



«Gidravlika va gidroinformatika» kafedrası

Topshiriq № 3.1

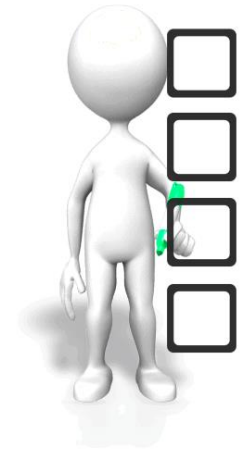
Gidravlik sakrash elementlarini hisoblansh va b'eflarni tutashtirish

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Amaliyot topshirig'idan asosiy maqsad:

Gidravlik sakrash turlari va gidravlik sakrash funksiyasi haqida umumiy tushunchaga ega bo'lish;

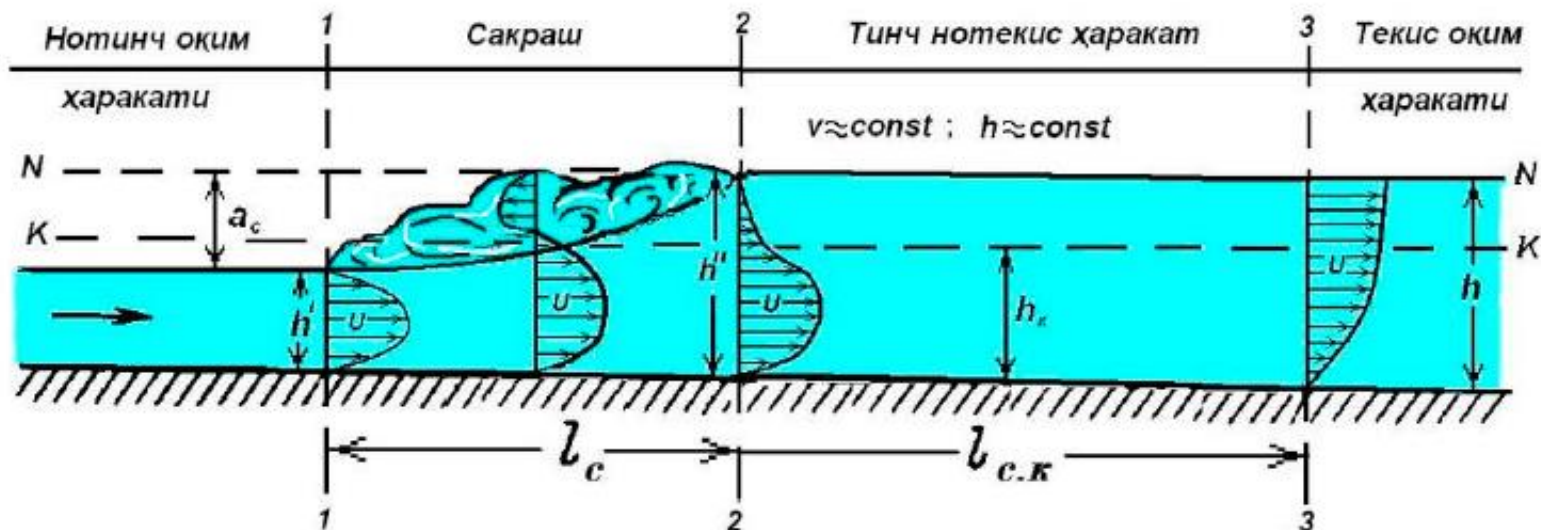
Sarf $Q=Q_{MK}$ bo'lganda, gidravlik sakrash elementlarini hisoblansh va inshoot b'eflarini tutashtirish hisobini bajarishdan iborat



Чугаев Р.Р., 1982. Гидравлика (техническая механика жидкости) с.324-333

Kirish

- Suv oqimining notinch holatdan tinch holatga o'tishi gidravlik sakrash orqali amalga oshadi.
- Suv oqimining kritik chuqurlikdan (h_{kp}) kichik bo'lgan h' chuqurligini undan katta bo'lgan h'' chuqurlikka keskin o'tishiga - **gidravlik sakrash** deyiladi.



- h' va h'' - gidravlik sakrashdan oldingi va keyingi oqim (tutashtirish) chuqurliklari (m);
 $a_c = h'' - h'$ - gidravlik sakrash balandligi (m);
 l_c - gidravlik sakrash uzunligi (m);
 l_{ck} - gidravlik sakrashdan keyingi uchastkaning uzunligi (m).

Gidravlik sakrash turlari

1. Mukammal gidravlik sakrash - aylana girdob harakat qismi bor bo'lgan sakrash:

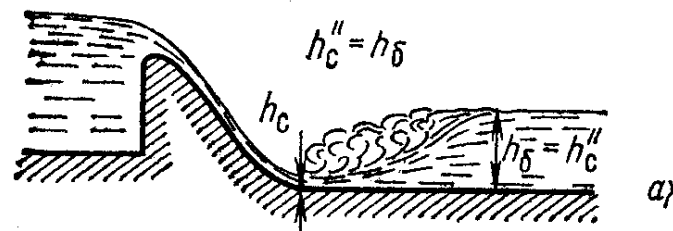
$$h'' / h' > 2; \quad a > h'$$

2. Nomukammal (to'liqinsimon), oqimning aylanma harakati yo'qligi bilan ajralib turadi:

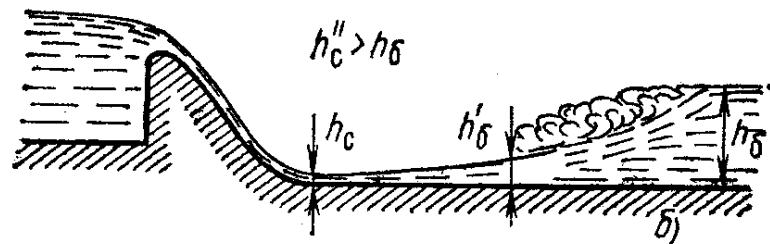
$$h'' / h' < 2; \quad a < h'$$

Gidrotexnik inshootga nisbatan - Gidravlik sakrash -

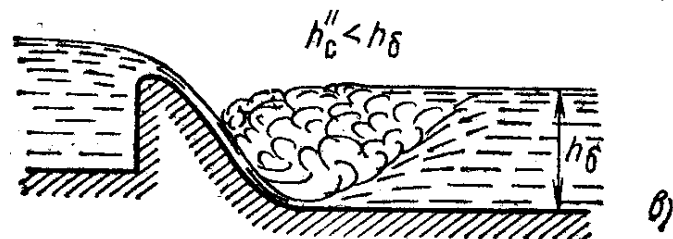
a). Boshlang'ich (siqilgan) holatda:



b) Uzoqlashgan (xaydalgan) xolatda:



c) Ko'milgan holatda:



BERILGAN:

$Q_{mk} =$	35	MK ning suv sarfi, m ³ /s
$g_o^{MK} =$	0.82	MK oqim tezligi, m/s (Topshiriq №3a, KMK boyicha), m/s
$C_B =$	1.1	Yuqori b'efdagi ostona balandligi, m
$P =$	10	MK dagi yuqori va pastki b'eflardagi ostona balandliklar farqi, m
$b_{st} =$	16	Kanal tubining kengligi (Topshiriq №3a, KMK boyicha), m
$m =$	1	Tezoqar-sharsharaning qiyalik koefficienti
$h_0^{MK} =$	2.21	MK normal chuqurligi (Topshiriq №3a, KMK boyicha), m

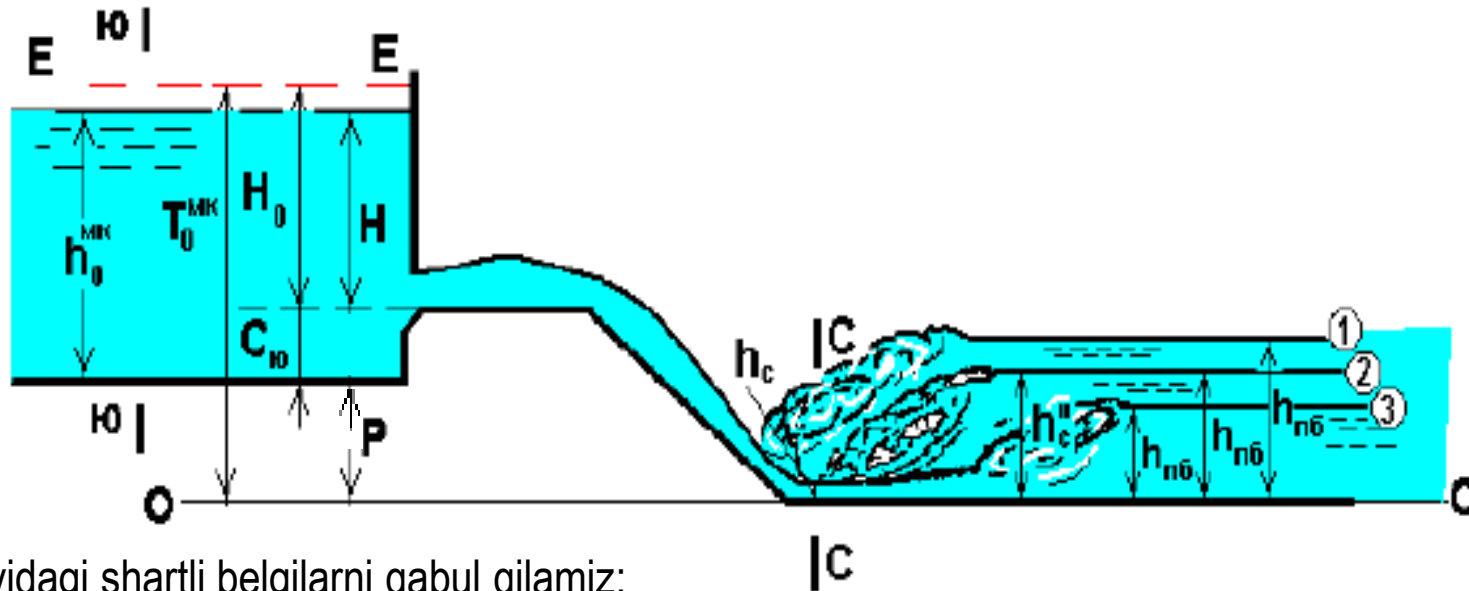
Talab qilinadi:

Sarf $Q=Q_{MK}$ bo'lganda:

1. Hidravlik sakrash elementlari hisoblansin va
2. B'eflarni tutashtirish shakli aniqlansin.

ECHILISHI:

1. Sxema masshtabda chiziladi va kesimlar (Ю-Ю va C-C) va taqqoslash tekisligini (O-O) belgilaymiz



Quyidagi shartli belgilarni qabul qilamiz:

- h_0^{MK} - MK normal chuqurligi, m;
- T_0^{MK} - taqqoslash tekisligiga (O-O) nisbatan hisoblaganda Ю-Ю kesimdagi to'la solishtirma energiya, m;
- H_0, H - darvoza oldidagi chuqurlik (to'la va geometrik naporlar), m;
- P - yuqori va pastki b'eflardagi ostona balandliklar farqi, m;
- $C_{Ю}$ - yuqori b'efdagi ostona balandligi, m
- h_{n6} - pastki b'efdagi oqim chuqurligi, m;
- h_c - siqilgan kesimdagi suv oqimining chuqurligi, m;
- h_c'' - gidravlik sakrashdan keyingi oqim chuqurligi, m.

2. Bernulli tenglamasini pastki b'efdagi kanal tubidan o'tkazilgan taqqoslash tekisligiga (O-O) nisbatan yozamiz:

$$Z_{\text{ю}} + \frac{P_{\text{ю}}}{\gamma} + \frac{\alpha v_{\text{ю}}^2}{2g} = Z_{\text{с}} + \frac{P_{\text{с}}}{\gamma} + \frac{\alpha v_{\text{с}}^2}{2g} + h_{f(\text{ю-с})} \quad [1]$$

Bu yerda, $Z_{\text{ю}} = P + h_0^{\text{MK}}$ $P_{\text{ю}} = P_{\text{с}} = P_{\text{ат}}$ $\gamma = \rho g$ $v_{\text{ю}} = v_{\text{MK}}$

$Z_{\text{с}} = h_{\text{с}}$ $v_{\text{с}}$ – C-C kesimdagi oqim tezligi, m/s

$h_{f(\text{ю-с})} = \xi v_{\text{с}}^2 / 2g$ - ю-ю va C-C kesimlar orasida yo'qolgan napor, m.

[1] Tenglikni quyidagicha yozamiz: $P + h_0^{\text{MK}} + \frac{\alpha v_{\text{MK}}^2}{2g} = h_{\text{с}} + \frac{\alpha v_{\text{с}}^2}{2g} + \xi \frac{v_{\text{с}}^2}{2g} \quad [2]$

Bu yerda, **$T_{\text{ю}} = P + h_0^{\text{mk}} + \alpha v_{\text{MK}}^2 / 2g$** - ю-ю kesimdagi toliq bosim, m (Tenglamaning o'ng qismi)

$T_{\text{с}} = h_{\text{с}} + \alpha v_{\text{с}}^2 / 2g + \xi v_{\text{с}}^2 / 2g$ - C-C kesimdagi toliq bosim, m (Tenglamaning chap qismi)

Agar $\alpha + \xi = 1 / \varphi^2$ belgilasak ($\varphi = 0.85 \div 0.95$), unda **$T_{\text{с}} = h_{\text{с}} + v_{\text{с}}^2 / 2g \varphi^2$**

3. Yuqori b'efdagi to'la solishtirma energiyaning qiymati ma'lum $T_{\text{Ю}} = P + h_0^{\text{mk}} + \alpha \vartheta_{\text{MK}}^2 / 2g = 12.24 \text{ m}$

Siqilgan kesimdagi suv chuqurligini (h_c) tanlash usulida, yani h_c -ga bir necha qiymatlarni berib, $T_c = h_c + \vartheta_c^2 / 2g\varphi^2$ tenglamani hisoblaymiz. Hisoblash natijalarni jadvalda keltiramiz (**1-jadval**)

1-jadval: B'eflardagi to'la solishtirma energiya hisobi

h_c [m]	ω_c [m ²]	ϑ_c [m/s]	$\vartheta_c^2 / \varphi_c^2 2g$ [m]	T_c [m]	$T_{\text{Ю}}$ [m]
0.10	1.61	21.74	29.74	29.84	12.24
0.12	1.93	18.09	20.60	20.72	
0.14	2.26	15.49	15.10	15.24	
0.16	2.52	13.89	12.13	12.29	
0.18	2.91	12.02	9.09	9.27	
0.20	3.24	10.80	7.34	7.54	
0.22	3.57	9.81	6.05	6.27	
0.24	3.90	8.98	5.07	5.31	
0.26	4.23	8.28	4.31	4.57	
0.28	4.56	7.68	3.71	3.99	
0.30	4.89	7.16	3.22	3.52	

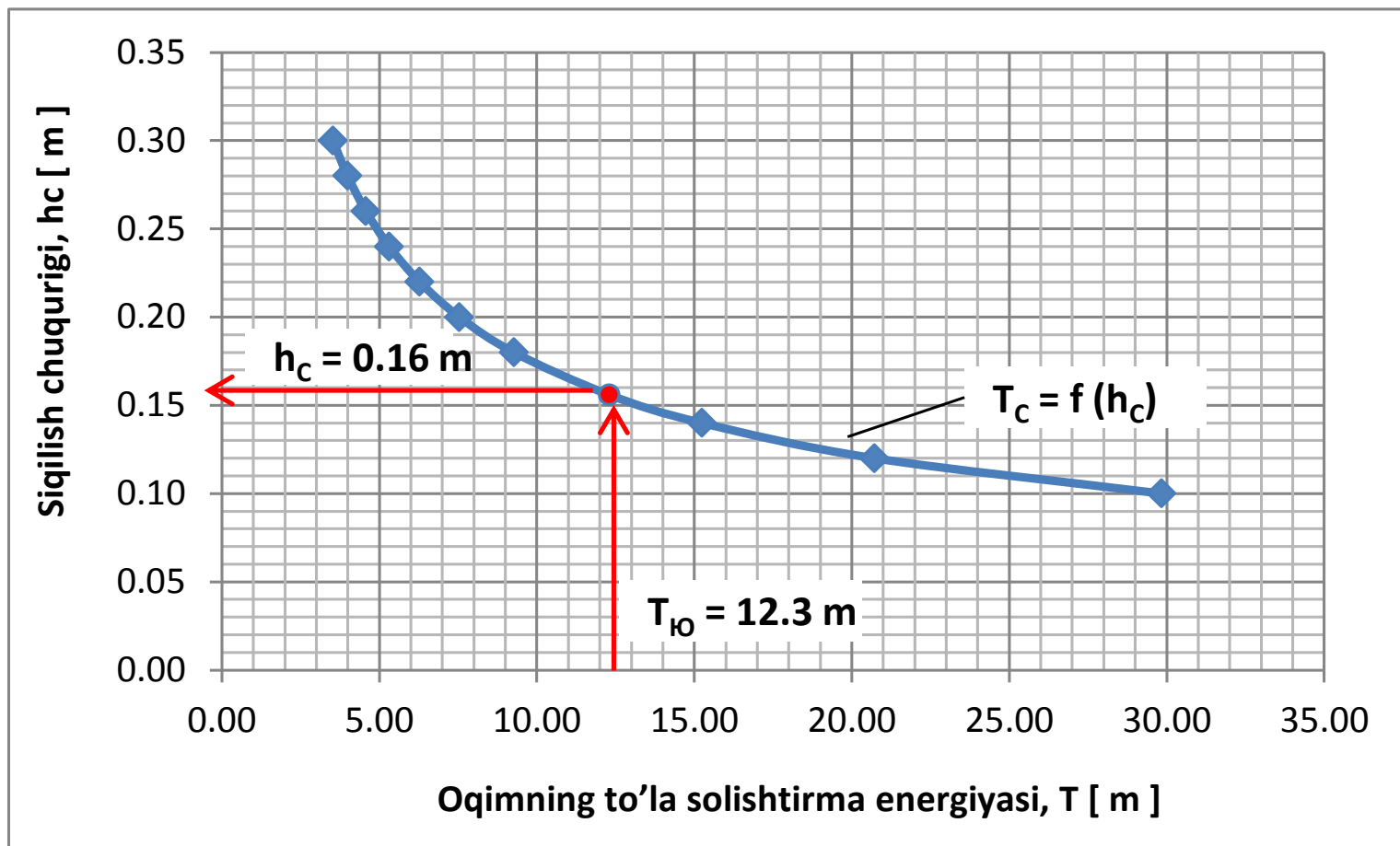
Hisoblash formulalari: $\omega_c = (b + h_c m) h_c$;

$\vartheta_c = Q_{\text{mk}} / \omega_c$

$\varphi = 0.9$ – tezlik koefficienti;

$m = 1$ tezoqar-sharsharaning qiyalik koefficienti

1-jadvaldagi h_c va T_c qiymatlari asosida $T_c = f(h_c)$ grafigini quramiz (1-rasm).



1-rasm: Kesimning to'la solishtirma energiya grafigi ($T_c = f(h_c)$)

1-rasmdan ma'lum bo'lgan yuqori b'efdagi to'la solishtirma energiyaning qiymati $T_{10} = 12.3$ m ga to'g'ri keladigan siqilish chuqurligi $h_c = 0.16$ m - ning qiymatini olamiz.

4. Sakrashning ikkinchi tutashtirish chuqurligini 2 hil usulda aniqlash.

A. Siqilgan kesimdagi suv chuqurligini birinchi tutashtirish chuqurligi ($h_c = h'$) deb qabul qilib, 2-chi tutashtirish chuqurligini (h'') sakrash funksiyasi grafigi ($\Pi(h) = f(h)$) orqali aniqlaymiz:

$$\Pi(h) = \frac{\alpha Q^2}{g\omega} + h_{ozup}\omega \quad [3]$$

bu erda: $h_{ozup} = \frac{h(B + 2b)}{3(B + b)}$ - kesim og'irlik markazining chuqurligi, m

$B = b + 2mh$ - kesimning suv sathidagi kengligi, m;

$b = b_{CT} = 16$ m - kanal tubining standard kengligi, m;

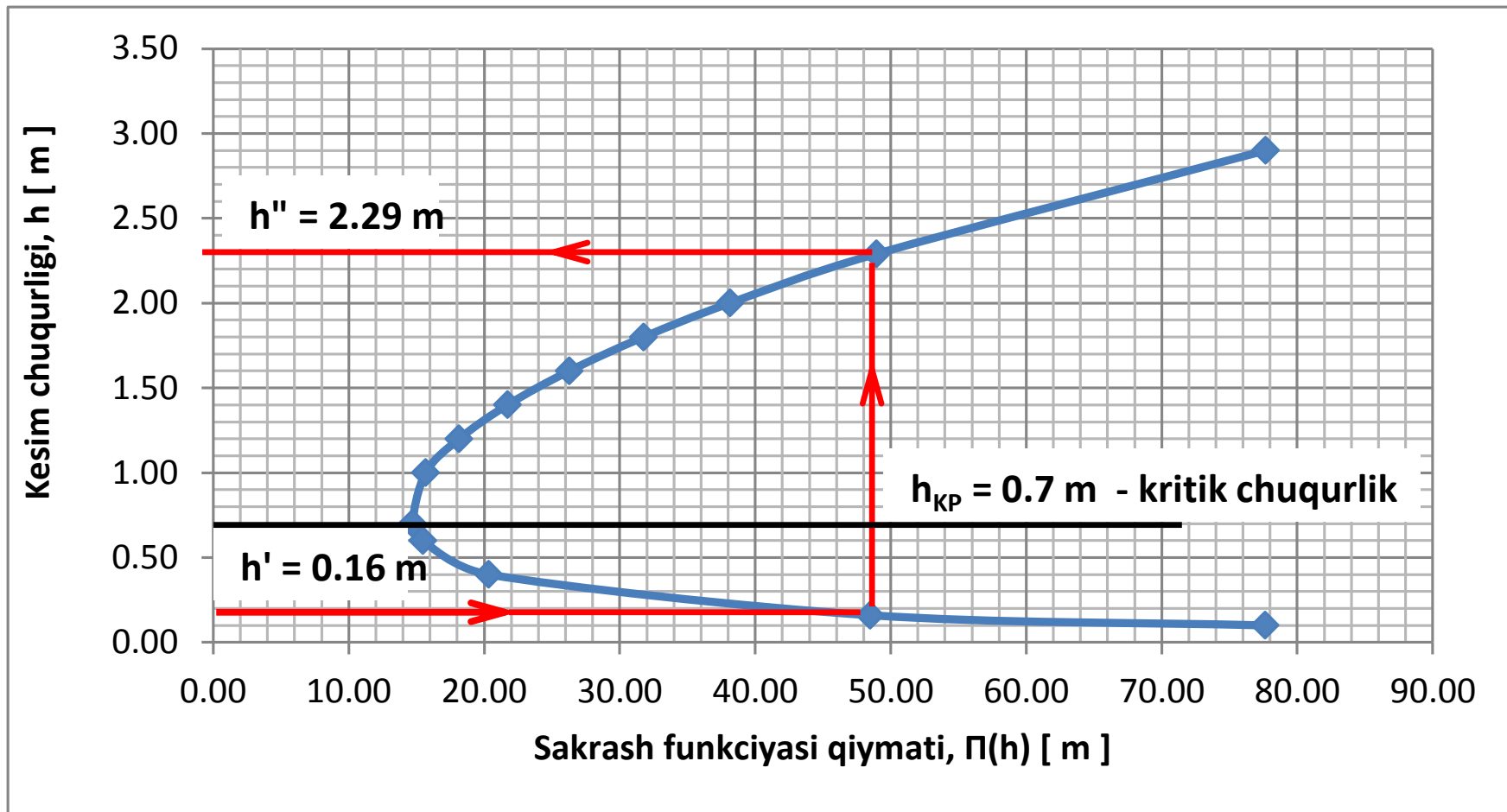
$m = 1$ - tezoqar-sharsharaning qiyalik koefficienti.

Suv chuqurligiga (h) bir necha qiymatlar berib, $\Pi(h)$ -ni aniqlaymiz. Hisoblash natijalarini jadvalda keltiramiz (**2-jadval**).

2-jadval: Sakrash funksiyasi grafigi $\Pi(h)$ - ni aniqlash hisobi

h [m]	B [m]	ω [m ²]	$\alpha \cdot Q_{mk}^2/g\omega$ [m ³]	$h_{O.M.}$ [m]	$h_{O.M.} \cdot \omega$ [m ³]	$\Pi(h)$ [m ³]
0.10	16.20	1.61	77.56	0.05	0.08	77.64
0.16	16.32	2.59	48.30	0.08	0.21	48.50
0.40	16.80	6.56	19.04	0.20	1.30	20.34
0.60	17.20	9.96	12.54	0.30	2.95	15.49
0.70	17.40	11.69	10.68	0.35	4.03	14.72
1.00	18.00	17.00	7.35	0.49	8.33	15.68
1.20	18.40	20.64	6.05	0.59	12.10	18.15
1.40	18.80	24.36	5.13	0.68	16.59	21.72
1.60	19.20	28.16	4.43	0.78	21.85	26.28
1.80	19.60	32.04	3.90	0.87	27.86	31.76
2.00	20.00	36.00	3.47	0.96	34.67	38.14
2.29	20.58	41.88	2.98	1.10	45.96	48.94
2.90	21.80	54.81	2.28	1.38	75.41	77.69

2-jadvaldagi h va $\Pi(h)$ qiymatlari asosida $\Pi(h) = f(h)$ grafigini quramiz (2-rasm).



2-rasm: Gidravlik sakrash funktsiyasi $\Pi(h) = f(h)$ grafigi

2-rasmdan ma'lum bo'lgan birinchi tutashtirish chuqurligi $h' = 0.16$ m - ning qiymati orqali $\Pi(h) = f(h)$ grafikdan ikkinchi tutashtirish chuqurligini $h'' = 2.29$ m - ning qiymatini olamiz.

B. 2-chi tutashtirish chuqurligini (h'') A.N.Raxmanovning empirik formulalari yordamida aniqlash:

$$\zeta' = \frac{1,2}{\zeta''} - 0,2; \quad \zeta'' = \frac{1}{0,167 + 0,834\zeta'}$$

bu erda ζ' va ζ'' - nisbiy chuqurliklar:

$$\zeta' = \frac{h'_c}{h_{\text{KP}}}; \quad \zeta'' = \frac{h''_c}{h_{\text{KP}}}.$$

$h' = 0.16 \text{ m}$
 $h_{\text{KP}} = 0.7 \text{ m}$ } **2-rasmdagi ma'lumotlar asosida**

$$\xi' = h' / h_{\text{KP}} = 0.22$$

$$\xi'' = 1 / 0.167 + 0.834 \xi' = 2.83$$

$$\xi'' = h'' / h_{\text{KP}}$$



$$h'' = \xi'' h_{\text{KP}} = 1.98 \text{ m}$$

5. Hidravlik sakrashning uzunligi (l_c) ni aniqlash

Trapesiya shakldagi kanallar uchun:

$$l_c = 5h'' \left(1 + 4 \sqrt{\frac{B_2 - B_1}{B_1}} \right) = 12.1 \text{ m}$$

bu erda: B_1 va B_2 - sakrashdan oldingi ($h'=0.16 \text{ m}$) va keyingi ($h'' = 2.29 \text{ m}$) kesimdagi sathdagi kengliklari, m:

$$\begin{aligned} B &= b_{CT} + 2mh \\ b_{CT} &= 16 \text{ m}; \quad m = 1 \end{aligned}$$

6. M.D.Chertousov formulasi bilan sakrashdan keyingi uzunlik ($l_{c.k.}$) ni aniqlash

$$l_{c.k.} = (13 \div 15.6) h_n = 14 * 2.55 = 33.6 \text{ m}$$

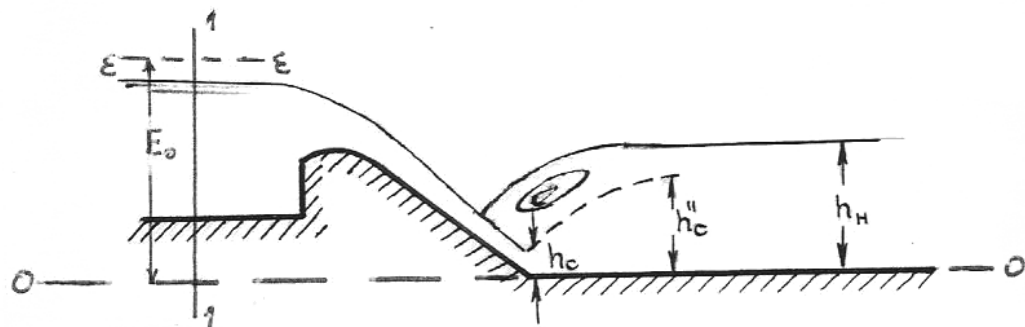
bu erda: $h_n = 2,47 \text{ m}$ –pastki b'efdagi suv chuqurligi, m (3-rasmdan olinadi).

7. Hidravlik sakrash balandligi (a) ni aniqlash: $a = h'' - h' = 2.29 - 0.16 = 2.13 \text{ m}$

8. Hidravlik sakrashning holatini aniqlash

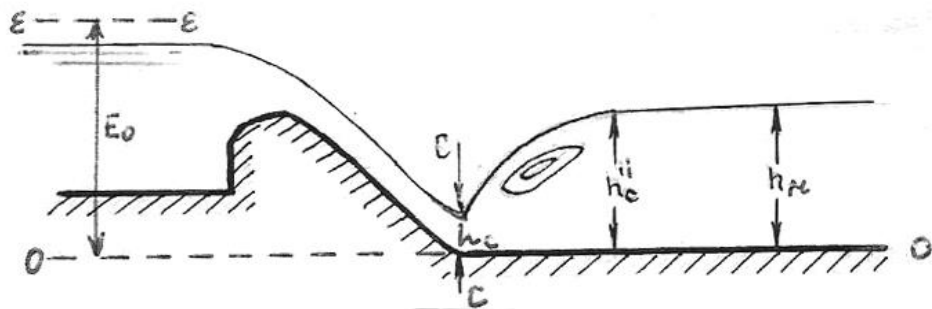
A) $h'' = 2.29 \text{ m} < h_n = 2.47 \text{ m}$

- gidravlik sakrash
ko'milgan kesimda



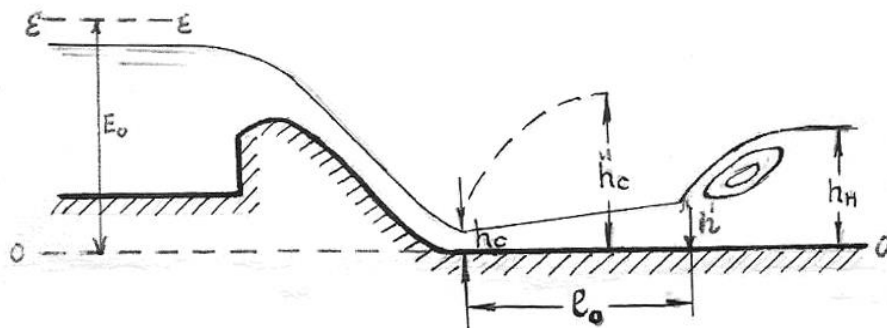
B) $h'' = h_n$

- gidravlik sakrash
boshlang'ich (siqilgan) kesimda



C) $h'' > h_n$

- gidravlik sakrash
uzoqlashgan (haydalgan) kesimda



9. Hidravlik sakrash turini aniqlash

Mukammal, aylana girdob harakat qismi bor bo'lgan sakrash:

$$\frac{h''}{h'} > 2; \quad a > h'$$

$$h''/h' = 14.7 > 2 \quad a = 2.13 \text{ m} > h' = 0.16 \text{ m}$$

Nomukammal (to'lqinsimon), oqimning aylanma harakati yo'q sakrash:

$$\frac{h''}{h'} < 2; \quad a < h'$$

10. MK ning gidravlik hisobi

$$Q_{MK} = 35 \text{ m}^3/\text{s}$$

$$n = 0.0225$$

$$b = 16 \text{ m}$$

$$i = 0.000107$$

$$m = 1.5$$

3a topshiriq javobi boyicha

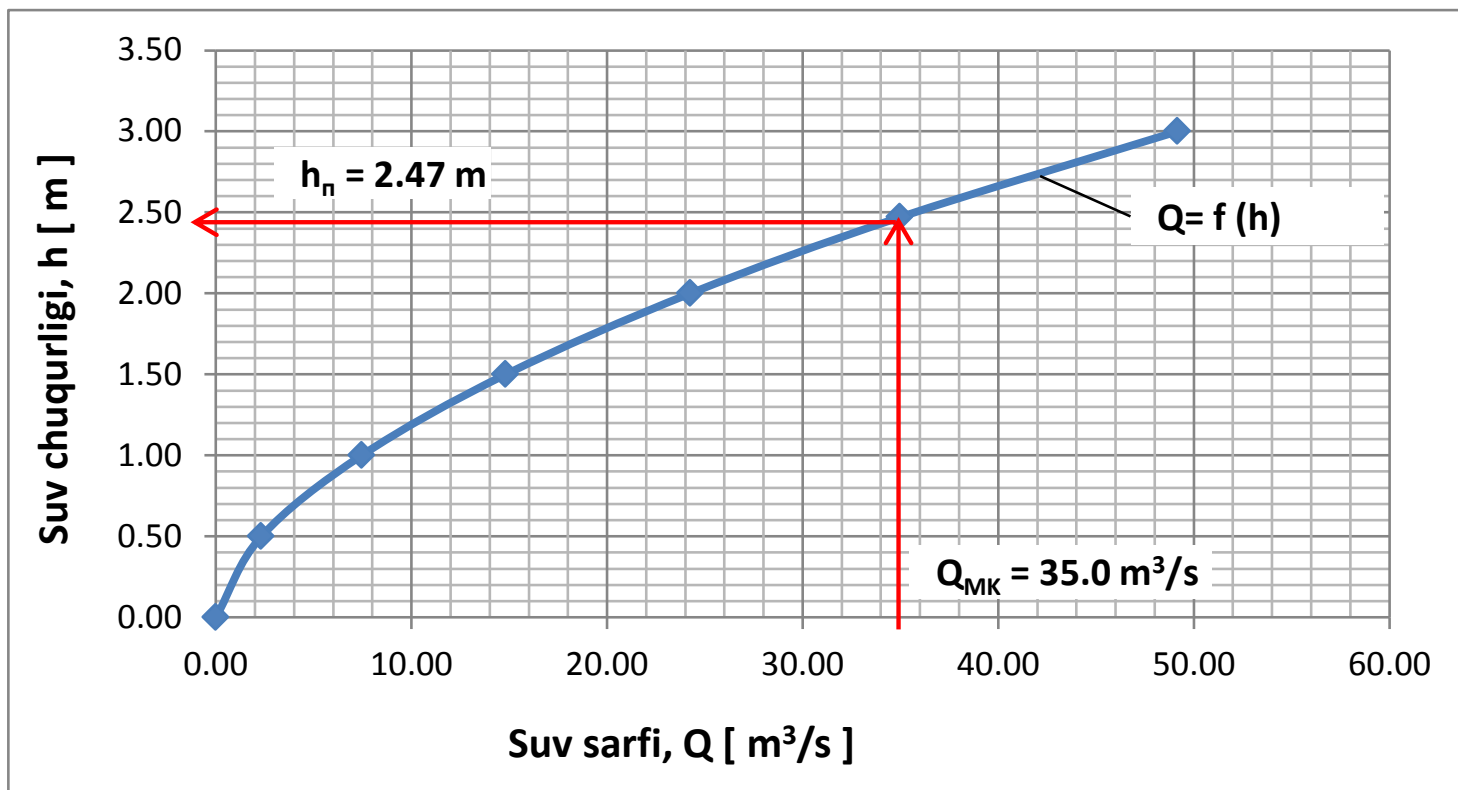
$$Q = \omega \cdot C \cdot \sqrt{R} \cdot i$$

$$\omega = (b + mh)h$$

$$\chi = b + 2h\sqrt{m^2 + 1}$$

$$R = \omega / \chi$$

$$C = 1/n \cdot R^{1/6}$$



3-rasm: MK ning ishchi grafigi $Q = f(h)$ - tekis harakatning asosiy tenglamasi bo'yicha

JAVOB:

Gidravlik sakrashdan oldingi tutash chuqurligi -	$h' = 0.16 \text{ m}$
Gidravlik sakrashdan keyingi tutash chuqurligi -	$h'' = 2.29 \text{ m}$
Gidravlik sakrash balandligi -	$a = h'' - h' = 2.13 \text{ m}$
Gidravlik sakrash uzunligi -	$l_{C.} = 12.1 \text{ m}$
Gidravlik sakrashdan keyingi uchastka uzunligi -	$l_{C.K.} = 33.6 \text{ m}$
Gidravlik sakrashning holati - gidravlik sakrash ko'milgan kesimda	$hc'' = 2.29 \text{ m} < h_{\pi} = 2.47 \text{ m}$
Gidravlik sakrash turi - mukammal, y'ani aylana girdob harakat qismi bor bo'lgan sakrash	$h'' / h' = 14.7 > 2$
	$a = 2.13 \text{ m} > h' = 0.16 \text{ m}$