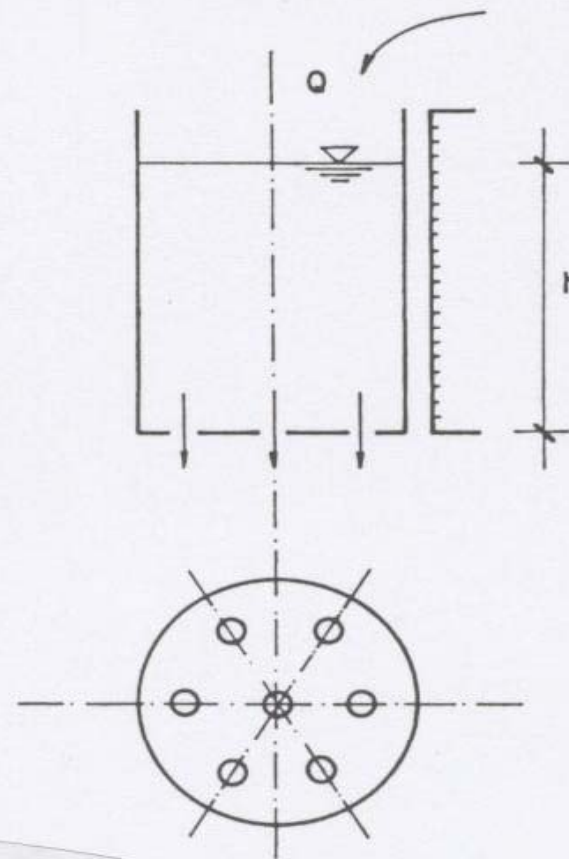


Mjerenje protoka -
mali protoci : *pomoću mjernih posuda*
(*volumetrijska metoda*)

MILNEOVA POSUDA



DANAIDA

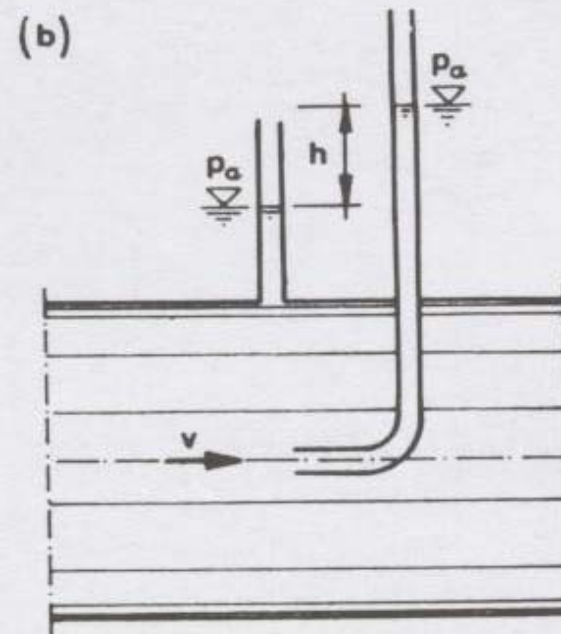
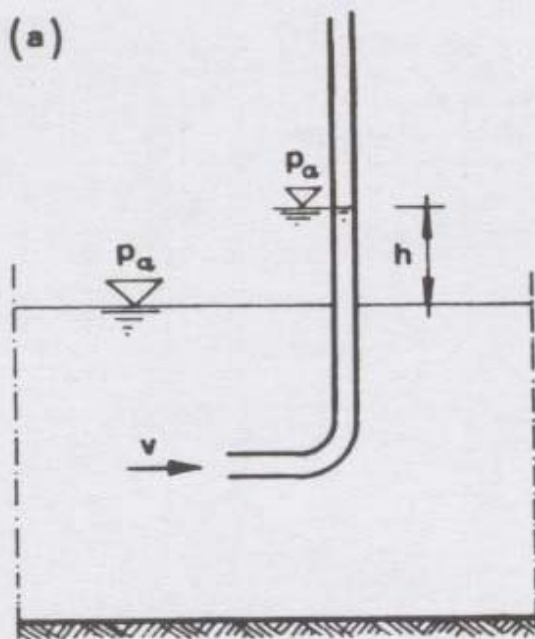


Mjerenje brzine toka pomoću Pitotove cijevi

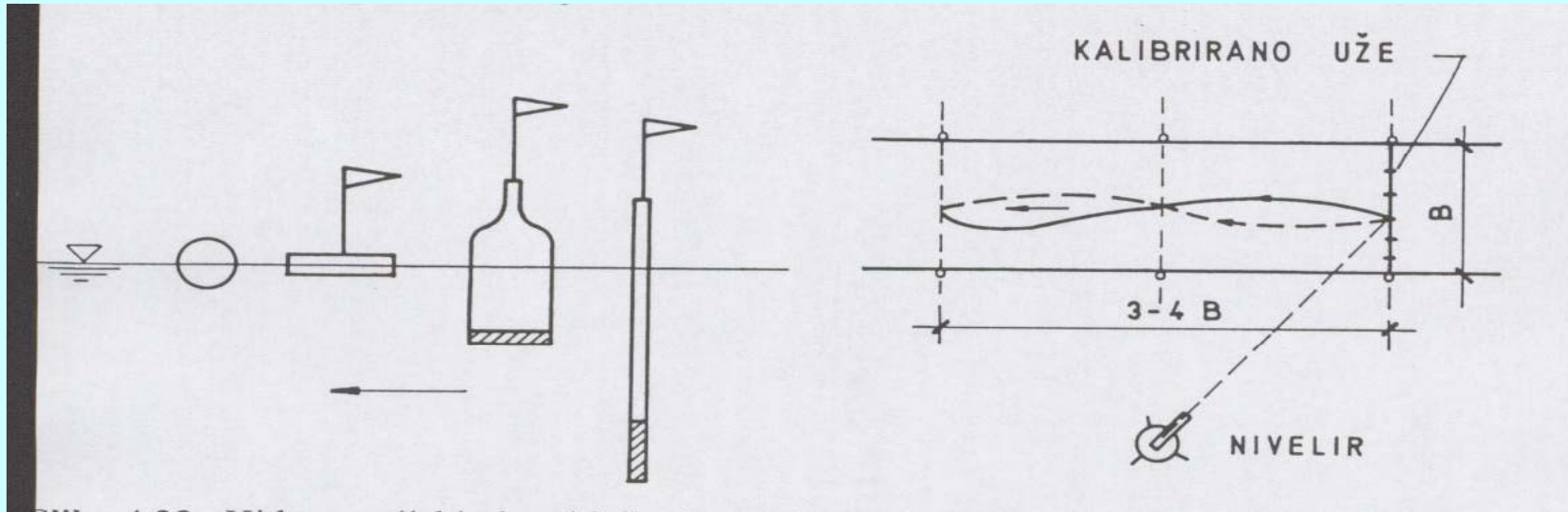
a) U otvorenim tokovima

b) u cijevima pod tlakom

$$v = \sqrt{2gh}$$

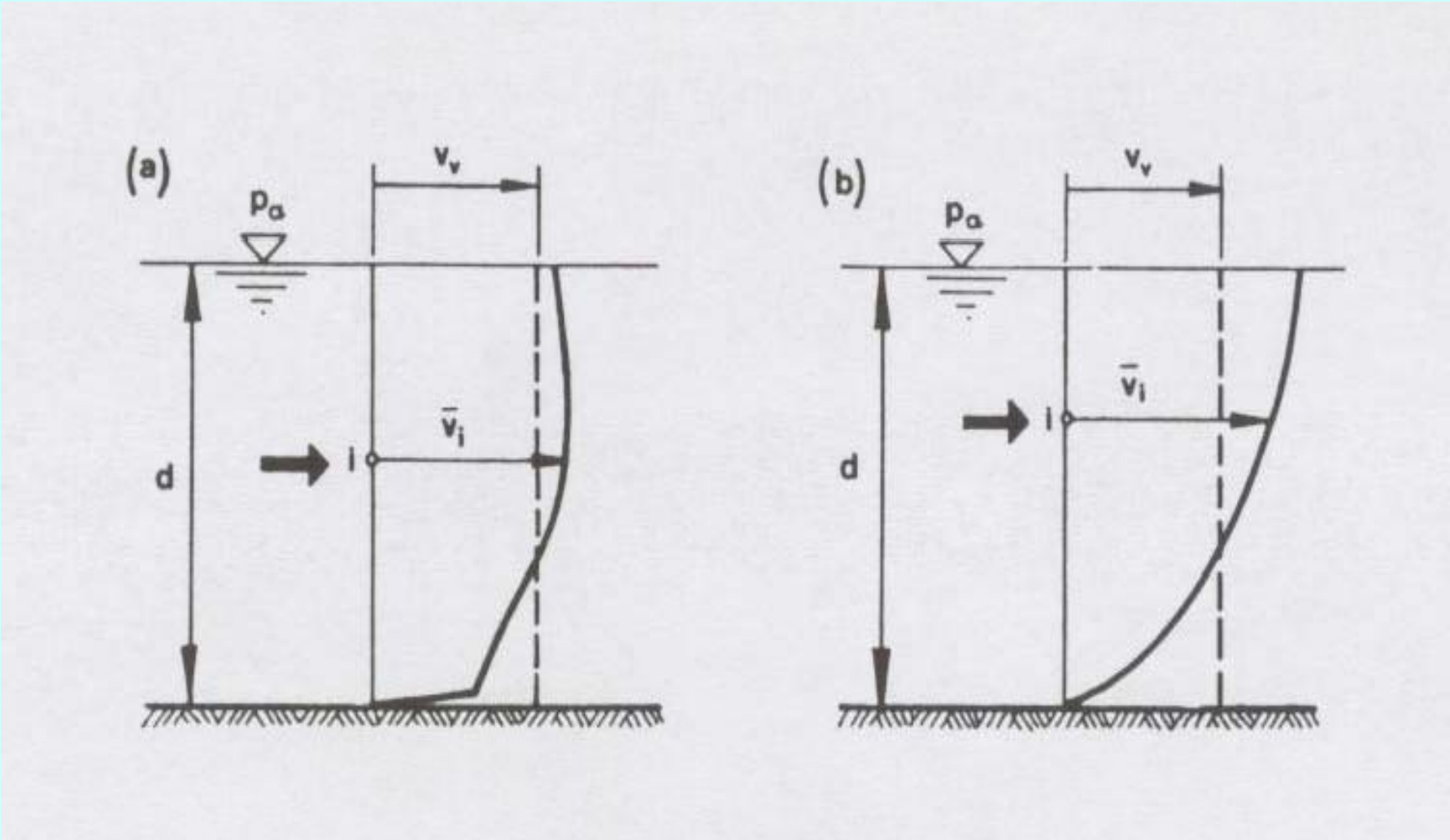


Mjerenje brzine toka pomoću plovka

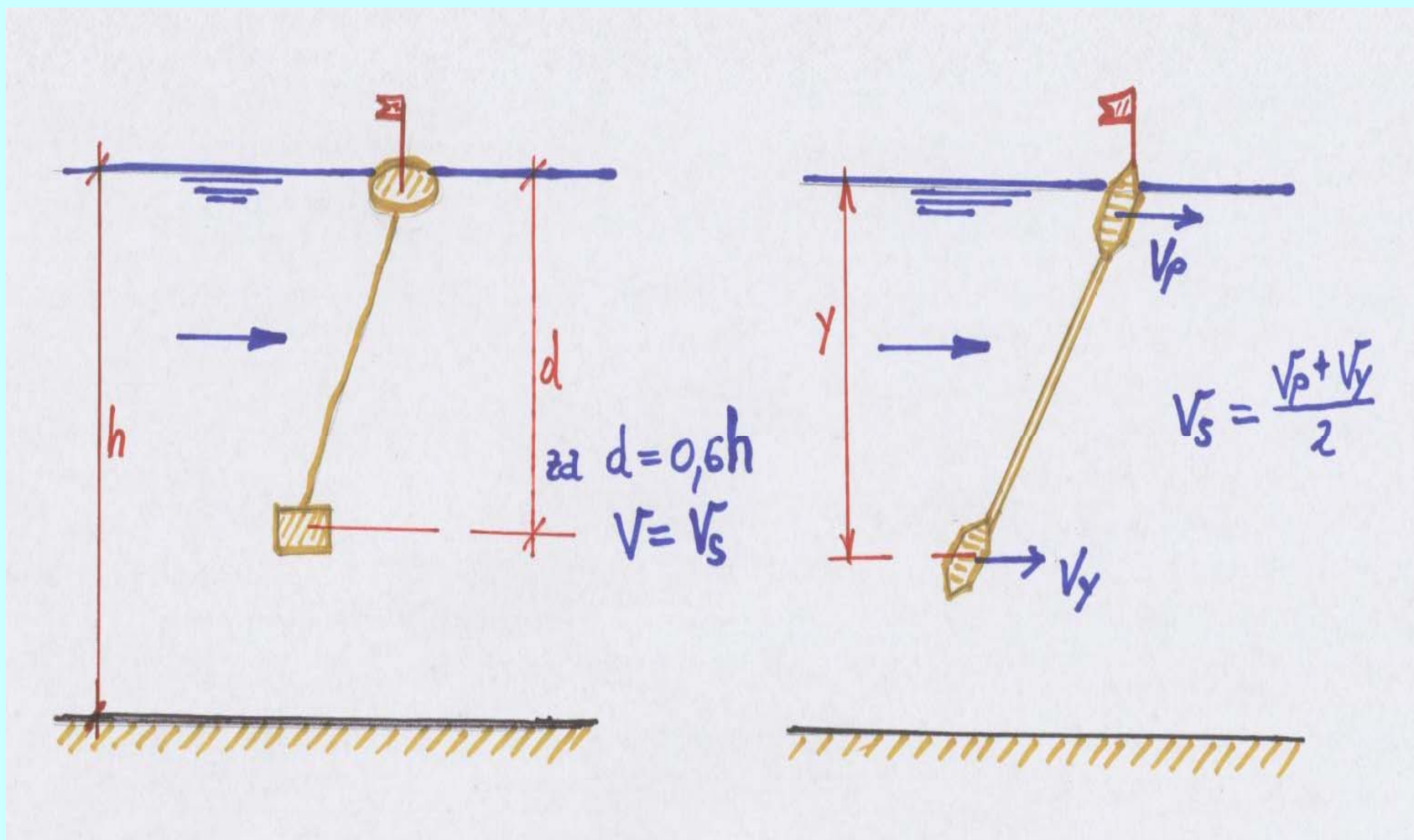


Na ravnoj dionici dužine $L = 3B$ (do $4B$) pušta se plovak i mjeri vrijeme putovanja plovka t ; Brzina na trasi plovka određena je izrazom za brzinu $v = L/t$; Plovak se pušta na više trasa po širini korita, a srednja se brzina dobije kao aritmetička sredina svih brzina po mjernim trasama.

Dijagram brzine tečenja po vertikali

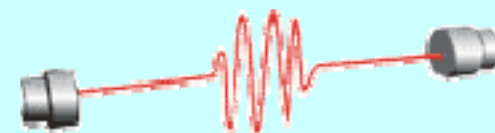
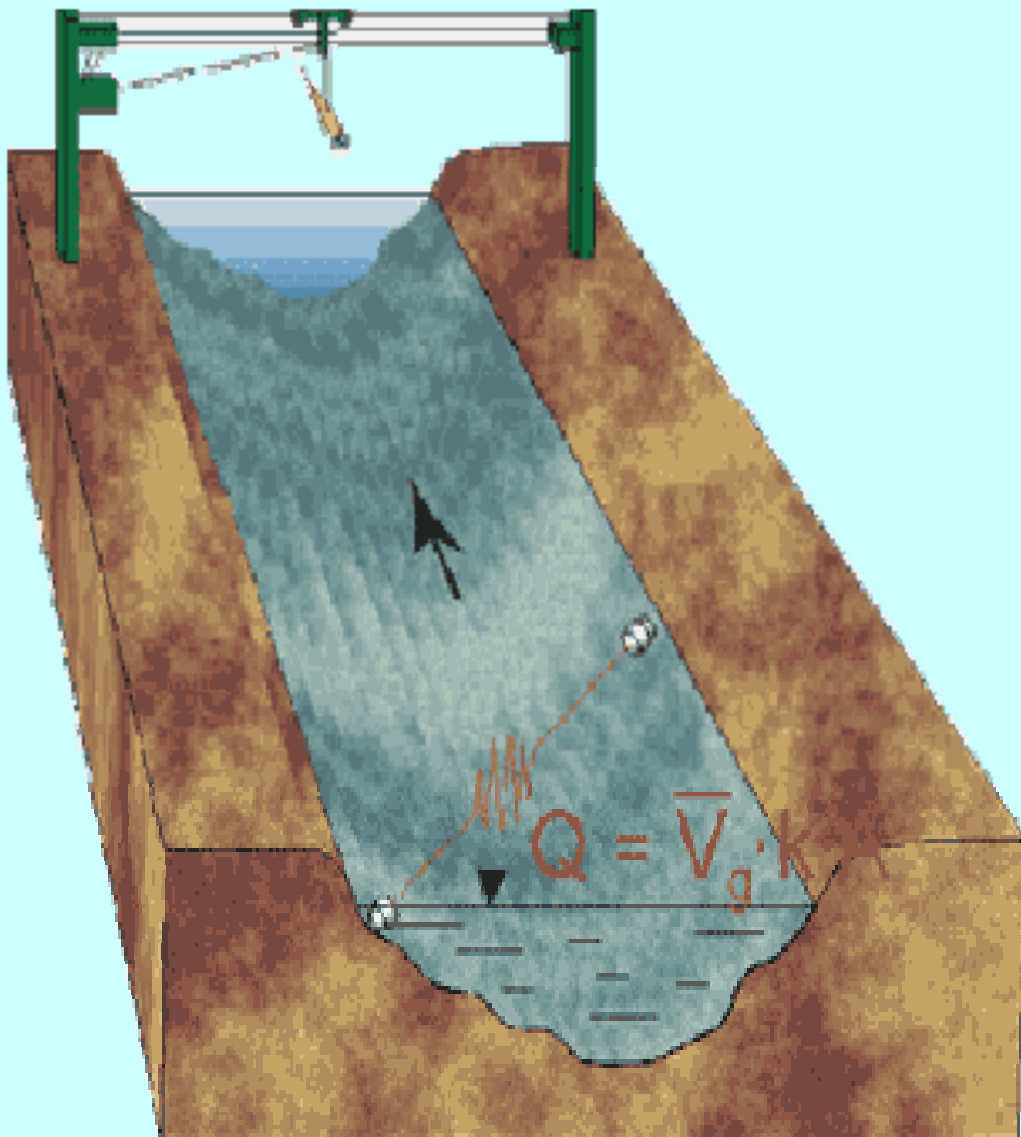


Dubinski ili dvojni plovci

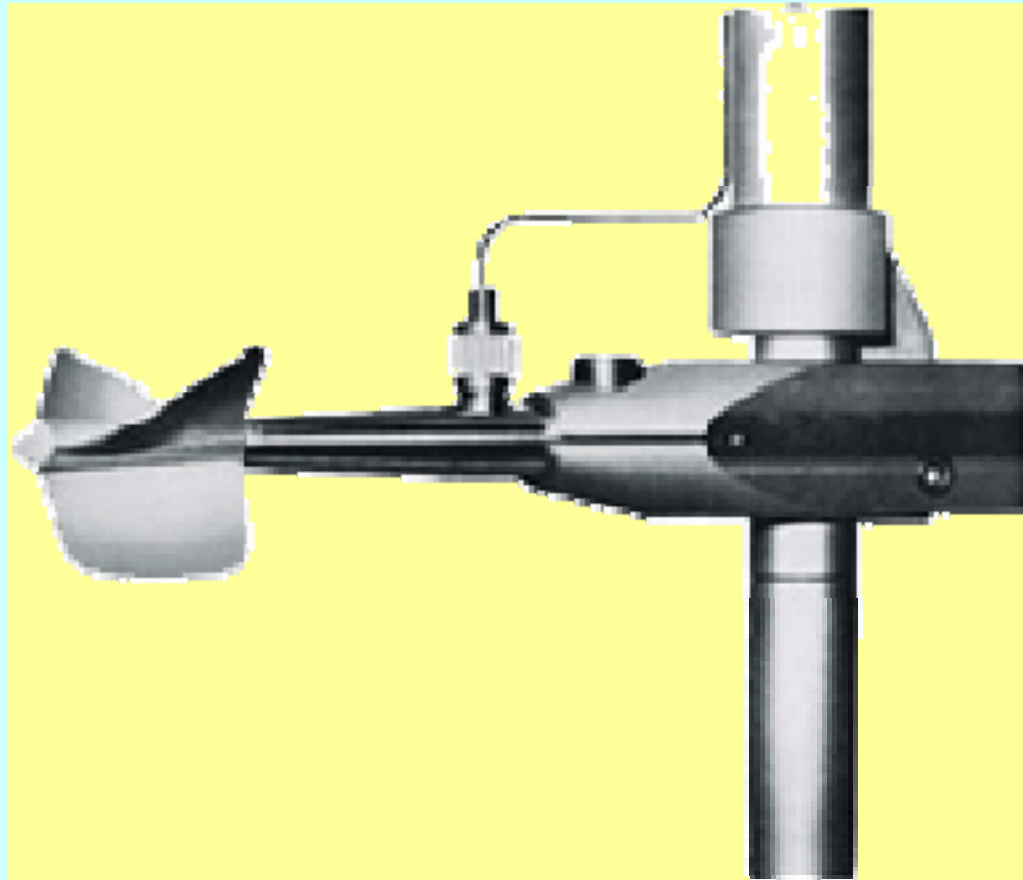


MJERENJE PROTOKA U VODOTOCIMA

$$Q = F \cdot v \quad [\text{m}^3/\text{s}]$$

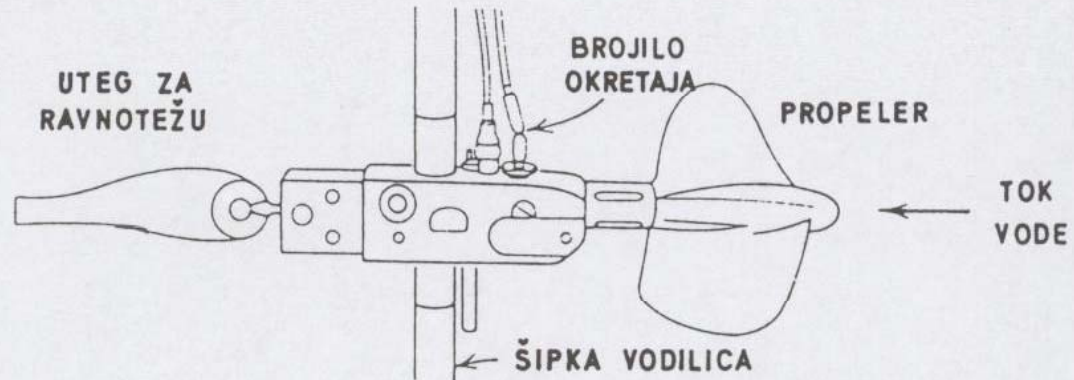


VODOMJERNO KRILO (hidrometrijsko krilo)

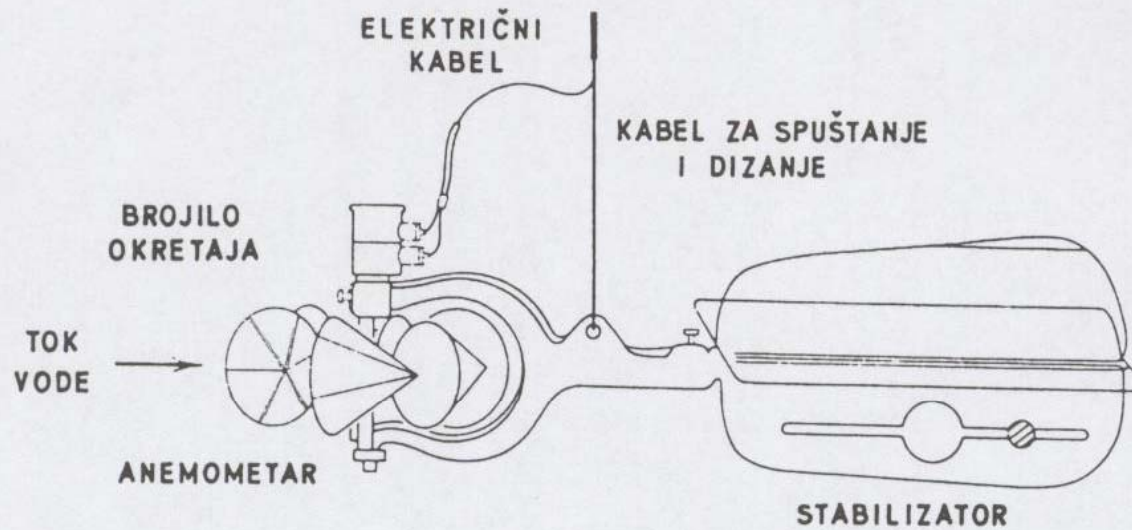


Hidrometrijsko krilo - shema

a)



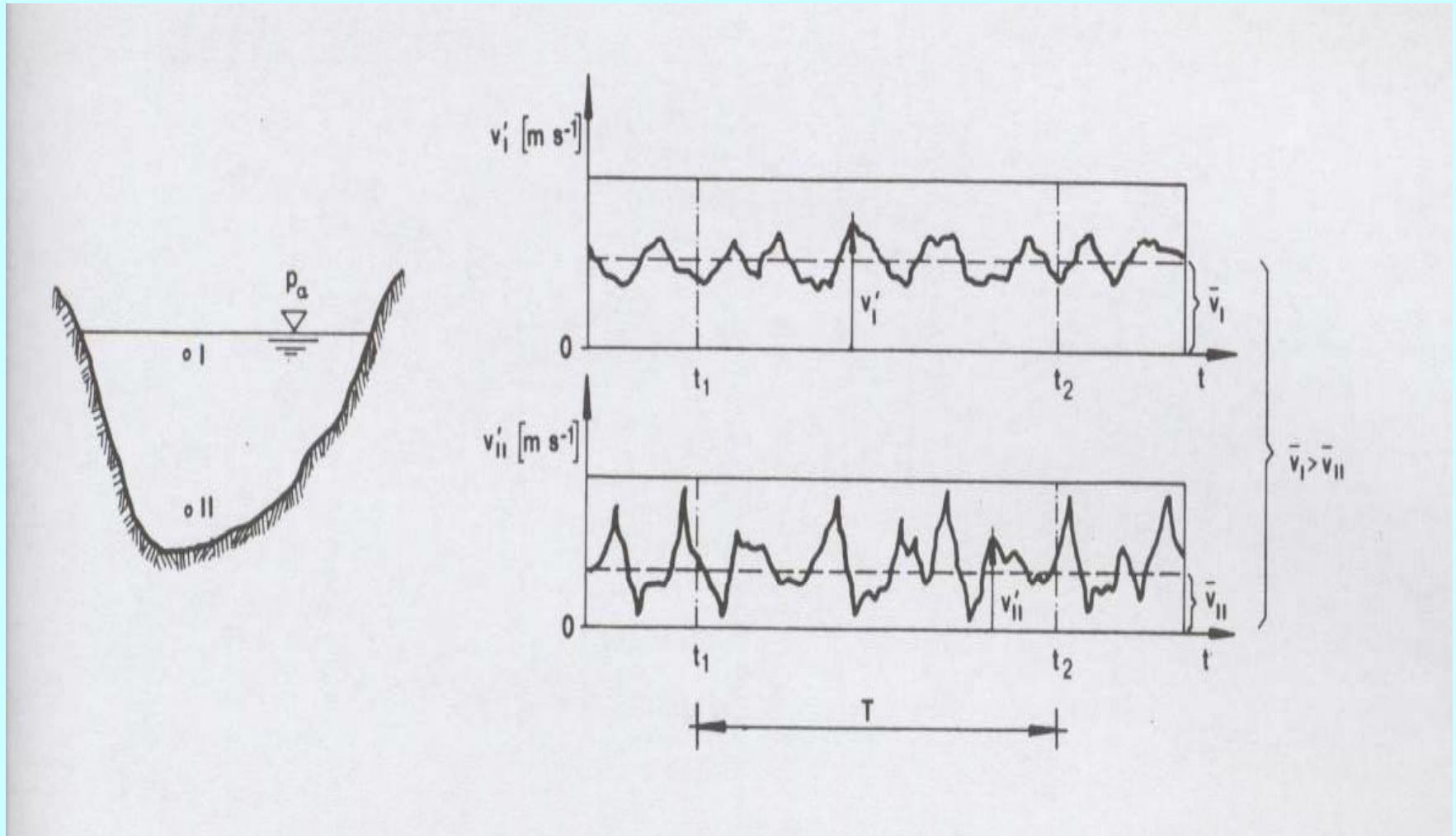
b)



PRIMJENA VODOMJERNOG KRILA S MOSTA

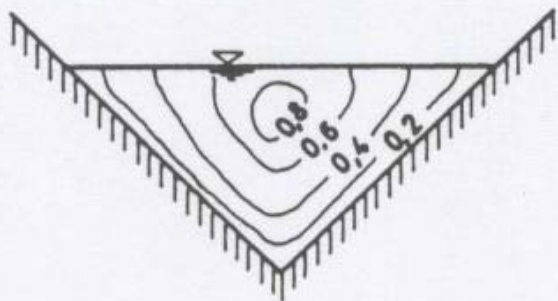


Pulsiranje brzine toka pri površini i pri dnu tijekom vremena

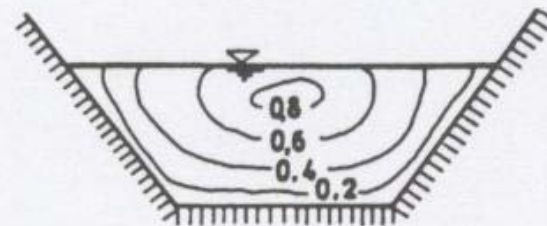


IZOTAHJE – crte jednakih brzina

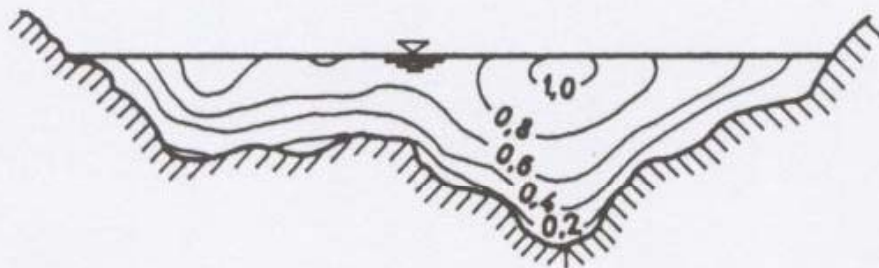
a)



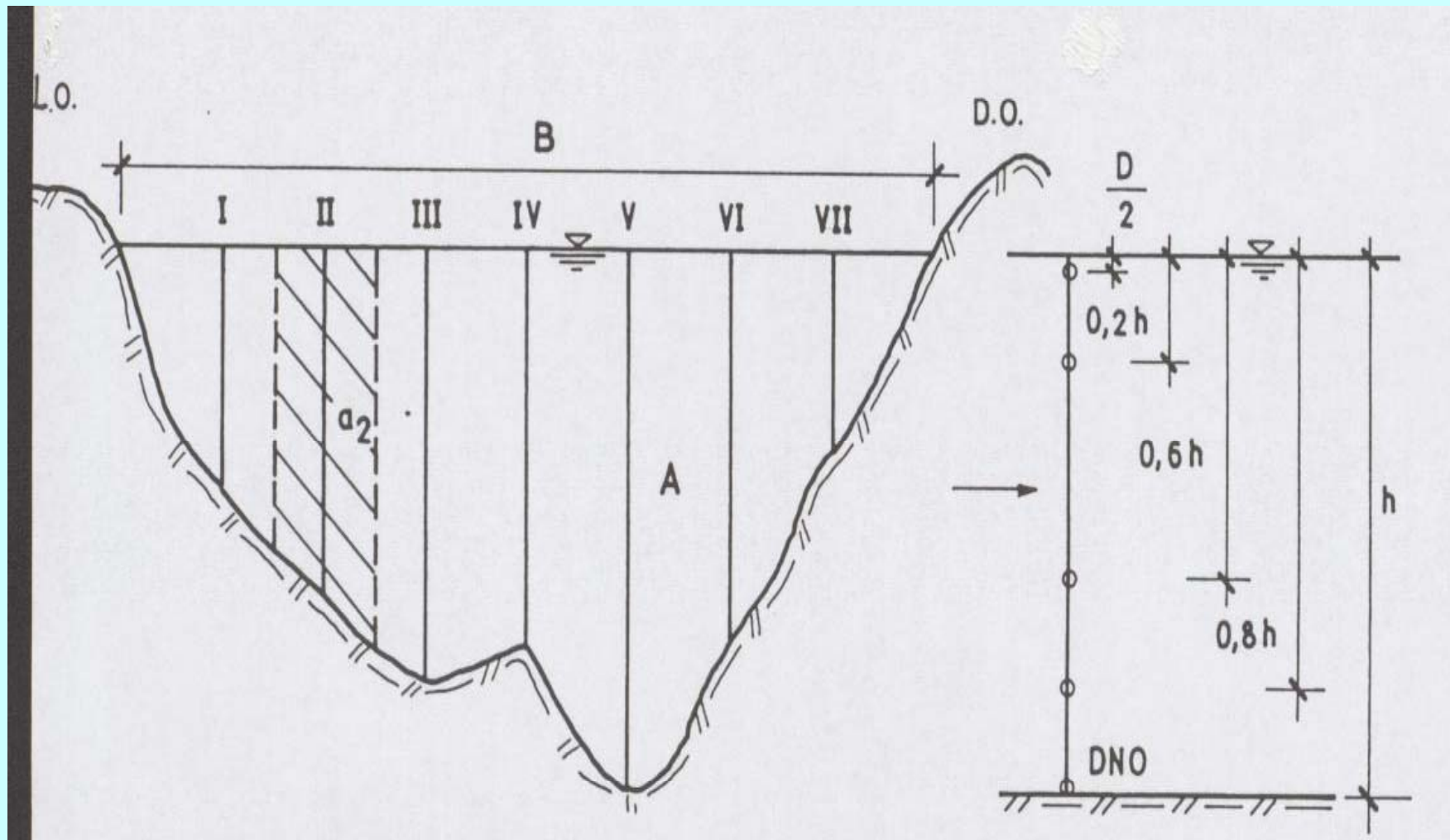
b)



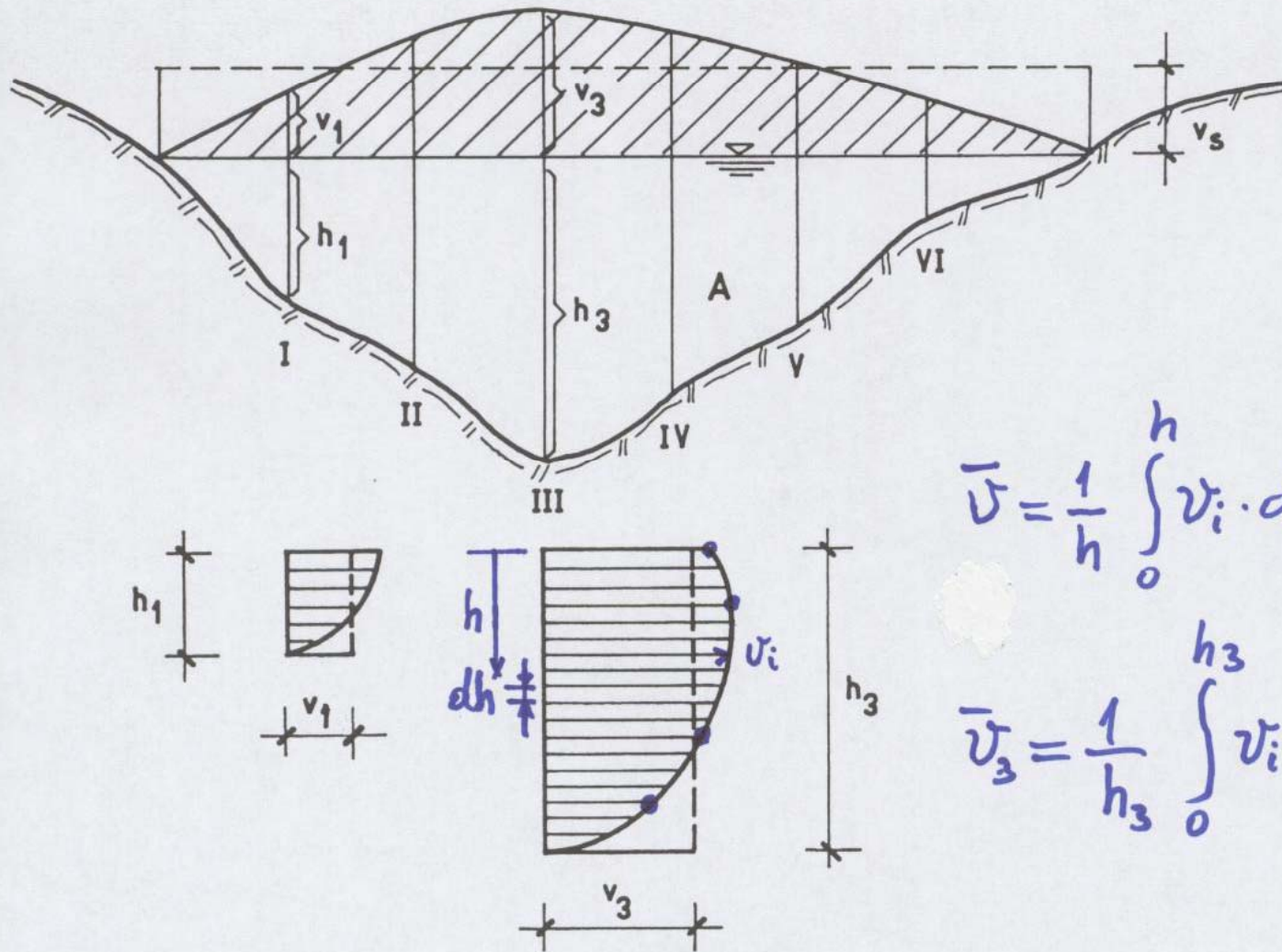
c)



Mjerenje brzina u vertikalama poprečnog presijeka



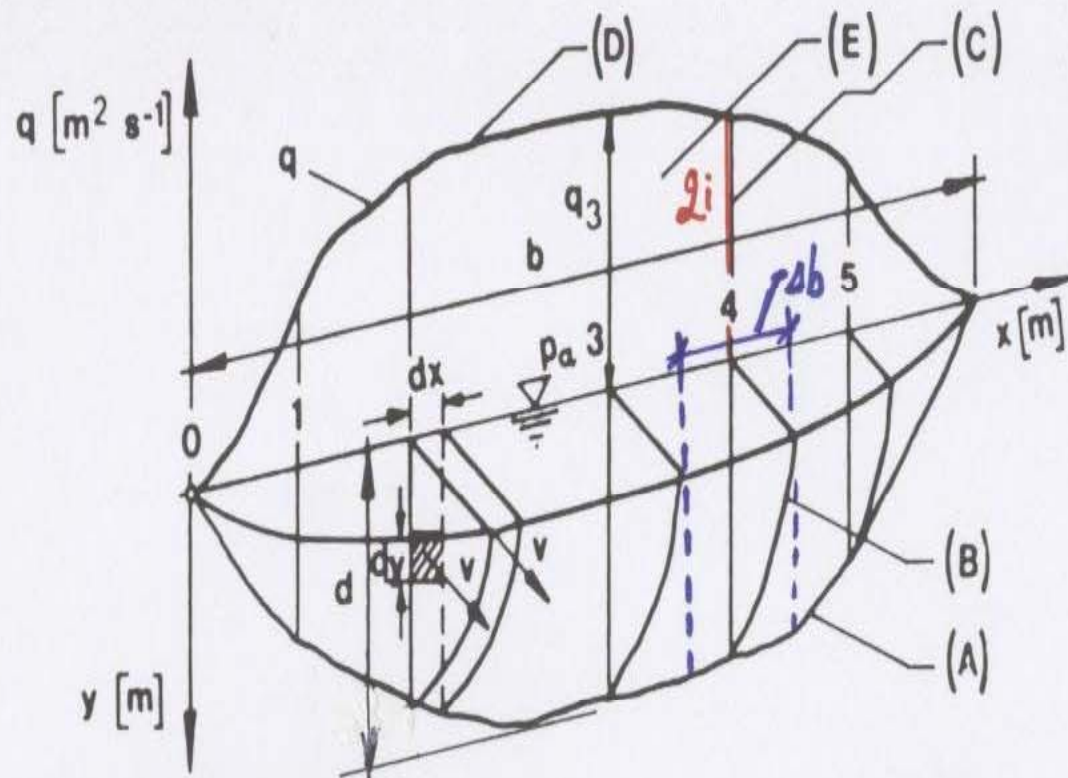
Određivanje srednje brzine toka za vertikalnu



$$\bar{v} = \frac{1}{h} \int_0^h v_i \cdot dh$$

$$\bar{v}_3 = \frac{1}{h_3} \int_0^{h_3} v_i \cdot dh$$

Proračun protoka za cijeli protočni presijek



$$Q = \int_0^b \int_0^d v \cdot dy \cdot dx$$

radi se:

$$q = \int_0^d v \cdot dy \quad [m^2/s]$$

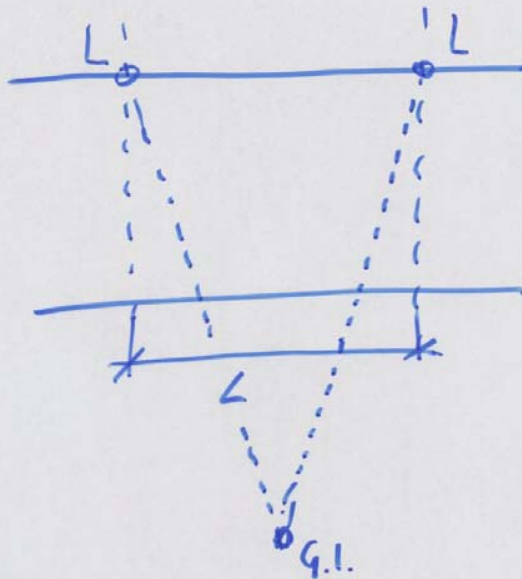
elementarni protok
(površina dijagrama
brzine po vertikalama)

$$Q = \int q \cdot dx$$

praktično:

$$Q = \sum_{i=1}^n l_i \cdot \Delta b$$

Određivanje brzine tečenja u vodotocima mjeranjem pada vodnog lica



$$v = C \sqrt{RJ} \quad (v = k R^{2/3} J^{1/2})$$

$$J_e \approx J_v = \frac{\Delta h_v}{L}$$



$$R = \frac{F}{O}$$

uvjet $F \approx const$

$$C = ?$$

Chezy: $v = C \cdot \sqrt{R \cdot I}$

v ... brzina u koritu

C ... koeficijent brzine

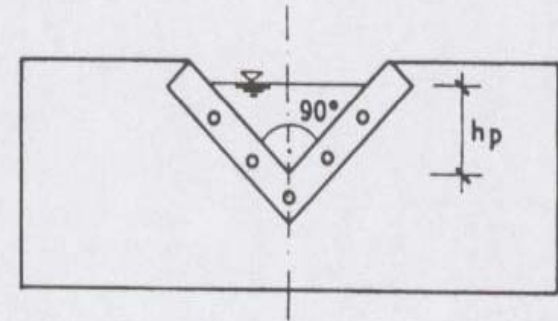
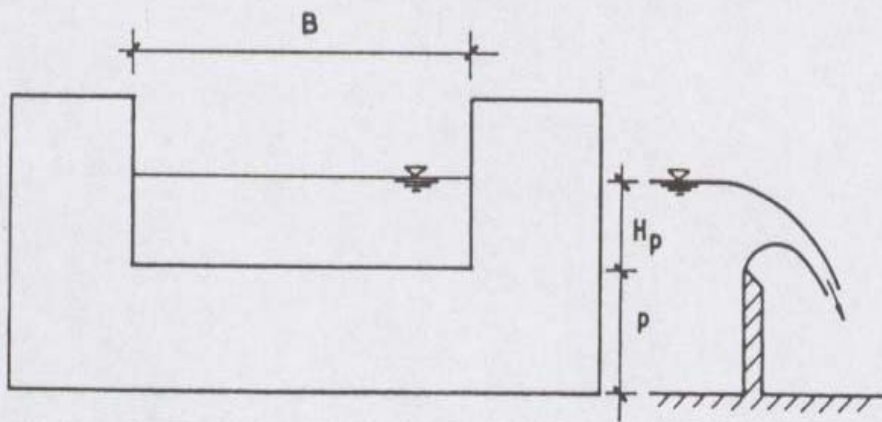
R ... Hidraulički radijus

I ... pad vodnog lica

Δh ... razlika nivoa
vodnog lica [m]

$$Q = F \cdot v$$

Mjerenje protoka pomoću preljeva



Bazinov preljev

$$Q = \frac{2}{3} C_b \cdot \sqrt{2g} \cdot B \cdot H_p^{\frac{3}{2}}$$

Thomsonov preljev

$$Q = \frac{8}{15} C_t \cdot \operatorname{tg} \frac{\alpha}{2} \sqrt{2g} \cdot h_p^{\frac{5}{2}}$$

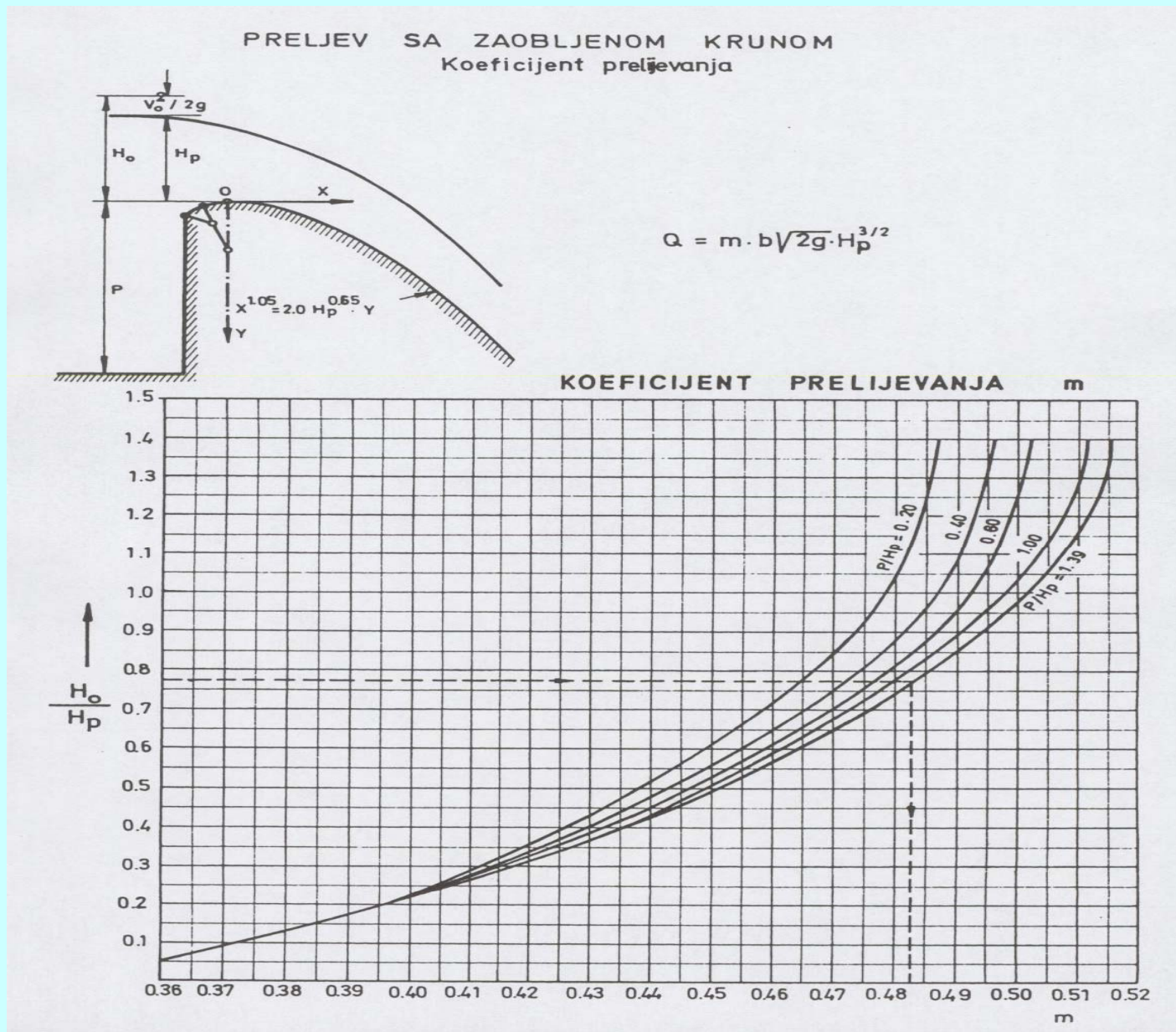
Thomsonov preljev



Kombinirani Thomson-Bazinov preljev i limnigraf



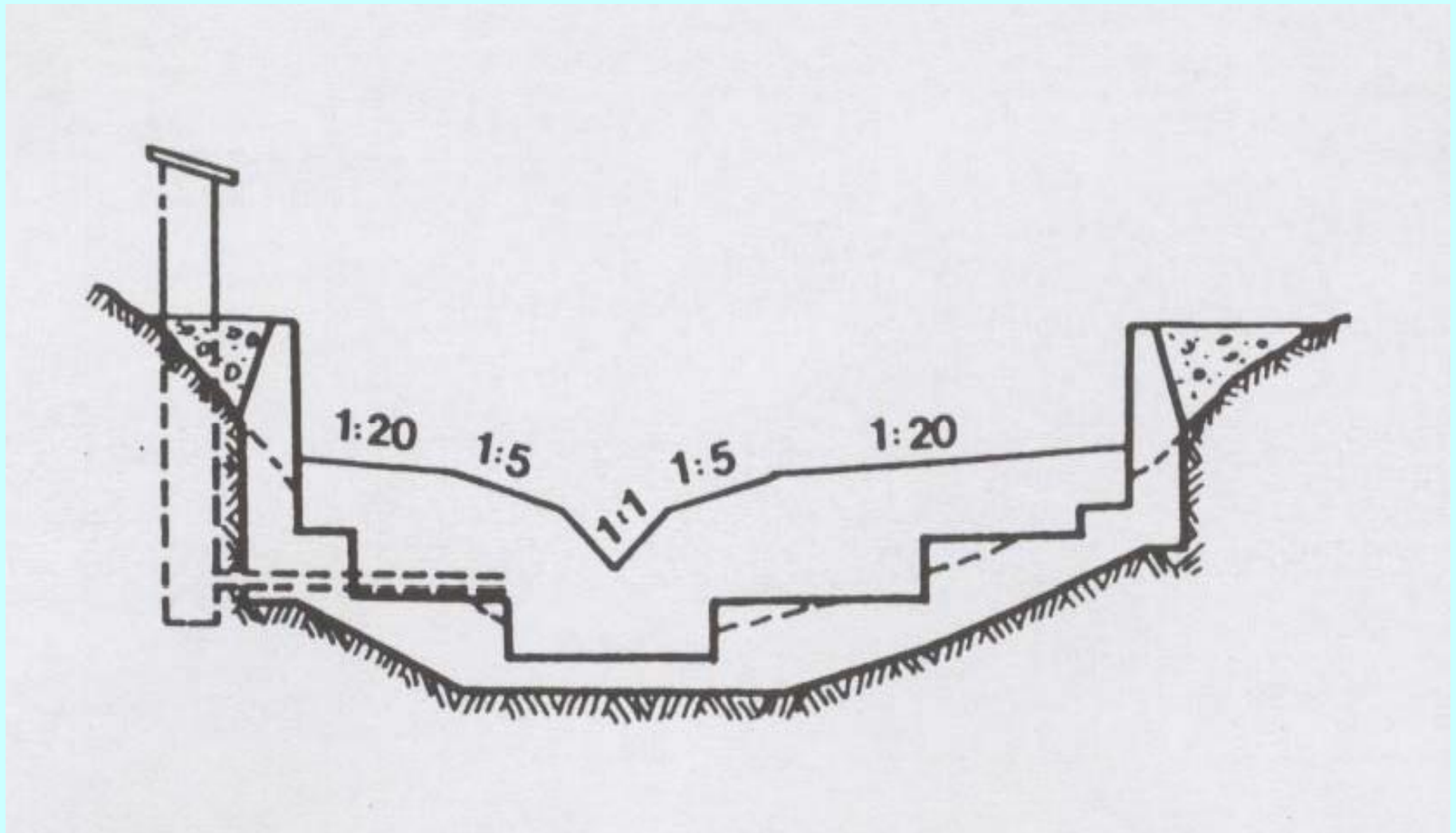
Preljev praktičnog profila



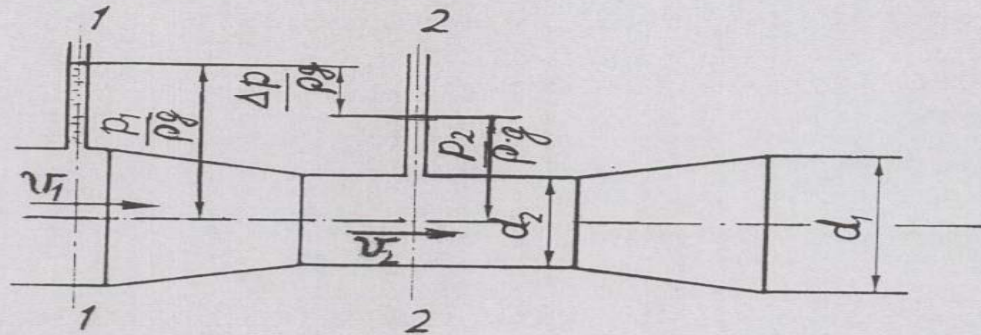
**Vodomjerna postaja za
kontinuirano mjerenje protoka**
(Station measuring discharge)



Mjerni preljev složenog presijeka na vodotoku



Venturijev vodomjer – tečenje u cijevima



Venturijev vodomjer

Bernoulijeva jednačina

$$h_1 + \frac{p_1}{\gamma g} + \frac{v_1^2}{2g} = h_2 + \frac{p_2}{\gamma g} + \frac{v_2^2}{2g}$$

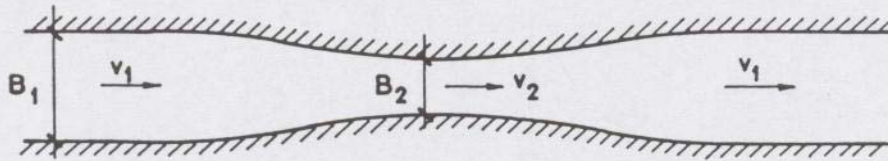
$$h_1 = h_2$$

$$\frac{p_1 - p_2}{\gamma g} = \frac{v_2^2 - v_1^2}{2g} \quad (1)$$

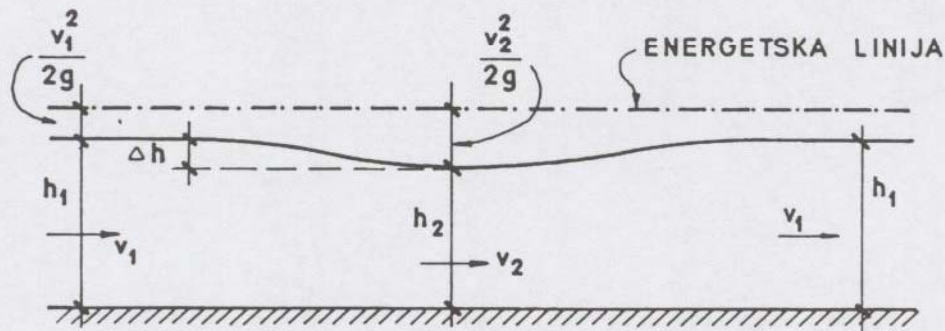
$$Q = \text{const} \quad v_1 \cdot \frac{d_1^2 \pi}{4} = v_2 \cdot \frac{d_2^2 \pi}{4} \quad (2)$$

nepoznanice : v_1 i v_2

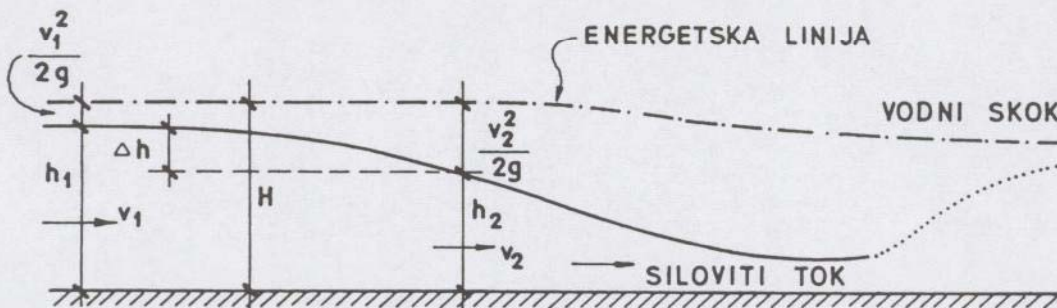
Venturijev kanal za mjerenje protoka



a) UZDUŽNI PRESJEK VENTURIJEVOGA KANALA



b) UZDUŽNI PRESJEK KANALA SA SILOVITIM TEČENJEM



1 Vrste mjernih kanala

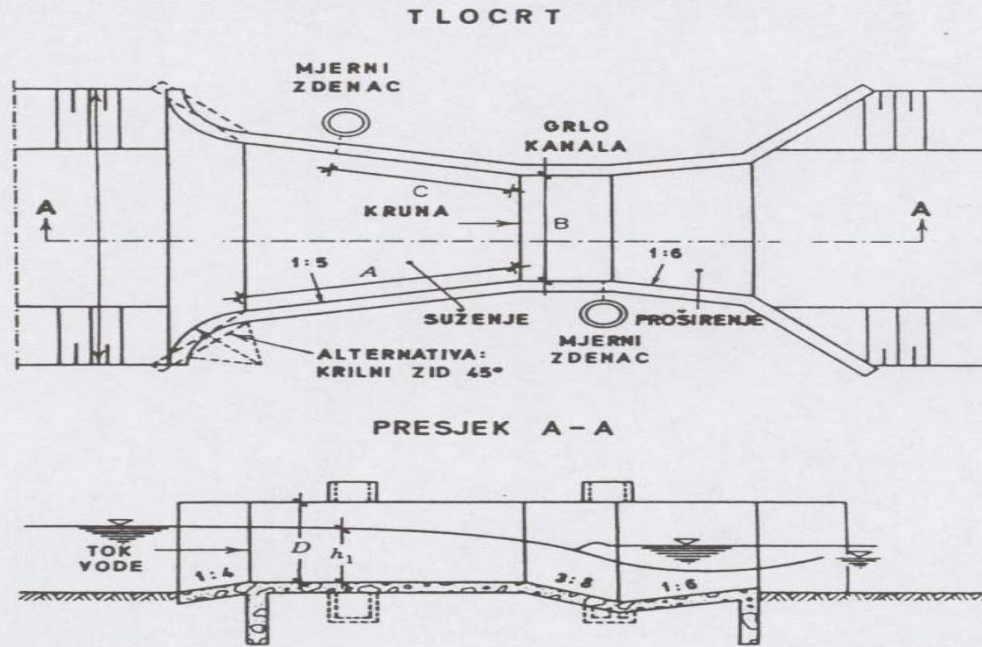
1) Bernoulli:

$$h_1 + v_1^2 / 2g = h_2 + v_2^2 / 2g$$

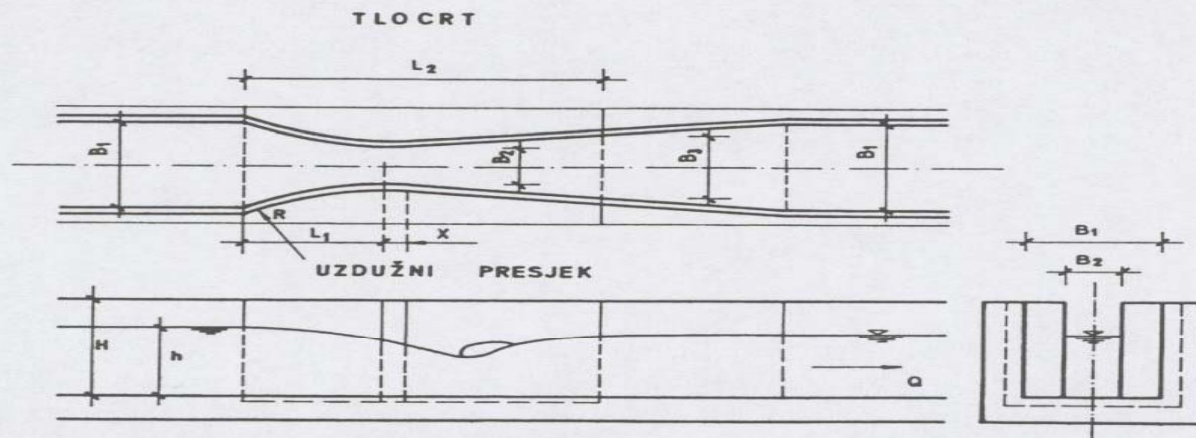
2) $Q = \text{const.}$

$$v_1 \cdot B_1 \cdot h_1 = v_2 \cdot B_2 \cdot h_2$$

Mjerenje protoka pomoću mjernih kanala



Parshallov mjerni kanal

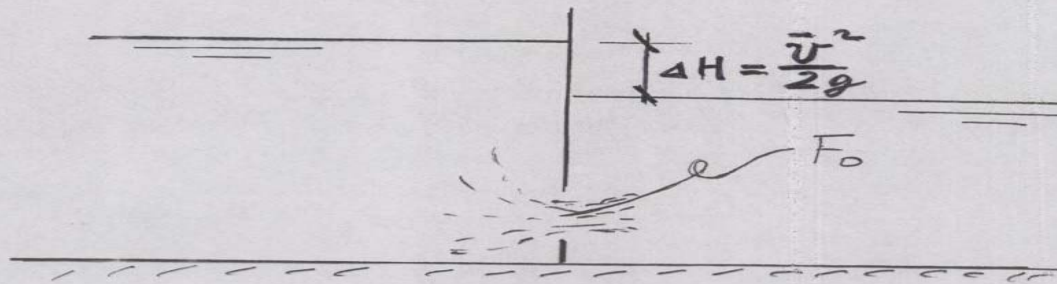


Khafagiventuri mjerni kanal (B. Terek, 1999.)

Kalibrirane ustave

za mjerenje protoka (kod navodnjavnja)

KALIBRIRANE USTAVE



$$\bar{v} = \sqrt{2g\Delta H}$$

$$v_{sr} = m \cdot \sqrt{2g\Delta H}$$

$$m = k_b \cdot k_c$$

k_b = koeficijent brzine
(zbog lokalnih gubitaka)

k_c = koeficijent kontrakcije mlaza

$$Q = F \cdot v_{sr}$$

